

1.3.2 Average percentage of courses that include experiential learning through project work/field work/internship as prescribed by the affiliating university / affiliating university curriculum For Year 2019-20

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First Year Engineering:

Sr. No.	Subject Code	Subject Name	Count
1	FEL101	Engineering Physics-I	1
2	FEL102	Engineering Chemistry-I	1
3	FEL104	Basic Electrical Engineering	1
4	FEL105	Basic Workshop practice-I	1
5	FEL201	Engineering Physics-I	1
6	FEL202	Engineering Chemistry-II	1
7	FEL203	Engineering Graphics	1
8	FEL204	C programming	1
9	FEL205	Professional Communication and Ethics- I	1
10	FEL206	Basic Workshop practice-II	1
		Total	10

UNIVERSITY OF MUMBAI



Bachelor of Engineering

First Year Engineering (Semester I & II), Revised course
(REV- 2019 'C' Scheme) from Academic Year 2019 – 20
(Common for All Branches of Engineering)

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year
2019–2020)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that in the present system, the first year syllabus is heavily loaded and it is of utmost importance that the students entering into the first year of an engineering course should feel at ease by lowering the burden of syllabus and credits. This is necessary for a student to get accustomed to the new environment of a college and to create a bonding between the teacher and a student. In this regard, AICTE has provided a model of Induction Program, which has been accommodated with certain modification and also overall credits proposed by AICTE in their model curriculum.

The present curriculum will be implemented for First Year of Engineering from the academic year 2019-20. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2020-21, for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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Structure for

Student Induction Program

New students enter an institution with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose.

The Induction Program is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing competition and making them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and building of character.

Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

Transition from school to university/college life is one of the most challenging events in student's life. Therefore, it should be taken seriously, and as something more than the mere orientation program.

The time during the Induction Program is also used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it.

New students be informed that the Induction is mandatory non-credit course for which a certificate will be issued by the institution.

At the start of the induction, the incumbents learn about the institutional policies, processes, practices, culture and values, and their mentor groups are formed. The different activities are:

1. **Orientation:** In the first session of Induction program learners and parents to be oriented about institute policies, processes, practices, culture and values. In addition to this, learners will be educated for 1st year academic program information in terms of academic calendar, Assessment plan, grading information, university ordinances, rules and regulations related to academics.
2. **Mentoring:** Mentoring and connecting the students with faculty members is the most important part of student induction. Mentoring process shall be carried out in small groups, group of 10 students to be formed and allocate one senior student from 3rd year of same program in which new students have taken admission, students mentor will continue for two years, till student mentors graduate from the institute. For two (2) such groups one faculty mentor to be allocated from the same department/program, who will remain the mentor till those students graduates from the institute. In the second session of Induction program, groups for mentoring to be formed and student mentors and faculty mentors to be introduced to newly inducted students. Introduction of mentoring system to be given to new students. Minimum one meeting to be conducted every month during semesters with students group by faculty mentors. For record keeping appropriate formats to be developed and information to be updated regularly by faculty mentors.

3. **Universal Human Values:** Universal Human Values gets the student to explore oneself and experience the joy of learning, prepares one to stand up to peer pressure and take decisions with courage, be aware of relationships and be sensitive to others, understand the role of money in life and experience the feeling of prosperity. Need for character building has been underlined by many thinkers, universal human values provide the base. Methodology of teaching this content is extremely important. It must not be through do's and don't's, but by getting the students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, and realizing values.
4. **Proficiency Modules:** The induction program period can be used to overcome some critical lacunas that students might have, for example, English, Mathematics, computer familiarity etc. These should run like crash courses, so that when normal courses start after the induction program, the student has overcome the lacunas substantially.

A diagnostic test should be conducted on Day 2 itself. Before the test, the students should be informed that the test would not affect their grades, branch change, or any aspect of their admission, placement, study, etc. Purpose of the test is to provide help to those students who need help in English, Mathematics, Computer proficiency etc. Students having more than 80% marks in their qualifying examination in respective subjects need not take the diagnostic test. For those below this cut-off, writing the test is mandatory. Students with weak performance in the test, must attend a non-credit course in Basic English, Basic Mathematics, and Basic Computer Operation etc. Their attending the course is mandatory. There would be no separate fee payable for the course. The classes of Basic courses must start from Day 4 at the latest. Students those who are excluded from basic courses, for them some activity in the domain of creative arts, cultural and literature to be organised.

5. **Physical Activity:** Fitness session, yoga classes, lecture(s) on facing world with sportsman spirit, making young students aware that there is nothing like being failure in the world. The world gives opportunities to all.

The incoming students must be divided into batches of 50 students maximum, and a qualified coach in physical education/ faculty member should be attached to each batch. The list of available games, sport, or physical activities should be announced in orientation program on Day 1. They should be asked to fill their choice with three preferences, and the game or sport be allotted to them as per their preference. The physical activity should start from Day 3 onwards, wherein the student learns and plays his assigned game during the induction program. It is also important that along with his assigned game the student also practises yoga.

6. **Creative Arts, Cultural and Literary Activity:** Qualified instructors for arts may be hired on contract basis and be paid honorarium as per norms of the institute. Daily 90 to 120 minute sessions may be arranged. The list of available art forms, such as vocal music, instrumental music, folk music, painting,

sketching, dance, group dance, clay modelling, pottery, dramatics, etc. should be announced. They should be asked to fill their choice with three preferences, and the art form be allotted to them as per their preference. There should be sufficient number of teachers for each art form. The ratio may be kept as 1 teacher for every 25 students.

A faculty member interested in literary activity should be assigned for organizing the activity. A list of books which are interesting and educational should be prepared beforehand. Books in Indian languages must be included and even given priority. Students are losing connection with languages in general and their own language, in particular. Students should be assigned a book or other smaller reading material. They should be asked to read and write a critical summary. They should present their summary in front of their group. A literary group may consist of around 30-40 students. Similarly, debating and public speaking activity could also be undertaken. If the college can arrange for a drama workshop where a group of students learn and enact a play it would be very good. Not all the incoming students would do this, but those who wish may be provided the opportunity. Help may be taken from senior students engaged in such extra-curricular activities in the college.

7. **Familiarisation with Institute and Department:** The students admitted in a branch would visit their allotted department or branch. The Head of the department and other associated faculty should address the new student's right on Day 2 or so. Arrangements should be made about the meeting/gathering. The parents of the students should also be welcomed if they accompany their ward. It would be helpful if an alumnus of the Dept. relates his professional experience related to the field of the study to the incoming students.
8. **Lectures /Workshops by Eminent People:** Eminent people from all walks of life may be invited to deliver lectures, namely, from industry, academia, social science (authors, historians), social work, civil society, alumni etc. be identified and invited to come and address the new students. Motivational lectures about life, meditation, etc. by Ramakrishna Mission, Art of Living, S-VYASA university, VivekanandKendras, etc. may be organized. Workshops which rejuvenate or bring relief to students would also be welcome, such as, Art of Living workshops.
9. **Extra-Curricular Activity:** Every college has extra-curricular activities. Most of them are student driven. They are organized by student councils and clubs. The extra-curricular activities going on in the college should be presented to the new students under the guidance of faculty advisors for such activity. The new students should be informed about how they can join the activities. Related facilities should be described to them. Presentation on the activities by the student council should be made.
10. **Feedback and Report on the Program:** A formal feedback at the end of the program should be collected from students by their filling a form in writing or online. Besides the above, each group (of 20 students) should write a report on the Induction Program towards the end of the semester. They would also have to make a presentation of their report. They should be encouraged to use slides while making a

presentation. Presentation of the report should be made in the language they are comfortable with, without any insistence that it should be in English. It is more important that they feel comfortable and confident. Each group may make the presentation through 4-5 of its group members or more. In case, the number of new students in a college is large, the presentation should be made by each group in front of 4 other groups besides their own, thus there would be about 100 students (in 5 groups) in the audience in a session. Several such sessions could run in parallel or serially. In each session, their faculty mentors and student guides, if any, should also be in the audience. These sessions would tell you how well the program ran, and what the students are feeling at the end of the program. This would also serve as a grand closure to the program.

A certificate shall be awarded to all the students, upon successful completion of the induction program based on their report and presentation.

Tentative schedule of 1st Week Induction Program:

Day 1	Session 1	Orientation program
	Session 2	Mentoring (group formation and introduction)
Day 2	Session 3	Diagnostic test (basic English, maths and computer operation)
	Session 4	Familiarisation of Department and Institute (Visits to department, laboratory, Library, Examination cell, office etc)
Day 3	Session 5	Physical Activity (Yoga, sports etc)
	Session 6	Universal human values session
Day 4	Session 7	Proficiency Modules (Short courses on basic maths, English and computer operation etc. for identified students)
	Session 8	Physical Activity (Yoga, sports etc)
Day 5	Session 9	Proficiency Modules (Short courses on basic maths, English and computer operation etc. for identified students)
	Session 10	Creative Arts, Cultural and Literary Activity

A session may be conducted for around 2-3 hours each.

Minimum 12 sessions to be conducted from the following 20 sessions, from 2nd week to last week of academics, throughout the semester.

Session 11	Physical Activity (Yoga, sports etc)- 1
Session 12	Extra-Curricular Activity- 1
Session 13	Physical Activity (Yoga, sports etc)-2
Session 14	Extra-Curricular Activity- 2
Session 15	Physical Activity (Yoga, sports etc)- 3
Session 16	Lectures /Workshops by Eminent People- 1
Session 17	Physical Activity (Yoga, sports etc)- 4
Session 18	Lectures /Workshops by Eminent People- 2
Session 19	Creative Arts, Cultural and Literary Activity- 1
Session 20	Lectures /Workshops by Eminent People- 3
Session 21	Creative Arts, Cultural and Literary Activity- 2
Session 22	Universal Human Values- 1(Group Discussion among students as per mentoring group on various aspects of life, values, ethics etc.)
Session 23	Creative Arts, Cultural and Literary Activity- 3
Session 24	Universal Human Values- 2 (Group Discussion among students as per mentoring group on various aspects of life, values, ethics etc.)
Session 25	Creative Arts, Cultural and Literary Activity- 4
Session 26	Universal Human Values- 3 (Group Discussion among students as per mentoring group on various aspects of life, values, ethics etc.)
Session 27	Creative Arts, Cultural and Literary Activity- 5
Session 28	Physical Activity (Yoga, sports etc)- 5
Session 29	Feedback and Report on the Program- 1
Session 30	Feedback and Report on the Program- 2

**Program Structure for First Year Engineering
Semester I & II
UNIVERSITY OF MUMBAI
(With Effect from 2019-2020)**

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
FEC101	Engineering Mathematics-I	3	--	1*	3	--	1	4	
FEC102	Engineering Physics-I	2		--	2		--	2	
FEC103	Engineering Chemistry-I	2	--	--	2	--	--	2	
FEC104	Engineering Mechanics	3	--	--	3	--	--	3	
FEC105	Basic Electrical Engineering	3	--	--	3	--	--	3	
FEL101	Engineering Physics-I	--	1	--	--	0.5	--	0.5	
FEL102	Engineering Chemistry-I	--	1	--	--	0.5	--	0.5	
FEL103	Engineering Mechanics	--	2	--	--	1	--	1	
FEL104	Basic Electrical Engineering	--	2	--	--	1	--	1	
FEL105	Basic Workshop practice-I	--	2	--	--	1	--	1	
Total		13	08	01	13	04	01	18	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC101	Engineering Mathematics-I	20	20	20	80	3	25	--	125
FEC102	Engineering Physics-I	15	15	15	60	2	--	--	75
FEC103	Engineering Chemistry-I	15	15	15	60	2	--	--	75
FEC104	Engineering Mechanics	20	20	20	80	3	--	--	100
FEC105	Basic Electrical Engineering	20	20	20	80	3	--	--	100
FEL101	Engineering Physics-I	--	--	--	--	--	25	--	25
FEL102	Engineering Chemistry-I	--	--	--	--	--	25	--	25
FEL103	Engineering Mechanics	--	--	--	--	--	25	25	50
FEL104	Basic Electrical Engineering	--	--	--	--	--	25	25	50
FEL105	Basic Workshop practice-I	--	--	--	--	--	50	--	50
Total		--	--	90	360	--	175	50	675

* May be conducted batch-wise

Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
FEC201	Engineering Mathematics-II	3	--	1*	3	--	1	4	
FEC202	Engineering Physics-II	2	--	--	2	--	--	2	
FEC203	Engineering Chemistry-II	2	--	--	2	--	--	2	
FEC204	Engineering Graphics	2	--	--	2	--	--	2	
FEC205	C programming	2	--	--	2	--	--	2	
FEC206	Professional Communication and Ethics- I	2	--	--	2	--	--	2	
FEL201	Engineering Physics-II	--	1	--	--	0.5	--	0.5	
FEL202	Engineering Chemistry-II	--	1	--	--	0.5	--	0.5	
FEL203	Engineering Graphics	--	4	--	--	2	--	2	
FEL204	C programming	--	2	--	--	1	--	1	
FEL205	Professional Communication and Ethics- I	--	2	--	--	1	--	1	
FEL206	Basic Workshop practice-II	--	2	--	--	1	--	1	
Total		13	12	01	13	06	01	20	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC201	Engineering Mathematics-II	20	20	20	80	3	25	--	125
FEC202	Engineering Physics-II	15	15	15	60	2	--	--	75
FEC203	Engineering Chemistry-II	15	15	15	60	2	--	--	75
FEC204	Engineering Graphics	15	15	15	60	3	--	--	75
FEC205	C programming	15	15	15	60	2	--	--	75
FEC206	Professional Communication and Ethics- I	10	10	10	40	2	--	--	50
FEL201	Engineering Physics-II	--	--	--	--	--	25	--	25
FEL202	Engineering Chemistry-II	--	--	--	--	--	25	--	25
FEL203	Engineering Graphics	--	--	--	--	--	25	50	75
FEL204	C programming	--	--	--	--	--	25	25	50
FEL205	Professional Communication and Ethics- I	--	--	--	--	--	25	--	25
FEL206	Basic Workshop practice-II	--	--	--	--	--	50	--	50
Total		--	--	90	360	--	200	75	725

* May be conducted batch-wise

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC201	Engineering Mathematics-II	3	--	1*	3	1	--	4	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC201	Engineering Mathematics-II	20	20	20	80	3	25	--	125

Objectives

1. The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.
2. To provide hands on experience in using SCILAB software to handle real life problems

Outcomes: Learners will be able to...

1. Solve various types of First Order differential equation.
2. Solve various types of Higher Order Differential equation.
3. Illustrate the concepts of Beta and Gamma function, DUIS and rectification.
4. Apply the concepts of Double integral
5. Apply the concept of Triple integral.
6. Apply the principles of Numerical Method for solving differential equation and numerical integration analytically and using Scilab also.

Module	Detailed Contents	Hrs.
01	Differential Equations of First Order and First Degree 1.1 Exact differential Equations, Equations reducible to exact form by using integrating factors.	4
	1.2 Linear differential equations (Review), equation reducible to linear form, Bernoulli's equation. # Self learning topics: Simple application of differential equation of first order and first degree to electrical and Mechanical Engineering problem	2
02	Linear Differential Equations With Constant Coefficients and Variable Coefficients Of Higher Order 2.1. Linear Differential Equation with constant coefficient- complementary function, particular integrals of differential equation of the type $f(D)y = X$ where X is $e^{ax}, \sin(ax + b), (ax + b), e^{ax}V, xV$.	4
	2.2. Method of variation of parameters. # Self learning topics: Cauchy's homogeneous linear differential equation and Legendre's differential equation, Applications of Higher order differential equation.	2
03	Beta and Gamma Function, Differentiation under Integral sign and Rectification Pre-requisite: Tracing of curves 1.1 Beta and Gamma functions and its properties. 1.2 Differentiation under integral sign with constant limits of integration.	2

	1.3 Rectification of plane curves.(Cartesian and polar) # Self learning topics: Rectification of curve in parametric co-ordinates.	2 2
04	Multiple Integration-1 4.1. Double integration-definition, Evaluation of Double Integrals.(Cartesian & Polar) 4.2. Evaluation of double integrals by changing the order of integration. 4.3. Evaluation of integrals over the given region. (Cartesian & Polar) # Self learning topics: Application of double integrals to compute Area, Mass.	2 2 2
05	Multiple Integration-2 5.1. Evaluation of double integrals by changing to polar coordinates. 5.2. Application of double integrals to compute Area 5.3. Triple integration definition and evaluation (Cartesian, cylindrical and spherical polarcoordinates). # Self learning topics: Application of triple integral to compute volume.	2 2 2
06	Numerical solution of ordinary differential equations of first order and first degree, and , Numerical Integration 6.1. Numerical solution of ordinary differential equation using (a) Euler’s method (b) Modified Euler method, (c) Runge-Kutta fourth order method 6.2. Numerical integration- by (a) Trapezoidal (b) Simpson’s 1/3rd (c) Simpson’s 3/8th rule(all with proof). # Self learning topics: Numerical solution of ordinary differential equation using Taylorseries method.	3 3

Term Work

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write SCILAB Programs in tutorial class only. Each Student has to write at least 4 SCILAB tutorials (including print out) and at least 6 class tutorials on entire syllabus.
3. SCILAB Tutorials will be based on (i) Euler Method, (ii) Modified Euler Method, (iii) Runge-Kutta Method of fourth order , (iv) Trapezoidal Rule , (v) Simpson’s 1/3rd Rule (vi) Simpson’s 3/8th rule

The distribution of marks for term work shall be as follows:

- Class Tutorials on entire syllabus : **10 marks**
- SCILAB Tutorials : **10 marks**
- Attendance (Theory and Tutorial) : **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Assessment

Internal Assessment Test

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 20 marks.

2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited, 9th Ed.
3. Engineering Mathematics by Srimanta Pal and Subodh, C. Bhunia, Oxford University Press
4. Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven Chapra, McGraw Hill
5. Elementary Linear Algebra with Application by Howard Anton and Christ Rorres. 6th edition. John Wiley & Sons, INC.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC202	Engineering Physics-II	2	--	--	2	--	--	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC202	Engineering Physics-II	15	15	15	60	2	--	--	75

Rationale:

Most of the engineering branches are being off-spring of basic sciences where physics is playing a pivotal role in concept and understanding of foundation of core engineering branches. This syllabus is developed by keeping in mind, needs of all branches that we offer in University of Mumbai.

The topic distribution is being done in systematic manner and whenever required, prerequisite to the topic are mentioned for frictionless teaching–learning process. In the distribution of topics, core physics and its applied form are given priority. At the same time few modules are introduced over emerging trends in the field of technology.

For the purpose of emphasis on applied part, list of suggestive experiments is added. As per new guidelines of AICTE, a scope is kept in the syllabus for simulation technique and use of information technology to supplement laboratory practices. Further, it is ensured that these modules will cover prerequisites needed for engineering courses to be introduced in higher semesters as core subjects or as interdisciplinary subjects in respective branches.

Objectives

1. To give exposure to the topics of fundamental physics in the area of electrodynamics and relativity.
2. To give exposure to fundamentals of physics related with current technology in the field of Nanotechnology and Physics of Sensor Technology.

Outcomes: Learners will be able to...

1. Describe the diffraction through slits and its applications.
2. Apply the foundation of laser and fiber optics in development of modern communication technology.
3. Relate the basics of electrodynamics which is prerequisite for satellite communications, antenna theory etc.
4. Explain the fundamentals of relativity.
5. Assimilate the wide scope of nanotechnology in modern developments and its role in emerging innovating applications.
6. Interpret and explore basic sensing techniques for physical measurements in modern instrumentations.

Module	Detailed Contents	Hrs.
01	DIFFRACTION (Prerequisites : Wave front and Huygen's principle, reflection and refraction, diffraction, Fresnel diffraction and Fraunhofer diffraction)	04

	Diffraction: Fraunhofer diffraction at single slit, Diffraction Grating, Resolving power of a grating; Applications of diffraction grating; Determination of wavelength of light using plane transmission grating	
02	<p>LASER AND FIBRE OPTICS (Prerequisites: Absorption, recombination, energy bands of p-n junction, refractive index of a material, Snell's law)</p> <p>Laser: spontaneous emission and stimulated emission; metastable state, population inversion, types of pumping, resonant cavity, Einstein's equations; Helium Neon laser; Nd:YAG laser; Semiconductor laser, Applications of laser- Holography</p> <p>Fibre optics: Numerical Aperture for step index fibre; critical angle; angle of acceptance; V number; number of modes of propagation; types of optical fibres; Fibre optic communication system;</p>	06
03	<p>ELECTRODYNAMICS (Prerequisites : Electric Charges, Coulomb's law-force between two point charges, Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole, Gauss's law, Faraday's law)</p> <p>Scalar and Vector field, Physical significance of gradient, curl and divergence in Cartesian co-ordinate system, Gauss's law for electrostatics, Gauss's law for magnetostatics, Faraday's Law and Ampere's circuital law; Maxwell's equations (Free space and time varying fields).</p>	05
04	<p>RELATIVITY (Prerequisites: Cartesian co-ordinate system)</p> <p>Special theory of Relativity: Inertial and Non-inertial Frames of reference, Galilean transformations, Lorentz transformations (space – time coordinates), Time Dilation, Length Contraction and Mass-Energy relation.</p>	02
05	<p>NANOTECHNOLOGY (Prerequisites : Scattering of electrons, Tunneling effect, Electrostatic focusing, magneto static focusing)</p> <p>Nanomaterials : Properties (Optical, electrical, magnetic, structural, mechanical) and applications, Surface to volume ratio; Two main approaches in nanotechnology -Bottom up technique and Top down technique;</p> <p>Tools for characterization of Nanoparticles: Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM).</p> <p>Methods to synthesize Nanomaterials: Ball milling, Sputtering, Vapour deposition, Solgel</p>	04
06	<p>PHYSICS OF SENSORS (Prerequisites : Transducer concept, meaning of calibration, piezoelectric effect)</p> <p>Resistive sensors: a) Temperature measurement: PT100 construction, calibration, b) Humidity measurement using resistive sensors,</p> <p>Pressure sensor: Concept of pressure sensing by capacitive, flex and inductive method, Analog pressure sensor: construction working and calibration and applications.</p> <p>Piezoelectric transducers: Concept of piezoelectricity, use of piezoelectric transducer as ultrasonic generator and application of ultrasonic transducer for distance measurement, liquid and air velocity measurement.</p> <p>Optical sensor: Photodiode, construction and use of photodiode as ambient light measurement and flux measurement.</p> <p>Pyroelectric sensors: Construction and working principle, application of pyroelectric sensor as bolometer.</p>	05

Assessment

Internal Assessment Test

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. A text book of Engineering Physics-Avadhanulu&Kshirsagar, S.Chand
2. Optics - Ajay Ghatak, Tata McGraw Hill
3. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
4. Concepts of Modern Physics- ArtherBeiser, Tata McGraw Hill
5. Introduction to Electrodynamics- D. J. Griffiths, Pearson publication
6. Introduction to Special Relativity- Robert Resnick, John Wiley and sons
7. Advances In Nano Materials And Applications: History of Nanotechnology From Pre-Historic to Modern Times, Madhuri Sharon, Wiley, USA
8. Nano: The essentials, understanding Nanoscience and Nanotechnology, T. Pradeep, Tata McGraw Hill, 2007.
9. Electronic Instrumentation –H.S. Kalsi, Tata McGraw-Hill Education
10. Handbook of Modern Sensors Physics design and application- Jacob Fraden, Springer, AIP press.
11. Instrumentation & Measurement Techniques by Albert D. Helfrick& William D. Cooper (PHI) Edition

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC203	Engineering Chemistry-II	2	-	-	2	-	-	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC203	Engineering Chemistry-II	15	15	15	60	2	--	--	75

Objectives

The concepts developed in this course will aid in quantification as well as understand the applications of several concepts in Chemistry that have been introduced at the 10 + 2 levels in schools.

Outcomes: Learners will be able to...

1. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.
2. Illustrate the concept of emission spectroscopy and describe the phenomena of fluorescence and phosphorescence in relation to it.
3. Explain the concept of electrode potential and nernst theory and relate it to electrochemical cells.
4. Identify different types of corrosion and suggest control measures in industries.
5. Illustrate the principles of green chemistry and study environmental impact.
6. Explain the knowledge of determining the quality of fuel and quantify the oxygen required for combustion of fuel.

Module	Detailed Contents	Hrs.
01	Principles of Spectroscopy: Introduction: Principle of spectroscopy, Definition, Origin of spectrum, Classification of spectroscopy – atomic and molecular, selection rules. Table of relation between electromagnetic spectrum, types of spectroscopy and energy changes.	02
02	Applications of Spectroscopy Emission spectroscopy- Principle, Instrumentation and applications (Flame Photometry) Introduction to florescence and phosphorescence, Jablonski diagram, application of fluorescence in medicine only.	04
03	Concept of Electrochemistry Introduction, concept of electrode potential, Nernst equation, types of electrochemical cells, concept of standard electrode with examples, electrochemical series, simplenumericals.	02

04	<p>Corrosion: Definition, Mechanism of Corrosion- (I) Dry or Chemical Corrosion-i) Due to oxygen ii)Due to other gases. (II)Wet or Electrochemical corrosion- Mechanism i) Evolution of hydrogen type ii) Absorption of oxygen. Types of Corrosion- Galvanic cell corrosion, Concentration cell corrosion (differential aeration principle), Pitting corrosion, Intergranular corrosion, Stress corrosion. Factors affecting the rate of corrosion- (i)Nature of metal, (ii)Nature of corroding environment. Methods of corrosion control- (I)Material selection and proper designing,(II) Cathodic protection- i) Sacrificial anodic protection ii) Impressed current method,(III) Metallic coatings- only Cathodic coating (tinning) and anodic coatings (Galvanising)</p>	06
05	<p>Green Chemistry and Synthesis of drugs Introduction – Definition, significance Twelve Principles of Green chemistry, numerical on atom economy, Conventional and green synthesis of Adipic acid, Indigo, Carbaryl, Ibuprofen, Benzimidazole, Benzyl alcohol, % atom economy and their numericals. Green fuel- Biodiesel.</p>	04
06	<p>Fuels and Combustion Definition, classification, characteristics of a good fuel, units of heat (no conversions). Calorific value- Definition, Gross or Higher calorific value & Net or lower calorific value, Dulong’s formula & numerical for calculations of Gross and Net calorific values. Solid fuels- Analysis of coal- Proximate and Ultimate Analysis- numerical problems and significance. Liquid fuels- Petrol- Knocking, Octane number, Cetane number, Antiknocking agents, unleaded petrol, oxygenates (MTBE), catalytic converter. Combustion- Calculations for requirement of only oxygen and air (by weight and by volume only) for given solid & gaseous fuels.</p>	06

Assessment

Internal Assessment Test

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

Recommended Books :

1. Engineering Chemistry - Jain & Jain, DhanpatRai
2. Engineering Chemistry – Dara & Dara, S Chand
3. Green Chemistry: A textbook – V.K.Ahluwalia, Alpha Science International
4. Fundamentals of Molecular Spectroscopy (4th Edition) - C.N.Banwell, Elaine M. McCash,
Tata McGraw Hill.
5. Elementary Organic Spectroscopy- Y.R.Sharma, S.Chand and Co.
6. A Text Book of Engineering Chemistry - ShashiChawla, DhanpatRai
7. Engineering Chemistry – Payal Joshi & Shashank Deep (Oxford University Press)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC204	Engineering Graphics	2	--	--	2	--	--	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC204	Engineering Graphics	15	15	15	60	3	--	--	75

Objectives

1. To impart and inculcate proper understanding of the theory of projection.
2. To impart the knowledge of reading a drawing
3. To improve the visualization skill.

Outcomes: Learners will be able to...

1. Apply the basic principles of projections in Projection of Lines and Planes
2. Apply the basic principles of projections in Projection of Solids.
3. Apply the basic principles of sectional views in Section of solids.
4. Apply the basic principles of projections in converting 3D view to 2D drawing.
5. Read a given drawing.
6. Visualize an object from the given two views.

Module	Detailed Contents	Hrs.
01	<p>Introduction to Engineering Graphics Principles of Engineering Graphics and their significance, usage of Drawing instruments, Types of Lines, Dimensioning Systems as per IS conventions. Introduction to plain and diagonal scales.</p> <p>Engineering Curves Basic construction of Cycloid, Involute and Helix (of cylinder) only.</p>	2
02	<p>Projection of Points and Lines Lines inclined to both the Reference Planes (Excluding Traces of lines) and simple application based problems on Projection of lines.</p> <p>@ Projection of Planes Triangular, Square, Rectangular, Pentagonal, Hexagonal and Circular planes inclined to either HP or VP only. (Exclude composite planes).</p>	5
03	<p>Projection of Solids (Prism, Pyramid, Cylinder, Cone only) Solid projection with the axis inclined to HP and VP. (Exclude Spheres, Composite, Hollow solids and frustum of solids). Use change of position or Auxiliary plane method</p>	5
04	<p>Section of Solids Section of Prism, Pyramid, Cylinder, & Cone cut by plane perpendicular to at least one reference plane (Exclude Curved Section Plane). Use change of position or Auxiliary plane method.</p>	5

05	#Orthographic and Sectional Orthographic Projections: - Fundamentals of orthographic projections. Different views of a simple machine part as per the first angle projection method recommended by I.S. Full or Half Sectional views of the Simple Machine parts.	3
06	#@ Missing Views: The identification of missing views from the given views. Create the third view from the two available views so that all the details of the object are obtained.	1
07	#Isometric Views:- Principles of Isometric projection – Isometric Scale, Isometric Views, Conversion of Orthographic Views to Isometric Views(Excluding Sphere).	3
@ only in Term Work (i.e; Questions will not be asked for any examination.)		
# more problems should be discussed during practical hours to strengthen the concepts.		

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 15 marks each.

Among the two tests One is Conventional (manual drawing) and Second using CAD software.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 15marks.
2. Any 4 questions need to be solved. There won't be any compulsory Question
3. Total 04 questions need to be solved.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Text Books.

1. N.D. Bhatt, "Engineering Drawing (Plane and solid geometry)", Charotar Publishing House Pvt. Ltd.
2. N.D. Bhatt & V.M. Panchal, "Machine Drawing", Charotar Publishing House Pvt. Ltd.

Reference Books

3. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publisher.
4. Prof. Sham Tickoo (Purdue University) & Gaurav Verma, "(CAD Soft Technologies) : Auto CAD 2012 (For engineers and Designers)", Dreamtech Press New Delhi.
5. Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC205	C Programming	2	--	--	2	--	--	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC205	C Programming	15	15	15	60	2	--	--	75

Objectives

To provide exposure to problem-solving by developing an algorithm, flowchart and implement the logic using C programming language.

Outcomes: Learner will be able to...

1. Formulate simple algorithms for arithmetic, logical problems and translate them to programs in C language
2. Implement, test and execute programs comprising of control structures.
3. Decompose a problem into functions and synthesize a complete program.
4. Demonstrate the use of arrays, strings and structures in C language.
5. Understand the concept of pointers

Module	Detailed Contents	Hrs.
1	Introduction	5
	<ul style="list-style-type: none"> ● Introduction to components of a Computer System ● Introduction to Algorithm and Flowchart 	
1	Fundamentals of C Programming	5
	<ul style="list-style-type: none"> ● Keywords, Identifiers, Constants and Variables ● Data types in C ● Operators in C ● Basic Input and Output Operations ● Expressions and Precedence of Operators ● In-built Functions 	
2	Control Structures	7
	<ul style="list-style-type: none"> ● Introduction to Control Structures 	
2	Branching and looping structures	7
	<ul style="list-style-type: none"> ● If statement, If-else statement, Nested if-else, else-if Ladder ● Switch statement ● For loop, While loop, Do while loop ● break and continue 	
3	Functions	4
	<ul style="list-style-type: none"> ● Introduction to functions ● Function prototype, Function definition, Accessing a function and parameter passing. ● Recursion. 	
4	Arrays and Strings	4

	<ul style="list-style-type: none"> ● Introduction to Arrays ● Declaration and initialization of one dimensional and two-dimensional arrays. ● Definition and initialization of String ● String functions 	
5	Structure and Union	4
	<ul style="list-style-type: none"> ● Concept of Structure and Union ● Declaration and Initialization of structure and union ● Nested structures ● Array of Structures ● Passing structure to functions 	
6	Pointers	4
	<ul style="list-style-type: none"> ● Fundamentals of pointers ● Declaration, initialization and dereferencing of pointers ● Operations on Pointers ● Concept of dynamic memory allocation 	

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 15marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Text Books:

1. E. Balaguruswamy, Programming in ANSI C, McGraw-Hill
2. Kernighan , Ritchie, “The C programming Language”, Prentice Hall of India
3. Sumitabha Das, Computer Fundamentals and C Programming, McGraw-Hill
4. Pradeep Day and ManasGosh ,“Programming in C”, Oxford University Press.

References:

1. Byron Gottfried, “Programming with C”, McGraw Hill (Schaum’s outline series)
2. Venugopal K.R, Prasad Sudeep, “Mastering C”, McGraw-Hill
3. KanetkarYashwant,” “Let Us C”, BPB Publication.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC206	Professional Communication and Ethics- I	2	--	--	2	--	--	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC206	Professional Communication and Ethics- I	10	10	10	40	2	--	--	50

Objectives

1. To demonstrate the fundamental concepts of interpersonal and professional communication.
2. To encourage active listening with focus on content, purpose, ideas and tone.
3. To facilitate fluent speaking skills in social, academic and professional situations.
4. To train in reading strategies for comprehending academic and business correspondence.
5. To promote effective writing skills in business, technology and academic arenas.
6. To inculcate confident personality traits along with grooming and social etiquettes.

Outcomes: Learners will be able to understand how to...

1. Eliminate barriers and use verbal/non-verbal cues at social and workplace situations.
2. Employ listening strategies to comprehend wide-ranging vocabulary, grammatical structures, tone and pronunciation.
3. Prepare effectively for speaking at social, academic and business situations.
4. Use reading strategies for faster comprehension, summarization and evaluation of texts.
5. Acquire effective writing skills for drafting academic, business and technical documents.
6. Successfully interact in all kinds of settings, displaying refined grooming and social skills.

Module	Detailed Contents	Hrs.
1	FUNDAMENTALS OF COMMUNICATION	12
	1.1. Introduction to Theory of Communication <ul style="list-style-type: none"> ● Definition ● Objectives ● Postulates/Hallmarks ● The Process of Communication ● Organizational Communication <ul style="list-style-type: none"> ○ Formal (Upward, Downward and Horizontal) ○ Informal (Grapevine) 1.2. Methods of Communication <ul style="list-style-type: none"> ● Verbal (Written & Spoken) ● Non-verbal <ul style="list-style-type: none"> ○ Non-verbal cues perceived through the five senses: (Visual, Auditory, Tactile, Olfactory and Gustatory cues) ○ Non-verbal cues transmitted through the use of: (The Body, Voice, Space, Time and Silence) 1.3. Barriers to Communication	

	<ul style="list-style-type: none"> ● Mechanical/External ● Physical/Internal ● Semantic & Linguistic ● Psychological ● Socio-Cultural <p>1.4. Communication at the Workplace</p> <ul style="list-style-type: none"> ● Corporate Communication - Case Studies ● Listening Tasks with Recordings and Activity Sheets ● Short Speeches as Monologues <ul style="list-style-type: none"> ○ Informative Speeches that Center on People, Events, Processes, Places, or Things ○ Persuasive Speeches to Persuade, Motivate or Take Action ○ Special Occasion Speeches for Ceremonial, Commemorative, or Epideictic purposes ● Pair-work Conversational Activities (Dialogues) ● Short Group Presentations on Business Plans 	
2	<p>VERBAL APTITUDE FOR EMPLOYMENT</p> <p>2.1. Vocabulary Building</p> <ul style="list-style-type: none"> ● Root words (Etymology) ● Meaning of Words in Context ● Synonyms & Antonyms ● Collocations ● Word Form Charts ● Prefixes & Suffixes ● Standard Abbreviations <p>2.2. Grammar</p> <ul style="list-style-type: none"> ● Identifying Common Errors <ul style="list-style-type: none"> ○ Subject - Verb Agreement ○ Misplaced Modifiers ○ Articles ○ Prepositions ● Tautologies ● Pleonasm (Redundancies) ● Idioms ● Cliches 	02
3	<p>DEVELOPING READING AND WRITING SKILLS</p> <p>3.1. Reading Comprehension</p> <ul style="list-style-type: none"> ● Long Passages ● Short Passages ● MCQs on Inferential Questions with 4 Options <p>3.2. Summarization of reading passages, reports, chapters, books</p> <ul style="list-style-type: none"> ● Graphic Organizers for Summaries <ul style="list-style-type: none"> ○ Radial Diagrams like Mind Maps ○ Flow Charts ○ Tree Diagrams ○ Cyclic Diagrams ○ Linear Diagrams like Timelines ○ Pyramids ○ Venn Diagrams ● Point-form Summaries ● One-sentence Summaries of Central Idea <p>3.3. Paraphrasing</p> <ul style="list-style-type: none"> ● Understanding Copyrights ● Running a Plagiarism Check on Paraphrased Passages ● Generating Plagiarism Reports 	02

	<ul style="list-style-type: none"> ● Basic APA and MLA Referencing Style and Format 	
4	<p>BUSINESS CORRESPONDENCE</p> <p>4.1. Seven Cs of Business Correspondence</p> <ul style="list-style-type: none"> ● Completeness ● Conciseness ● Consideration ● Concreteness ● Clarity ● Courtesy ● Correctness <p>4.2. Parts of a Formal Letter and Formats</p> <ul style="list-style-type: none"> ● Parts/Elements of a Formal Letter <ul style="list-style-type: none"> ○ Letterheads and/or Sender’s Address ○ Dateline ○ Inside Address ○ Reference Line (Optional) ○ Attention Line (Optional) ○ Salutation ○ Subject Line ○ Body ○ Complimentary Close ○ Signature Block ○ Enclosures/Attachments ● Complete/Full Block Format <p>4.3. Emails</p> <ul style="list-style-type: none"> ● Format of Emails ● Features of Effective Emails ● Language and style of Emails <p>4.4. Types of Letters in Both Formal Letter Format and Emails</p> <ul style="list-style-type: none"> ● Claim & Adjustment Letters ● Request/Permission Letters ● Sales Letters 	06
5	<p>BASIC TECHNICAL WRITING</p> <p>5.1. Introduction</p> <ul style="list-style-type: none"> ● What is Technical Writing? ● Importance and Principles of Technical Writing ● Difference between Technical Writing & Literary Writing ● Framing Definitions ● Difference between Technical Description & Instructions <p>5.2. Description of a Technical Object</p> <ul style="list-style-type: none"> ● Definition ● Diagram ● Discussion of Parts/Characteristics <p>Working</p> <p>5.3. Writing User Instructions</p> <ul style="list-style-type: none"> ● User Instructions ● Special Notices (Note, Warning, Caution and Danger) ● Styles of Presentation <ul style="list-style-type: none"> ○ Impersonal ○ Indirect ○ Direct ● Imperative <p>5.4. Description of a Technical / Scientific Process</p>	02

	<ul style="list-style-type: none"> ● Definition ● Diagram ● Tools/ Apparatus/Software/ Hardware Used ● Working ● Result 	
6	PERSONALITY DEVELOPMENT AND SOCIAL ETIQUETTES	02
	<p>6.1. Personality Development</p> <ul style="list-style-type: none"> ● Introducing Self and/or a Classmate ● Formal Dress Code <p>6.2. Social Etiquettes</p> <ul style="list-style-type: none"> ● Formal Dining Etiquettes ● Cubicle Etiquettes ● Responsibility in Using Social Media ● Showing Empathy and Respect ● Learning Accountability and Accepting Criticism ● Demonstrating Flexibility and Cooperation ● Selecting Effective Communication Channels 	

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 10 marks each.

TEST I -Public speech on general topics (Maximum 5 mins. per student)

TEST II - Written test covering modules 1 - 6

The second test should be based on theory and application exercises as mentioned in the syllabus. (Note: Summarization should be a compulsory question in Test II and not in the End Semester Theory Examination.)

End Semester Theory Examination:

- 1.Question paper will comprise of total 06 questions, each carrying 15marks.
- 2.Total 04 questions need to be solved.
- 3.Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
- 4.Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
- 5.In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus
6. The first module (Fundamentals of Communication) will carry 40 % weightage.

Text Books.

1. Sanjay Kumar & Pushp Lata (2018). Communication Skills with CD. New Delhi: Oxford University Press.
2. Hemphill, P.D., McCormick, D. W., & Hemphill, R. D. (2001). Business Communication with writing improvement exercises. Upper Saddle River, NJ: Prentice Hall.
3. Locker, Kitty O. Kaczmarek, Stephen Kyo. (2019). Business Communication: Building Critical Skills. Place of publication not identified: Mcgraw-hill.
4. Murphy, H. (1999). Effective Business Communication. Place of publication not identified: Mcgraw-Hill.
5. Raman, M., & Sharma, S. (2016). Technical Communication: Principles and practice. New Delhi: Oxford University Press.
6. Kaul, A. (2015). Effective Business Communication. Place of publication not identified: Prentice-Hall of India.

7. Rizvi, A. M. (2010). Effective Technical Communication: A guide for Scientists and Engineers. New Delhi: Tata McGraw Hill.
8. Lewis, N. (2014). Word power made easy. Random House USA.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL201	Engineering Physics-II	-	01	-	-	-	0.5	0.5	
Course Code	Course Name	Examination Scheme							Total
		Theory					Term Work	Pract. /oral	
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL201	Engineering Physics-II	--	--	--	--	--	25	--	25

Objectives

1. To improve the knowledge about the theory learned in the class.
2. To improve ability to analyze experimental result and write laboratory report.

Outcomes: Learners will be able to...

1. Perform the experiments based on diffraction through slits using Laser source and analyze the results.
2. Perform the experiments using optical fibre to measure numerical aperture of a given fibre.
3. Perform the experiments on various sensors and analyze the result.

Suggested Experiments:(Any five)

1. Determination of wavelength using Diffraction grating. (Hg/Na source)
2. Determination of number of lines on the grating surface using LASER Source.
3. Determination of Numerical Aperture of an optical fibre.
4. Determination of wavelength using Diffraction grating.(Laser source)
5. Study of divergence of laser beam
6. Determination of width of a slit using single slit diffraction experiment(laser source)
7. Study of I-V characteristics of Photo diode.
8. Study of ultrasonic distance meter/ interferometer.
9. Study of PT100 calibration and use and thermometer
10. Study of J /K type thermocouple, calibration and use and thermometer
11. Simulation experiments based on nanotechnology using open source simulation softwares like Avogadro, Chimera, JMOL etc.

Term work:

Term Work shall consist of minimum five experiments.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) : 10 marks
- Project Groupwise (Execution & Submission) : 10 marks
- Attendance (Theory and Tutorial) : 05 marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL202	Engineering Chemistry-II	-	01	-	-	-	0.5	0.5	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL202	Engineering Chemistry-II	--	--	--	--	--	25	--	25

Outcomes: Learner will be able to...

1. Determine moisture and ash content of coal
2. Analyze flue gas
3. Determine saponification and acid value of oil
4. Determine flash point of a lubricating oil
5. Synthesize a drug and a biofuel.
6. Determine na/k and emf of cu-zn system

Suggested Experiments

1. Determination of Moisture content of coal.
2. Determination of Ash content of coal.
3. Flue gas analysis using Orsat's apparatus.
4. Saponification value of oil
5. Acid value of oil
6. Determination of Na/K by Flame photometry.
7. Preparation of Biodiesel from edible oil.
8. To estimate the emf of Cu-Zn system by Potentiometry.
9. Synthesis of Aspirin.
10. Determination of Flash point of a lubricant using Abel's apparatus

Term work:

Term Work shall consist of minimum five experiments.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) : **10 marks**
- Assignments and Viva on practicals : **10 marks**
- Attendance (Theory and Practical) : **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL203	Engineering Graphics	-	04	-	-	-	2	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL203	Engineering Graphics	--	--	--	--	--	25	50	75

Objectives

1. To inculcate the skill of drawing with the basic concepts.
2. To Use AutoCAD for daily working process.
3. To teach basic utility of Computer Aided drafting (CAD) tool

Outcomes: Learner will be able to...

1. Apply the basic principles of projections in 2D drawings using a CAD software.
2. Create, Annotate, Edit and Plot drawings using basic AutoCAD commands and features.
3. Apply the concepts of layers to create drawing.
4. Apply basic AutoCAD skills to draw different views of a 3D object.
5. Apply basic AutoCAD skills to draw the isometric view from the given two views.

Component-1 (Use half Imperial Drawing Sheet)

	Hrs
Activities to be completed in the Drawing Laboratory.	
One Practice sheet on projection of solids(minimum 2 problems)	4
# Term Sheet 1: Projection of Solids (3 Problems).	4
One Practice sheet on Section of Solids. (minimum 2 problems) # Term Sheet 2: Section of solids. (3 problems).	6
One practice sheet on Orthographic projection. (minimum 1 problem) # Term Sheet 3: Orthographic Projection (With section 1 problem, without section 1 problem).	6
One practice sheet on Isometric drawing. (minimum 2 problems) # Term Sheet 4: Isometric Projection. (3 problems).	4
# Term sheets to be done in laboratory only and to be submitted as part of term work. <i>Note: Practice sheets to be done before starting the Term Sheets.</i>	

Component-2

Self-study problems/ Assignment: (In A3 size Sketch book, to be submitted as part of Term Work)

1. Engineering Curves. (2 problems)
2. Projection of Lines (2 problems)
3. Projection of planes (2 problems)
4. Projection of solids. (2 problems)
5. Section of solids (2 problems)
6. Orthographic Projection. (With section 1 problem, without section 1 problem).
7. Missing views. (1 problem)
8. Isometric Drawing. (2 problems)

Computer Graphics: Engineering Graphics Software - Orthographic Projections, Isometric Projections, Co-ordinate Systems, Multi-view Projection.

	To be Taught in laboratory.	Hrs
Part-A	Overview of Computer Graphics Covering: Listing the computer technologies that impact on graphical communication, demonstrating knowledge of the theory of CAD software such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.	3
	Customization & CAD Drawing: Consisting of set up of the drawing page and the printer including scale settings, Setting up of units and drawing limits, ISO and ANSI standards for coordinate dimensioning.	3
	Annotations, layering & other Functions Covering: Applying dimensions to objects, applying annotations to drawings, Setting up and use of layers, layers to create drawings, Create, edit and use customized layers, Changing line lengths through modifying existing lines (extend/lengthen), Printing documents to paper using the print command, orthographic projection techniques, Drawing sectional views of objects (simple machine parts).	4
Part-B	* Activities to be completed in the CAD Laboratory. (All printouts to be the part of Term Work. Preferably, Use A3 size sheets for print out.) <u>Component-3</u>	
	1. Orthographic Projections (without section)- 1 problem	4
	2. Orthographic Projection (with section)- 1 problem	4
	3. Orthographic Reading – 1 problem	2
	4. Isometric Drawing – 3 problem.	4

Note: * Give practice sheet problems before going for Term Sheet problems. Students are supposed to bring complete solution of problems before coming to CAD practical.

Term Work:

Component-1	:	7Marks
Component-2	:	6 Marks
Component-3	:	7 Marks
Attendance	:	5 Marks

Total Marks : 25 Marks

Note: Satisfactory submission of all 3 components is mandatory to full fill the Term.

Topic for the End Semester Practical Examination (Auto CAD) (2 hours/ 50 Marks.)

1. Isometric drawing. (1 problem) (20 Marks)
2. Orthographic Projection (With Section) (1 problem). (30 Marks)

Note:

1. **Printout of the answers have to be taken preferably in A3 size sheets and should be Assessed by External Examiner only.**
2. **Knowledge of Auto CAD software, concepts of Engineering Graphics related to specified problem and accuracy of drawing should be considered during evaluation.**

Text Books.

1. N.D. Bhatt, "Engineering Drawing (Plane and solid geometry)", Charotar Publishing House Pvt. Ltd.
2. N.D. Bhatt & V.M. Panchal, "Machine Drawing", Charotar Publishing House Pvt. Ltd.

Reference Books

1. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publisher.
2. Prof. Sham Tickoo (Purdue University) &GauravVerma, "(CAD Soft Technologies) : Auto CAD 2012 (For engineers and Designers)", Dreamtech Press NewDelhi.
3. Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL204	C programming	--	2	--	--	--	1	1	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg					
FEL204	C programming	--	--	--	--	--	25	25	50

Outcomes: Learner will be able to...

1. Translate given algorithms to a program.
2. Correct syntax and logical errors.
3. Write iterative as well as recursive programs.
4. Represent data in arrays, strings and structures and manipulate them through a program.
5. Declare pointers and demonstrate call by reference concept.

Lab Description:

Weekly 2 hours of laboratory Programming Assignments on the following topics:

1. Basic data types and I/O operations
2. Branching Statements
3. Loop Statements
4. Arrays
5. Strings
6. Functions
7. Recursion
8. Structure and Union
9. Pointers

Term Work:

Experiments (20 Programs) and Assignments (2 Assignments) should be completed by students on the given time duration

Experiments:	15 Marks
Assignment:	05 Marks
Attendance:	05 Marks
Total:	25 Marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Practical and Oral :

Practical and oral Exam should be conducted for the Lab, on Computer Programming in C subject for given list of experiments.

Implementation:	15 Marks
Oral:	10 Marks

Information Technology

Sr. No.	Subject Code	Subject Name	Count
1	ITL301	Digital Design Lab	1
2	ITL302	Data Structures Lab	1
3	IT303	SQL Lab	1
4	ITL304	Java Programming Lab	1
5	ITL401	Networking Lab	1
6	ITL402	Unix Lab	1
7	ITL403	Microprocessor Programming Lab	1
8	ITL404	Python Lab	1
9	ITC501	Microcontroller and Embedded Programming	1
10	ITL501	Internet Programming Lab	1
11	ITL503	OLAP Lab	1
12	ITL502	Security Lab	1
13	ITL504	IOT (Mini Project) Lab	1
14	ITL601	Software Design Lab	1
15	ITL602	Business Intelligence Lab	1
16	ITL603	Cloud Service Design Lab	1
17	ITL604	Sensor Network Lab	1
18	ITM605	Mini-Project	1
19	ITL701	Network Design Lab	1
20	ITL702	Advanced Security Lab	1
21	ITL703	Intelligence System Lab	1
22	ITL704	Android Apps Development Lab	1
23	ITL801	Big Data Lab	1
24	ITL802	Internet of Everything Lab	1
25	ITL803	DevOps Lab	1
26	ITL804	R Programming Lab	1
27	ITM805	Project-II	1
		Total	27

UNIVERSITY OF MUMBAI



Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Under

FACULTY OF TECHNOLOGY

Information Technology

Second Year with Effect from AY 2017-18

Third Year with Effect from AY 2018-19

Final Year with Effect from AY 2019-20

As per **Choice Based Credit and Grading System**

with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande

Co-ordinator,

Faculty of Technology,

Member - Academic Council

University of Mumbai, Mumbai

Preamble

It is an honor and a privilege to present the revised syllabus of Bachelor of Engineering in Information Technology (effective from year 2016-17) with inclusion of cutting edge technology.

Information Technology is comparatively a young branch among other engineering disciplines in the University of Mumbai. It is evident from the placement statistics of various colleges affiliated to the University of Mumbai that IT branch has taken the lead in the placement. The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students, and increased Industry Institute Interactions.

Industries views are that, only 16 % graduates are directly employable. One of the reasons is a syllabus which is not in line with the latest technologies. Our team of faculties has tried to include all the latest technologies in the syllabus. Also the first time we are giving the choice of elective from fifth semester such that students will be master in one of the IT domain.

The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers future trends in IT technology and research opportunities available due to these trends.

I would like to thank senior faculties of IT department of all colleges affiliated to Mumbai University for significant contribution in framing the syllabus. Also behalf of all faculties I thank all the industry experts for their valuable feedback and suggestions.

I sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in the field of information and technology

Program Outcome for graduate Program in Information Technology

1. Apply Core Information Technology knowledge to develop stable and secure IT system.
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology management and security to enterprise processes.
3. Manage IT projects using written and oral communication skills in collaborative environments by Participating on teams that address solutions for IT management challenges.
4. Identify and discuss professional, individual, organizational, societal, and regulatory implications of Information systems and technology.
5. Assess Security of the IT Systems and able to respond to any breach in IT system
6. Ability to work in multidisciplinary projects and make it IT enabled.
7. Ability to propose the system to reduce carbon footprint.
8. Ability to adapt the lifelong learning process to be in sync with trends in Information Technology

Dr. Deven Shah

**Chairman (Ad-hoc Board Information Technology)
University of Mumbai)**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
ITC301	Applied Mathematics III	4+1@	-	-	5	-	-	5
ITC302	Logic Design	4	-	-	4	-	-	4
ITC303	Data Structures & Analysis	4	-	-	4	-	-	4
ITC304	Database Management System	4	-	-	4	-	-	4
ITC305	Principle of Communications	3+1\$	-	-	4	-	-	4
ITL301	Digital Design Lab	-	2	-	-	1	-	1
ITL302	Data Structures Lab	-	2	-	-	1	-	1
IT303	SQL Lab	-	2	-	-	1	-	1
ITL304	Java Programming Lab	-	2+2*	-	-	2	-	2
	Total	21	10	-	21	5	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
ITC301	Applied Mathematics III	20	20	20	80	3	-	-	-	100
ITC302	Logic Design	20	20	20	80	3	-	-	-	100
ITC303	Data Structures & Analysis	20	20	20	80	3	-	-	-	100
ITC304	Database Management System	20	20	20	80	3	-	-	-	100
ITC305	Principle of Communications	20	20	20	80	3	--	-	-	100
ITL301	Digital Design Lab	-	-	-	-	-	25	--	25	50
ITL302	Data Structures Lab	-	-	-	-	-	25	--	25	50
IT303	SQL Lab	-	-	-	-	-	25	-	25	50
ITL304	Java Programming Lab	-	-	-	-	-	50	--	50	100
	Total	100	100	100	400	-	125	--	125	750

@ 4 hours shown as theory to be taken class wise and 1 hour to be taken tutorial as class wise

\$ 3 hours shown as theory to be taken class wise and 1 hour to be taken tutorial as batch wise

* 2 hours shown as practical's to be taken class wise lecture and another 2 hours to be taken as batch wise practices in the lab.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC301	Applied Mathematics III	04	--	01	04	--	--	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of Two Tests					
ITC301	Applied Mathematics III	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

1. The concepts of Set theory and Relation.
2. The concepts of Functions and define the recursive functions.
3. The concept of Laplace transforms.
4. The concept of Inverse Laplace transforms.
5. The concept of permutations and combinations.
6. The concept of variable and also identify the mapping.

Course Outcomes: Students will able to:

1. Apply the Set theory and Relation concepts.
2. Apply the Functions and define the recursive functions.
3. Apply Laplace transform to different applications.
4. Apply Inverse Laplace transform to different applications.
5. Identify the permutations and combinations.
6. Define variable and also identify the mapping.

Prerequisite: Applied Mathematics I, Applied Mathematics II

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic of AM-I and AM-II.	02	
I	Set Theory	Set Theory: Definition of Sets, Venn Diagrams, complements, cartesian products, power sets, counting principle, cardinality and countability (Countable and Uncountable sets), proofs of some general identities on sets, pigeonhole principle.	08	CO1

II	Relation & Function	<p>Relation: Definition, types of relation, composition of relations, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation.</p> <p>Function: Definition and types of function, composition of functions, recursively defined functions.</p>	08	CO1 CO2
III	Laplace Transform	<p>Introduction, Definition of Laplace transforms Laplace transform of constant, trigonometrical, exponential functions. Important properties of Laplace transform: First shifting theorem, Laplace transform of $L\{f(at)\}$, $L\{t^n f(t)\}$, $L\left\{\frac{f(t)}{t}\right\}$, $L\left\{\frac{d^n f(t)}{dt^n}\right\}$, $L\left\{\int_0^t f(u)du\right\}$ (all without proof).</p> <p>Unit step function, Heavi side function, Dirac-delta function, Periodic function and their Laplace transforms, Second shifting theorem.</p>	08	CO3
IV	Inverse Laplace Transform	<p>Inverse Laplace transform with Partial fraction and Convolution theorem (without proof).</p> <p>Application to solve initial and boundary value problem involving ordinary differential equations with one dependent variable and constant coefficients.</p>	08	CO4
V	Complex Variable & mapping	<p>Functions of a complex variable, Analytic functions, Cauchy-Riemann equations in Cartesian co-ordinates, Polar co-ordinates. Harmonic functions, Analytic method and Milne Thomson methods to find $f(z)$, Orthogonal trajectories.</p> <p>Conformal Mapping, Linear, Bilinear transformations, Cross ratio, fixed points and standard transformation such as rotation and magnification, inversion, translation.</p>	10	CO6
VI	Permutations, Combinations and Probability	<p>Rule of sum and product, Permutations, Combinations, Algorithms for generation of</p>	08	CO5

		Permutations and Combinations. Discrete Probability, Conditional Probability, Bayes' Theorem, Information and Mutual Information.		
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Text Books:

1. Higher Engineering Mathematics by Grewal B. S. 38th edition, Khanna Publication 2005.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
3. A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan, Pune.
4. Modern Digital Electronics by R. P. Jain 8th edition, Tata Mcgraw Hill
5. C. L. Liu and D. P. Mohapatra, "Elements of Discrete Mathematics", SiE Edition, TataMcGraw-Hill.

References:

1. Advanced Engineering Mathematics by C. Ray Wylie & Louis Barrett, TMH International Edition.
2. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
3. Laplace Transforms by Murray R. Spiegel, Schaun's out line series-McGraw Hill Publication.

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC302	Logic Design	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Two Tests					
ITC302	Logic Design	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

1. The concept of various components.
2. The concepts that underpin the disciplines of Analog and digital electronic logic circuits.
3. Various Number system and Boolean algebra.
4. Design and implementation of combinational circuits
5. Design and implementation of Sequential circuits
6. Hardware description language

Course Outcomes: Students will able to:

1. Understand the concepts of various components to design stable analog circuits.
2. Represent numbers and perform arithmetic operations.
3. Minimize the Boolean expression using Boolean algebra and design it using logic gates
4. Analyze and design combinational circuit.
5. Design and develop sequential circuits
6. Translate real world problems into digital logic formulations using VHDL.

Prerequisite: Basic Electrical Engineering

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Semiconductor theory, Diodes, Integrated Circuits	02	
I	Biasing of BJT	Biasing of BJT: DC operating point, BJT characteristics & parameters, all biasing circuits, analysis of above circuits and their design, variation of operation point and its stability. Differential	08	CO1

		Amplifier, constant current source, current mirror.		
II	Number System and codes	Introduction to Number systems, Binary Number systems, Signed Binary Numbers, Binary, Octal, Decimal and Hexadecimal number Systems and their conversion, Binary arithmetic using compliments, Gray Code, BCD Code, Excess-3 code, ASCII Code.inter-conversion of codes,	08	CO2
III	Boolean Algebra and Logic gates	Introduction, NAND and NOR operations, Exclusive –OR and Exclusive –NOR operations, Boolean Algebra Theorems and Properties , Standard SOP and POS form, Reduction of Boolean functions using Algebraic method, K-map method (2,3,4 Variable).Variable entered Maps, Quine Mc Cluskey, Mixed Logic Combinational Circuits and multiple output function Basic Digital Circuits: NOT,AND, OR,NAND,NOR,EX-OR,EX-NOR Gates.	10	CO2 CO3
IV	Design and Analysis of Combinational Circuits	Introduction, Half and Full Adder, Half and Full Subtractor, Four Bit Binary Adder, One digit BCD Adder, code conversion, Encoder and Decoder ,Multiplexers and Demultiplexers, Decoders, Binary comparator (2,3 variable)4-bit Magnitude Comparator IC 7485 and ALU IC74181.	08	CO2 CO3 CO4
V	Sequential Logic Design	Flip Flops : SR, JK, D, T, master slave flip flop, Truth Table, excitation table and conversion Register: Shift register, SISO, SIPO, PISO, PIPO, Bi-directional and universal shift register. Counters: Design of synchronous and asynchronous ,Modulo Counter, Up Down counter IC 74193, Ring and Johnson Counter	9	CO4 CO5
VI	VHDL	Introduction to VHDL, Library, Entity, Architecture Modeling styles, Concurrent and Sequential statements, data objects and data types, attributes, design examples	07	CO5 CO6

		for combinational circuits		
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Text Books:

1. Robert L. Boylestad, Louis Nashelsky, “Electronic devices and circuit Theory”, PHI
2. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill.
3. M. Morris Mano, “Digital Logic and computer Design”, PHI
4. J. Bhasker. “VHDL Primer”, Pearson Education.
5. Balbaniam, Carison, “Digital Logic Design Principles”, Wiley Publication

References:

1. Martin s. Roden, Gordon L. Carpenter, William R. Wieserman “Electronic Design-From Concept to Reality”, Shroff Publishers and Distributors.
2. A. Anand Kumar, “Fundamentals of Digital Circuits ”, Prentice Hall India
3. Subrata Ghosal, ”Digital Electronics”, Cengage Learning.
4. Anil K. Maini, “Digital Electronics Principles and Integrated Circuits”, Wiley India
5. Donald p Leach, Albert Paul Malvino, “Digital principles and Applications”, Tata McGraw Hill

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC303	Data Structures & Analysis	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of two Tests					
ITC303	Data Structures & Analysis	20	20	20	80	--	--	--	100

Course Objectives: Students will try to:

1. Understand and remember algorithms and its analysis procedure.
2. Introduce the concept of data structures through ADT including List, Stack, Queues .
3. To design and implement various data structure algorithms.
4. To introduce various techniques for representation of the data in the real world.
5. To develop application using data structure algorithms.
6. Compute the complexity of various algorithms.

Course Outcomes: Students will be able to:

1. Select appropriate data structures as applied to specified problem definition.
2. Implement operations like searching, insertion, and deletion, traversing mechanism etc. on various data structures.
3. Students will be able to implement Linear and Non-Linear data structures.
4. Implement appropriate sorting/searching technique for given problem.
5. Design advance data structure using Non-Linear data structure.
6. Determine and analyze the complexity of given Algorithms.

Prerequisite: C Programming Language

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	C Programming Language	02	
I		Introduction to Data structures, Need of Data structures, Types of	07	CO1

	Introduction to Data structures and Analysis	Data structures : Linear and non linear data structures Arrays, Stacks, Queue, Linked list and Tree, Graph, Recursion, ADT (Abstract Data type). Introduction to Analysis, Algorithms, characteristics of an algorithms, Time and Space complexities, Order of growth functions, Asymptotic notations		CO2 CO3 CO6
II	Stack	Introduction to Stack, Stack as ADT, Operations on stack, Application of stack: – reversing string, Polish notations	07	CO1 CO2 CO3 CO6
III	Queue	Introduction to Queue, Queue as ADT, Operations on Queue, Linear representation of queue, Circular Queue, Priority Queue, De-queue, Application of Queues	06	CO1 CO2 CO3 CO6
IV	Linked list	Introduction to Linked List, Basic concept of Linked List, Memory allocation & de allocation of Linked list, Singly Linked list, Doubly Linked list, Circular linked list, Operations on linked list, Linked representation of stack, Linked representation of Queue, Application of linked list.	08	CO1 CO2 CO3 CO6
V	Sorting and Searching	Introduction to Sorting: Bubble Sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Shell Sort, Radix sort. Analysis of Sorting Techniques. Comparison of sorting Techniques Introduction to Searching: Linear	12	CO4 CO5 CO6

		search, Binary search, Hashing Techniques, Different Hash functions, Collision& Collision resolution techniques, Analysis of searching Techniques.		
VI	Trees & Graph	Introduction to Trees, Definitions& Tree terminologies, Binary tree representation, Operations on binary tree, Traversal of binary trees, Binary search tree, Threaded Binary tree, Expression tree, Application of Trees Introduction to Graph, Introduction Graph Terminologies, Graph Representation, Type of graphs, Graph traversal:Depth first search(DFS)&Breadth First search(BFS), Minimum Spanning Tree : Prim's & Kruskal's Shortest Path Algorithm – Dijkstra's Algorithm. Applications of graph	10	CO1 CO2 CO3 CO6

Text Books:

1. Data structures using C by Tenenbaum, Langsam, Augenstein , Pearson.
2. Data Structures using C, ReemaThareja, Oxford.
3. C and Data structures, Prof. P.S.Deshpande, Prof. O.G.Kakde, Dreamtech Press.
4. Introduction to Data Structure and its Applications Jean-Paul Tremblay, P. G. Sorenson

Reference Books:

1. Data Structures Using C & C++, Rajesh K. Shukla, Wiley- India.
2. Data Structures and Algorithm Analysis in C ,Mark A.Weiss ,Pearson
3. ALGORITHMS Design and Analysis, Bhasin, OXFORD.
4. Computer Algorithms by Ellis Horowitz and Sartaj Sahni, Universities Press.

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**

- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC304	Database Management Systems	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory Marks					Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test 2	Avg. of two Tests						
ITC304	Database Management Systems	20	20	20	80	--	--	--	100	

Course Objectives: Students will try:

1. To describe a sound introduction to the discipline of database management systems.
2. To give a good formal foundation on the relational model of data and usage of Relational Algebra
3. To introduce the concepts of basic SQL as a universal Database language
4. To enhance knowledge to advanced SQL topics like embedded SQL, procedures connectivity through JDBC
5. To demonstrate the principles behind systematic database design approaches by covering conceptual design, logical design through normalization
6. To provide an overview of physical design of a database system, by discussing Database indexing techniques and storage techniques.

Course Outcomes: Student should be able to:

1. Explain the features of database management systems and Relational database
2. Design conceptual models of a database using ER modeling for real life applications and also construct queries in Relational Algebra
3. Create and populate a RDBMS for a real life application, with constraints and keys, using SQL.
4. Retrieve any type of information from a data base by formulating complex queries in SQL.
5. Analyze the existing design of a database schema and apply concepts of normalization to design an optimal database.
6. Build indexing mechanisms for efficient retrieval of information from a database

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Basic knowledge of operating systems and file systems, Any programming	02	

		knowledge		
I	Introduction Database Concepts	Introduction, Characteristics of databases, File system V/s Database system, Users of a Database system Data Models, Schemas, and Instances, Three-Schema Architecture and Data Independence, Database Administrator (DBA), Role of a DBA	05	CO 1
II	Entity–Relationship Data Model	Conceptual Modeling of a database, The Entity-Relationship (ER) Model, Entity Types, Entity Sets, Attributes, and Keys, Relationship Types, Relationship Sets, Weak Entity Types Generalization, Specialization and Aggregation, Extended Entity-Relationship (EER) Model.	09	CO 2
III	Relational Model and Relational Algebra	Introduction to Relational Model, Relational Model Constraints and Relational Database Schemas, Concept of Keys: Primary Key, Secondary key, Foreign Key, Mapping the ER and EER Model to the Relational Model, Introduction to Relational Algebra, Relational Algebra expressions for <ul style="list-style-type: none"> • Unary Relational Operations, • Set Theory operations, • Binary Relational operation Relational Algebra Queries	09	CO 2
IV	Structured Query Language (SQL)	Overview of SQL , Data Definition Commands, Set operations , aggregate function , null values, , Data Manipulation commands, Data Control commands , Views in SQL, Complex Retrieval Queries using Group By, Recursive Queries, nested Queries ; Referential integrity in SQL. Event Condition Action (ECA) model (Triggers) in SQL; Database Programming with JDBC, Security and authorization in SQL Functions and Procedures in SQL and cursors.	10	CO 3, CO 4
V	Relational–Database Design	Design guidelines for relational schema, Functional Dependencies, Definition of Normal Forms- 1NF, 2NF, 3NF, BCNF, Converting Relational Schema to higher normal forms.	08	CO 5

VI	Storage and Indexing	Operation on Files; hashing Techniques; Types of Indexes: Single-Level Ordered Indexes; Multilevel Indexes; Overview of B-Trees and B+-Trees; Indexes on Multiple Keys.	09	CO 6
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Text Books:

1. Korth, Silberchatz, Sudarshan, "Database System Concepts", 6th Edition, McGraw – Hill
2. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
3. G. K. Gupta : "Database Management Systems", McGraw – Hill

References:

1. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH
2. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom "Database System Implementation", Pearson Ltd. 1/ e
3. Thomas M. Connolly Carolyn Begg, Database Systems : A Practical Approach to Design, Implementation and Management, 4/e, Pearson Education.

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC305	Principle of Communications	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITC305	Principle of Communications	20	20	20	80	--	--	--	100

\$ 3 hours shown as theory to be taken class wise and 1 hour to be taken tutorial as batch wise

Course Objectives: Students will try to:

1. Study the basic principles and techniques used in analog and digital communications.
2. Understand the concept of noise and Fourier transform for designing and analysing communication system.
3. Acquire the knowledge of different modulation techniques such as AM , FM and study the block diagrams of transmitter and receiver.
4. Study the Sampling theorem and Pulse Analog Modulation techniques.
5. Learn the concepts of Digital modulation techniques such as PCM, DM, ADM and multiplexing techniques.
6. Gain the core idea of Electromagnetic Radiation and propagation of waves.

Course Outcomes: Students will be able to:

1. Differentiate analog and digital communication systems
2. Identify different types of noise occurred, its minimization and able to apply Fourier analysis in frequency & time domain to quantify bandwidth requirement of variety of analog and digital communication systems.
3. Design generation & detection AM, DSB, SSB, FM transmitter and receiver.
4. Apply sampling theorem to quantify the fundamental relationship between channel bandwidth, digital symbol rate and bit rate
5. Explain different types of line coding techniques for generation and detection of signals.
6. Describe Electromagnetic Radiation and propagation of waves.

Prerequisite: Basic Electrical Engineering

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Electrical engineering concepts, analog and digital electronics.	02	--
I	Introduction	Basics of analog communication systems (Block diagram), Sources of information, Baseband and band pass signals, Types of communication channels, Frequency / Spectrum allocations, Need for modulation and demodulation	03	CO1
II	Fourier Transform and Noise	Introduction to Fourier Transform, its properties (time and frequency shifting and convolution property), Fourier transform of unit step, delta and gate function. Correlated and uncorrelated sources of noise in communication system, Noise parameters –Signal to noise ratio, Noise factor, Noise figure, Friis formula and Equivalent noise temperature	05	CO2
III	Modulation and Demodulation (AM and FM)	AM: Amplitude modulation techniques and its types- DSBFC AM, DSBSC-AM, SSB SC AM-spectrum, waveforms, bandwidth, Power calculations. AM Receivers – Block diagram of TRF receivers and Super heterodyne receiver. Receiver characteristics - Sensitivity, Selectivity, Fidelity, Image frequency and its rejection and double spotting FM : Principle of FM- waveforms, spectrum, bandwidth. Pre-emphasis and de-emphasis in FM, FM noise triangle, Comparison of AM and FM systems, FM generation: Direct method –Varactor diode Modulator, Indirect method (Armstrong method) block diagram and waveforms. FM demodulator: Foster Seely discriminator, Ratio detector.	12	CO3
IV	Pulse Analog Modulation	Sampling theorem for low pass and band pass signals with proof, Anti- aliasing filter, PAM, PWM and PPM generation and	05	CO4

		Degeneration.		
V	Digital Modulation Techniques and Transmission	Introduction to digital communication (Block diagram), Quantization process, Pulse code modulation, Delta modulation, Adaptive delta modulation, Principle of time division multiplexing, Frequency division multiplexing and its applications. Introduction to Line codes, Inter-symbol interference, Binary phase shift keying, Differentially encoded phase shift keying, Quadrature phase shift keying, M-ary phase shift keying, Quadrature amplitude shift keying	08	CO5
VI	Radiation and Propagation of Waves	Electromagnetic radiation, fundamentals, types of propagation, ground wave, sky wave, tropospheric scatter propagation	04	CO6

Text Books:

1. Simon Haykin, Michael Moher, Introduction to Analog & Digital Communications, Wiley India Pvt. Ltd., 2nd Ed.
2. Herbert Taub, Donald L Schilling, Goutam Saha, Principles of Communication Systems, Tata McGraw Hill, 3rdEd.
3. V Chandrasekar, Communication Systems, Oxford University Press, 1st Ed.

References:

1. George Kennedy, Bernard Davis, SRM Prasanna, Electronic Communication Systems, Tata McGraw Hill, 5th Ed.
2. Wayne Tomasi, Electronic Communications Systems, Pearson Publication, 5th Ed.
3. BP Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University.
4. K Sam Shanmugam, Digital and Analog Communication Systems, Wiley India Pvt. Ltd, 1st Ed.

Suggested Topics for Tutorials (Any 10):

1. Demonstration of Amplitude modulation.
2. Demonstration of Frequency modulation.
3. Study of AM/ FM receiver.
4. Demonstration of Signal sampling and reconstruction.
5. Study of PWM generation and detection.
6. Study of PCM coding and decoding.
7. Study of Delta modulation and demodulation
8. Demonstration of TDM/ FDM.
9. Demonstration of BPSK, BFSK, BASK
10. Study of QPSK
11. Study of Inter symbol Interference and Line coding.
12. Study of different types of Propagation.

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ITL301	Digital Design Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITL301	Digital Design Lab	--	--	--	--	25	25	50

Lab Objectives: Students will try to:

1. Learn to minimize and design combinational logic;
2. Understand the relationships between combination logic and Boolean algebra, and between sequential logic and finite state machines;
3. Appreciate tradeoffs in complexity and speed of combinational designs;
4. Understand how state can be stored in a digital logic circuit;
5. Study how to design a simple finite state machine from a specification and be able to implement this in gates and edge triggered flip-flops
6. Learn to translate real world problems into digital logic formulations

Lab Outcomes: Students will be able to:

1. Minimize the Boolean algebra and design it using logic gates.
2. Analyse and design combinational circuit.
3. Realise given function using combinational circuit.
4. Design and develop sequential circuits
5. Implement digital systems using programmable logic devices
6. Translate real world problems into digital logic formulations using VHDL.

Prerequisite: Concepts of Logic Design

Hardware requirement:

Digital Trainer kit, ICs for various logic gates and functions, connecting wires

Software requirement:

VHDL tool

Detail Syllabus:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
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I	Boolean Algebra and Logic gates	a. Verify the truth table of logic gates (basic and universal gates) b. Realization of Boolean algebra using gates	04	LO1
II	Design and Analysis of Combinational Circuits	a. Design of Full Adder and Full Subtractor. b. verify the operation of 4- bit magnitude comparator	04	LO2
III	Implementation of Combinational Circuits	a. Implementation of MUX and DeMUX. b. Implementation of Encoder and Decoder	04	LO3
IV	Sequential Logic Design	a. To verify and observe the operation of flip-flop(any two) b. To design any two shift register. c. To design Modulo and ring Counter	06	LO4
V	Programmable logic Devices	a. Evaluate and observe Boolean expression using PALs and PLAs..	04	LO5
VI	VHDL	a. Implementation of Logic Gates using VHD b. Evaluate and observe combinational circuits on VHDL.	04	LO6

Text Books:

1. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill.
2. Balbaniam, Carison, "Digital Logic Design Principles", Wiley Publication

References:

1. M. Morris Mano, "Digital Logic and computer Design", PHI
2. J. Bhasker. "VHDL Primer", Pearson Education.

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral & Practical Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ITL302	Data Structures Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITL302	Data Structures Lab	--	--	--	--	25	25	50

Lab Objectives: Students will try:

1. Understand and remember algorithms and its analysis procedure.
2. Introduce the concept of data structures through ADT including List, Stack, Queues .
3. To design and implement various data structure algorithms.
4. To introduce various techniques for representation of the data in the real world.
5. To develop application using data structure algorithms.
6. Compute the complexity of various algorithms.

Lab Outcomes: Students will be able to:

1. Select appropriate data structures as applied to specified problem definition.
2. Implement operations like searching, insertion, and deletion, traversing mechanism etc. on various data structures.
3. Students will be able to implement Linear and Non-Linear data structures.
4. Implement appropriate sorting/searching technique for given problem.
5. Design advance data structure using Non-Linear data structure.
6. Determine and analyze the complexity of given Algorithms.

Prerequisite: C Programming Language

Hardware Requirement: PC i3 processor and above	Software requirement: Turbo/Borland C complier.
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Detailed Syllabus:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Introduction of C programming language		
I	Stack	<ol style="list-style-type: none"> 1. Implementations of stack menu driven program 2. Implementation of multistack in one array. 3. *Implementations of Infix to Postfix Transformation and its evaluation program. 4. Implementations of Infix to Prefix Transformation and its evaluation program. 	04	LO1 LO2 LO3 LO6
II	Queue	<ol style="list-style-type: none"> 1. Implementations of circular queue menu driven program 2. * Implementations of double ended queue menu driven program 3. Implementations of queue menu driven program 4. Implementation of Priority queue program using array. 	04	LO1 LO2 LO3 LO6
III	Linked List	<ol style="list-style-type: none"> 1. Implementations of Linked Lists menu driven program. 2. *Implementation of different operations on linked list –copy, concatenate, split, reverse, count no. of nodes etc 3. Implementation of polynomials operations (addition, subtraction) using Linked List. 4. Implementations of Linked Lists menu driven program (stack and queue) 	04	LO1 LO2 LO3 LO6
IV	Tree & Graph	<ol style="list-style-type: none"> 1. Implementations of Binary Tree menu driven program 2. Implementation of Binary Tree Traversal program. 3. *Implementation of construction of expression tree using postfix expression. 4. Implementations of BST program 5. Implementation of various operations on tree like – copying tree, mirroring a tree, counting the number of nodes in the tree, counting only 	04	LO1 LO2 LO3 LO6

		leaf nodes in the tree. 6. Implementation of Preorder traversal of a threaded binary tree. 7. Implementations of Huffman code construction 8. Implementations of Graph menu driven program (DFS & BSF)		
V	Sorting	1. Implementations of Shell sort, Radix sort and Insertion sort menu driven program. 2. *Implementations of Quick Sort, Merge sort and Heap Sort menu driven program 3. Implementations of Advanced Bubble Sort, Insertion Sort and Selection Sort menu driven program	04	LO4 LO5 LO6
VI	Searching	1. Implementations of searching methods (Index Sequential, Interpolation Search) menu driven program 2. *Implementation of hashing functions with different collision resolution techniques	02	LO4 LO5 LO6

Text Books:

1. Data structures using C by Tenenbaum, Langsam, Augenstein , Pearson.
2. Data Structures using C, ReemaThareja, Oxford.

Reference Books:

1. C and Data structures, Prof. P.S.Deshpande, Prof. O.G.Kakde, Dreamtech Press.
2. Data Structures A Pseudocode Approach with C, Richard F. Gilberg & Behrouz A. Forouzan, second edition, CENGAGE Learning.

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral & Practical Exam: An Oral & Practical exam will be held based on the above syllabus.

		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ITL303	SQL Lab	--	2	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of 2 Tests				
ITL303	SQL Lab	--	--	--	--	25	25	50

Course Objectives: Students will try:

1. To provide a sound introduction to the creation of problem statements from real life situations.
2. To give a good formal foundation on the relational model of data and usage of Relational Algebra.
3. To introduce the concepts of basic SQL as a universal Database language.
4. To enhance knowledge to advanced SQL topics like embedded SQL, procedures connectivity through JDBC.
5. To enable the design of an efficient database using normalization concepts.
6. To enable students to be create indexes for databases for efficient retrieval.

Course Outcomes: Student should be able to:

1. Construct problem definition statements for real life applications and implement a database for the same.
2. Design conceptual models of a database using ER modeling for real life applications and also construct queries in Relational Algebra.
3. Create and populate a RDBMS, using SQL.
4. Write queries in SQL to retrieve any type of information from a data base.
5. Analyze and apply concepts of normalization to design an optimal database.
6. Implement indexes for a database using techniques like B or B+ trees.

Hardware Requirement: PC i3 processor and above	Software requirement: Any SQL Compiler
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Prerequisite: C Programming Language

Detailed syllabus:

Sr. No.	Detailed Content	Hours	CO Mapping
1	a) Students to be given assignments to construct detailed problem definitions for real life applications. b) Construction of ER/EER diagrams for the given problems. c) Assignment based on relational Algebra	4	CO 1 CO 2
2	a) Basic SQL Queries-DDL and DML. b) Construction of Database-Keys c) Population of the database	5	CO 3
3	Complex Queries using group by, nested queries, recursive queries, joins, views, Triggers, Cursors	5	CO 4
4	Design and Implementation of a fully fledged Database with front end for a real life application (Using JDBC)	4	CO 1
5	Assignment for conversion of relation to different normal forms.	2	CO 5
6	Program for construction of index- B-Tree / B+-Tree	4	CO 6

Text Books:

1. SQL The Complete Reference, 3rd Edition , James R Groff, Paul N. Weinberg, Andy Oppel, McGraw Hill.
2. G. K. Gupta :”Database Management Systems”, McGraw – Hill

References:

1. Korth, Silberchatz,Sudarshan, :”Database System Concepts”, 6th Edition, McGraw – Hill
2. Raghuramkrishnan and Johannes Gehrke, “ Database Management Systems”, TMH

Term Work:

Term Work shall consist of at least 10 to 12 practical’s based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral & Practical Exam: An Oral & Practical exam will be held based on the above SQL syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ITL304	Java Programming Lab	--	2+2*	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of two Tests				
ITL304	Java Programming Lab	--	--	--	--	50	50	100

* 2 hours shown as practical's to be taken class wise lecture and other 2 hours to be taken as batch wise practical's in Lab.

Lab Objectives: Students will try:

1. To understand how to design, implement, test, debug, and document programs that use basic data types and computation, simple I/O, conditional and control structures, string handling and functions.
2. To understand the importance of Classes & objects along with constructors, Arrays and Vectors.
3. Discuss the principles of inheritance, interface and packages and demonstrate through problem analysis assignments how they relate to the design of methods, abstract classes and interfaces and packages.
4. To understand importance of Multi-threading & different exception handling mechanisms.
5. To learn experience of designing, implementing, testing, and debugging graphical user interfaces in Java using applet and AWT that respond to different user events.
6. To understand Java Swings for designing GUI applications based on MVC architecture.

Lab Outcomes: Upon Completion of the course the learner should be able to:

1. Implement Object Oriented programming concept using basic syntaxes of control Structures, strings and function for developing skills of logic building activity.
2. Identify classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem
3. Demonstrates how to achieve reusability using inheritance, interfaces and packages and describes faster application development can be achieved.
4. Demonstrate understanding and use of different exception handling mechanisms and

- concept of multithreading for robust faster and efficient application development.
5. Identify and describe common abstract user interface components to design GUI in Java using Applet & AWT along with response to events
 6. Identify, Design & develop complex Graphical user interfaces using principal Java Swing classes based on MVC architecture

Hardware Requirements	Software Requirements	Other Requirements
PC With Following Configuration 1. Intel PIV Processor 2. 2 GB RAM 3. 500 GB Harddisk 4. Network interface card	1. Windows or Linux Desktop OS 2. JDK 1.8 or higher 3. Notepad ++ 4. JAVA IDEs like Netbeans or Eclipse	1. Internet Connection for installing additional packages if required

Detailed Syllabus:

Sr. No.	Module	Detailed Contents	Hours	LO Mapping
1)	Fundamental of Java Programming	<p>Theory</p> <p>1.1 Overview of procedure and object oriented Programming, Java Designing Goals, Features of Java Language.</p> <p>1.2 Introduction to the principles of object-oriented programming: Classes, Objects, Abstraction, Encapsulation, Inheritance, Polymorphism,</p> <p>1.3 Keywords, Data types, Variables, Operators, Expressions, Types of variables and methods.</p> <p>1.4 Control Statements: If Statement, If-else, Nested if, switch Statement, break, continue. Iteration Statements: for loop, while loop, and do-while loop.</p> <p>Experiment 1:</p> <p>(Perform any three programs that covers Classes, Methods, Control structures and Looping statements)</p> <p>i) Write a Java program to understand how to accept input using Scanner or</p>	12	LO 1 LO 2

		<p>BufferedReader and print output using System.out.println statement.</p> <p>ii) Write a Java program to display the default value of all primitive data types in Java.</p> <p>iii) Write a Java program that prints all real solutions to the quadratic equation $ax^2+bx+c = 0$. Read in a, b, c and use the quadratic formula. If the discriminant b^2-4ac is negative, display a message stating that there are no real solutions.</p> <p>iv) Write a java program to test whether string is palindrome or not</p> <p>v) Write a java program to count number of alphabets, digits, special symbols, blank spaces and words from the given sentence.</p> <p>vi) Write a java program to count number of vowels and consonants from the given strings.</p> <p>vii) Write a Menu driven program in java to implement simple banking application. Application should read the customer name, account number, initial balance, rate of interest, contact number and address field etc. Application should have following methods.</p> <ol style="list-style-type: none"> 1. createAccount() 2. deposit() 3. withdraw() 4. computeInterest() 5. displayBalance() <p>viii) Write a menu driven Java program which will</p>		
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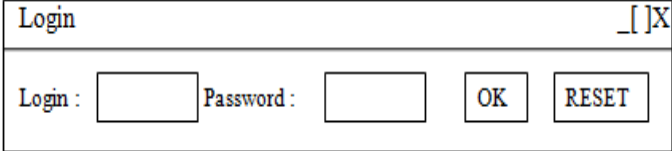
		<p>read a number and should implement the following methods</p> <ol style="list-style-type: none"> 1. factorial() 2. reverse() 3. testArmstrong() 4. testPalindrome() 5. testPrime() 6. fibonacciSeries() <p>ix) Write a Java program to demonstrate Method overloading</p>		
2)	<p>Classes, Objects, Arrays and Recursion</p>	<p>Theory</p> <p>2.1 Classes & Objects: Class Fundamentals: Assigning Object Reference Variables, Passing parameters to Methods and Returning parameters from the methods, Nested and Inner Classes.</p> <p>2.2 Constructors: Parameterized Constructors, finalize() Method, Method overloading, Constructors overloading, Recursion, Command-Line Arguments.</p> <p>2.3 Wrapper classes, Java.util.Scanner, Java.io.BufferedReader, Java.io.DataInputStream, Java.io.DataOutputStream and String Buffer classes and String functions.</p> <p>2.4 Arrays & Vectors: One Dimensional arrays, Two Dimensional array, Irregular arrays, dynamic arrays, Array List and Array of Object.</p> <p>Experiment 2</p> <p>(Perform any Five programs that covers Classes & objects, Constructors, Command Line Arguments,</p>	12	<p>LO 1</p> <p>LO 2</p>

		<p>Arrays/Vectors & recursions)</p> <ul style="list-style-type: none"> i) Write a java program to demonstrate Constructors, Parameterized Constructors and Constructor Overloading ii) Write a java program to demonstrate Command Line Arguments iii) Write a java program to demonstrate String Functions iv) Write a java program to demonstrate Array and Vectors operations v) Write a java programs to add n strings in a vector array. Input new string and check whether it is present in the vector. If it is present delete it otherwise add it to the vector. vi) Write a java programs to test whether the given element is present in the vector array. vii) Write a java programs to find frequency of a element in the given Vector array. viii) Write a java programs to add n strings in a vector array. Input new string and check whether it is present in the vector. If it is present delete it otherwise add it to the vector. ix) Write menu driven program to implement recursive functions for following tasks. <ul style="list-style-type: none"> a) To find GCD and LCM b) To find X^Y c) To print n Fibonacci numbers 		
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		<p>d) To find reverse of number</p> <p>e) To $1+2+3+4+\dots+(n-1)+n$</p> <p>x) Write the Menu driven program to perform</p> <p>a) Addition of two matrices of order $m*n$ and $p*q$</p> <p>b) Multiplication of two matrices of order $m*n$ and $p*q$</p> <p>c) Transpose of matrix of order $m*n$</p> <p>d) addition of diagonal and non-diagonal elements</p>		
3)	Inheritance, Interface and Packages	<p>Theory</p> <p>3.1 Inheritance Basics, , Types of Inheritance in Java, Concept of Super and sub class, inheriting Data members and Methods, Role of Constructors in inheritance, Making methods and classes final , Method overriding, Dynamic Method Dispatch, Abstract classes and methods</p> <p>3.2 Defining an interface, extending interfaces , implementing interfaces, accessing implementations through interface references, Interfaces vs. Abstract classes.</p> <p>3.3 Packages – Steps for defining, creating and accessing a Package, importing packages, Making JAR Files for Library Packages, java.util.Vector</p> <p>Experiment 3</p> <p>(Perform any Two programs that covers Inheritance, interfaces and packages)</p> <p>i) Write a java programs to demonstrate hierarchical inheritance</p> <p>ii) Write a java program to demonstrate extending & implementing Interfaces</p>	08	LO 3

		<p>iii) Write a java program to demonstrate Modules and packages</p> <p>iv) Write a java program to create user defined packages</p>		
4)	Exception Handling and Multithreading	<p>Theory:</p> <p>4.1 Exception handling Mechanism: try, catch, throw, throws and finally.</p> <p>4.2 Multithreading: Need of Multithreading , Java thread Model, thread Life-Cycle, thread class Methods, Implementing Runnable, Extending thread, Synchronizing threads, synchronized Statement, Critical Factor in Thread –Deadlock.</p> <p>Experiment 4</p> <p>(Perform any Two programs that covers Exception Handling & Multithreading)</p> <p>i) Write java programs to demonstrate Exception handling using try, catch, throw, throws and finally statements.</p> <p>ii) Write a Java Program to input the data through command Line and Find out total valid and in-valid integers. (Hint: use exception handling).</p> <p>iii) Write a Java Program to calculate the Result. Result should consist of name, seatno, date, center number and marks of semester three exam. Create a User Defined Exception class MarksOutOfBoundsException, If Entered marks of any subject is greater than 100 or less than 0, and then program should create a user defined Exception of type MarksOutOfBoundsException and must have a provision to handle it.</p>	06	LO3 LO 4

		<p>iv) Write java program to create a user defined Exception class known as PayOutOfBoundsException. Organization does not offer basic salary less than 8000. If entered salary is less than 8000 then program should create an Exception of Type PayOutOfBoundsException. Program should calculate gross salary by considering salary parameters such as DA, HRA, CA, TA, Professional tax, TDS, PF.. etc</p> <p>v) Write java programs to create user defined threads by extending thread class and by implementing runnable.</p> <p>vi) Write java program to print Table of Five, Seven and Thirteen using Multithreading (Use Thread class for the implementation) .</p> <p>vii) Write a java program to print first 20 prime numbers and 15 Fibonacci numbers by creating two child threads and also print the total time taken by each thread for the execution.</p> <p>viii) Write a java program to implement use of nested try-catch concept using appropriate example.</p> <p>ix) Write java program to create the child thread. Comment on the execution of main and Child Thread.</p> <p>x) Write java program to implement the concept of Thread Synchronization</p> <p>xi) Write a Java program to identify whether inputted data is byte/short/int/long/float/double/String/char type. (Use Exception Handling)</p>		
5)	Applet Programming, GUI	5.1 Applet: Applet fundamentals, Applet lifecycle, Creating applet, paint method Applet tag, Applet class methods.	10	LO3 LO4

	<p>development using AWT and Event handling</p>	<p>5.2 Designing Graphical User Interfaces in Java, Components and Containers, Basics of Components, Using Containers, Layout Managers, AWT Components, Adding a Menu to Window, Extending GUI Features</p> <p>5.3 Event-Driven Programming in Java, Event-Handling Process, Event- Handling Mechanism, Delegation Model of Event Handling, Event Classes, Event Sources, Event Listeners, Adapter Classes as Helper Classes in Event Handling.</p> <p>Experiment 5</p> <p>(Perform any Three programs that covers Applet Programming, GUI development using AWT and Event handling)</p> <p>i) Write java program to draw the house on an applet.</p> <p>ii) On Applet: Take a Login and Password from the user and display it on the third Text Field which appears only on clicking OK button and clear both the Text Fields on clicking RESET button Perform same using AWT and Swings as well.</p>  <p>iii) Write java program to create an advertisement banner on an applet using multithreading</p> <p>iv) Write java program to create a registration form using AWT.</p> <p>v) Write a Java program to demonstrate the use of AWT components namely buttons, labels, text boxes, lists/combo boxes, menus with event handling.</p>	<p>LO 5</p>
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		vi) Write a java program to store personal telephone directory in such a way that when user hits a character, the names which starts with the character and telephone numbers should appear.		
6)	Java Swings	<p>Theory</p> <p>6.1 Introducing Swing: AWT vs Swings, Components and Containers, Swing Packages, A Simple Swing Application, Painting in Swing, Designing Swing GUI Application using Buttons, JLabels, Checkboxes, Radio Buttons, JScrollPane, JList, JComboBox, Trees, Tables Scroll pane Menus and Toolbars</p> <p>Experiment 6</p> <p>(Perform any one programs that covers concept of Swings)</p> <p>i) Write a Java program to implement Swing components namely Buttons, JLabels, Checkboxes, Radio Buttons, JScrollPane, JList, JComboBox, Trees, Tables Scroll pane Menus and Toolbars to design interactive GUI.</p> <p>ii) Write a program to create a window with four text fields for the name, street, city and pincode with suitable labels. Also windows contains a button MyInfo. When the user types the name, his street, city and pincode and then clicks the button, the types details must appear in Arial Font with Size 32, Italics.</p>	06	LO4 LO 6

Textbook Books:

1. Herbert Schildt, "Java-The Complete Reference", Seventh Edition, Tata McGraw Hill Publication
2. E. Balguruswamy, "Programming with java A primer", Fifth edition, Tata McGraw Hill Publication

Reference Books:

1. D.T. Editorial Services, "Java 8 Programming Black Book", Dreamtech Press
University of Mumbai, B. E. (Information Technology), Rev 2016

2. H. M. Deitel, P. J. Deitel, S. E. Santry, "Advanced Java 2 Platform How to Program" Prentice Hall
3. Learn to Master JAVA, from Star EDU solutions, by ScriptDemics

Term Work:

The term Work shall consist of at least 12 to 15 practical's based on the above list. The also Term work Journal must include at least 2 assignments.

Term Work Marks: 50 Marks (Total marks) = 40 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral & Practical Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
ITC401	Applied Mathematics-IV	4+1@	-	-	5	-	-	5
ITC402	Computer Networks	4	-	-	4	-	-	4
ITC403	Operating Systems	4	-	-	4	-	-	4
ITC404	Computer Organization and Architecture	4	-	-	4	-	-	4
ITC405	Automata Theory	3+1\$	-	-	4	-	-	4
ITL401	Networking Lab	-	2	-	-	1	-	1
ITL402	Unix Lab	-	2	-	-	1	-	1
ITL403	Microprocessor Programming Lab	-	2	-	-	1	-	1
ITL404	Python Lab	-	2+2*	-	-	2	-	2
Total		21	10	-	21	5	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
ITC401	Applied Mathematics-IV	20	20	20	80	3	-	-	-	100
ITC402	Computer Networks	20	20	20	80	3	-	-	-	100
ITC403	Operating Systems	20	20	20	80	3	-	-	-	100
ITC404	Computer Organization and Architecture	20	20	20	80	3	-	-	-	100
ITC405	Automata Theory	20	20	20	80	3	--	-	-	100
ITL401	Networking Lab	-	-	-	-	-	25	25	--	50
ITL402	Unix Lab	-	-	-	-	-	25	--	25	50
ITL403	Microprocessor Programming Lab	-	-	-	-	-	25	25	--	50
ITL404	Python Lab	-	-	-	-	-	50	--	50	100
Total		100	100	100	400	-	125	50	75	750

@ 4 hours shown as theory to be taken class wise and 1 hour to be taken tutorial as class wise

\$ 3 hours shown as theory to be taken class wise and 1 hour to be taken tutorial as batch wise

*2 hours shown as practical's to be taken class wise lecture and other 2 hours to be taken as batch wise practicals in Lab.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC401	Applied Mathematics IV	04	--	01	04	--	--	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Two Tests					
ITC401	Applied Mathematics IV	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

1. The concepts of Number Theory by using different theorem.
2. The concepts of probability and study PDF.
3. The concept of sampling theory and correlation.
4. The concept of graphs and trees.
5. The concept of groups theory.
6. The concept of Lattice theory.

Course Outcomes: Students will able to:

1. Apply the Number Theory to different applications using theorem.
2. Apply probability and understand PDF.
3. Understand sampling theory and correlation.
4. Apply the graphs and trees concepts to different applications.
5. Understand group's theory.
6. Understand the Lattice theory.

Prerequisite: Applied Mathematics III

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic of Set, Permutations, Combination and Probability .	02	
I	Elements of Number Theory I	Modular Arithmetic, Divisibility and Euclid Algorithm, Primes and the Sieve of Eratosthenes, Testing for primes, Prime Number Theorem	06	CO1

II	Elements of Number Theory II	Euler's, Fermat's Little theorems, Congruences, Computing Inverse in Congruences, Legendre and Jacobi Symbols, Chinese Remainder Theorem	06	CO1
III	Probability	Statistics: Formal concept, sample space, outcomes, events Random Variables: discrete & continuous random variables, expectation, Variance, Probability Density Function & Cumulative Density Function Moments, Moment Generating Function Probability distribution: binomial distribution, Poisson & normal distribution	08	CO2
IV	Sampling theory	Test of Hypothesis, Level of significance, Critical region, One Tailed and two Tailed test, Test of significant for Large Samples:- Means of the samples and test of significant of means of two large samples Test of significant of small samples:- Students t- distribution for dependent and independent samples Chi square test:- Test of goodness of fit and independence of attributes, Contingency table. Correlation Scattered diagrams Karl Pearson's coefficient of correlation Spearman's Rank correlation Regression Lines	10	CO3
V	Graph & Groups theory.	Introduction to graphs, graph terminology, representing graphs and graph isomorphism, connectivity, Euler and Hamilton paths, planar graphs, graph coloring, introduction to trees, application of trees. Groups, subgroups, generators and evaluation of powers, cosets and Lagrange's theorem, permutation groups and Burnside's theorem, isomorphism, automorphisms, homomorphism and normal	12	CO4 CO5

		subgroups, rings, integral domains and fields.		
VI	Lattice theory	Lattices and algebras systems, principles of duality, basic properties of algebraic systems defined by lattices, distributive and complimented lattices, Boolean lattices and Boolean algebras, uniqueness of finite Boolean expressions, propositional calculus. Coding theory: Coding of binary information and error detection, decoding and error correction.	08	CO5

Text Books:

1. Cryptograph and Network Security by B. A. Forouzan & D. Mukhopadhyay, 11th edition, McGraw Hill Publication.
2. Network Security and Cryptograph by Bernard Menezes, Cengage Learning Publication.
3. Higher Engineering Mathematics by Grewal B. S. 38th edition, Khanna Publication 2005.
4. Probability and Statistics for Engineering, Dr. J Ravichandran, Wiley-India.
5. Mathematical Statistics by H. C Saxena, S Chand & Co.
6. *C. L. Liu: Elements of Discrete Mathematics*, 2nd edition, TMH

References:

1. Elementary Number Theory and its applications by Kenneth H. Rosen, 5th edition, Addison Wesley Publication.
2. Abstract Algebra by I. N. Herstein, 3rd edition, John Wiley and Sons Publication.
3. Discrete Mathematics by Norman Biggs, 2nd edition, Oxford University Press.
4. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett. TMH International Edition.
5. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
6. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
7. Probability by Seymour Lipschutz, McGraw-Hill publication.

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**

- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC402	Computer Networks	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of two Tests					
ITC402	Computer Networks	20	20	20	80	--	--	--	100

Course Objectives: Students will try to:

1. Study the basic taxonomy and terminology of the computer networking and enumerate the layers of OSI model and TCP/IP model.
2. Acquire knowledge of Application layer and Presentation layer paradigms and protocols.
3. Study Session layer design issues, Transport layer services, and protocols.
4. Gain core knowledge of Network layer routing protocols and IP addressing.
5. Study data link layer concepts, design issues, and protocols.
6. Read the fundamentals and basics of Physical layer, and will apply them in real time applications.

Course Outcomes: Students will be able to:

1. Describe the functions of each layer in OSI and TCP/IP model.
2. Explain the functions of Application layer and Presentation layer paradigms and Protocols.
3. Describe the Session layer design issues and Transport layer services.
4. Classify the routing protocols and analyze how to assign the IP addresses for the given network.
5. Describe the functions of data link layer and explain the protocols.
6. Explain the types of transmission media with real time applications.

Prerequisite: COA, Logic Design

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Von Neumann model, Modulation, Demodulation, encoding, Decoding.	02	--

I	Introduction	Network Criteria, Physical Structures, Network Types: LAN, WAN, Switching, OSI Reference model, TCP/IP suite, Comparison of OSI and TCP/IP, Network devices.	04	CO1
II	Application layer and Presentation layer	Introduction: Providing Services, Application layer Paradigms, Client-Server Paradigm: Application Programming Interface, Using Services of the Transport Layer, Standard Client Server applications: World Wide Web and HTTP, FTP, Electronic Mail, TELNET, Secure Shell (SSH), Domain Name System (DNS), Compression: Lossless Compression, Lossy Compression, Multimedia data: Text, Image, Video , Audio ,Multimedia in the Internet: Streaming Stored Audio/Video, Streaming Live Audio/Video, Real-Time Interactive Audio/Video, Optimal Compression Algorithms, Huffman Coding, Adaptive Huffman Compression, Dictionary Based Compression, Speech Compression, LZW, RLE, Image Compression – GIF,JPEG.	10	CO1 CO2
III	Session layer and Transport layer	Session layer design issues, Session Layer protocol - Remote Procedure Call (RPC), Transport layer services, Transport Layer Protocols: Simple Protocol, Stop-and-Wait Protocol, Go-Back-N Protocol (GBN), Selective-Repeat Protocol, Bidirectional Protocols: Piggybacking, Internet Transport-Layer Protocols, User Datagram Protocol: User Datagram, UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, Segment, A TCP Connection, State Transition Diagram, Windows in TCP, Flow Control, Error Control, TCP Congestion Control, TCP Timers, Options.	10	CO1 CO3
IV	Network Layer	Introduction: Network-Layer Services, Packet Switching, Network-Layer Performance, Network-Layer Performance, Network-Layer Congestion, Structure of A Router, Network Layer Protocols: IPv4 Datagram Format, IPv4 Addresses,	12	CO1 CO4

		Forwarding of IP Packets, ICMPv4, Unicast Routing: General Idea, Routing Algorithms, Unicast Routing Protocols, Multicast Routing : Introduction, Multicasting Basics, Intradomain Routing Protocols, Interdomain Routing Protocols, Next generation IP: Packet Format , IPv6 Addressing , Transition from IPv4 to IPv6, ICMPv6, Mobile IP: Addressing , Agents , Three Phases , Inefficiency in Mobile IP.		
V	Data Link Layer	Wired Networks; Introduction: Nodes and Links, Two Types of Links, Two Sublayers, Data Link Control: Framing, Flow and Error Control, Error Detection and Correction, Two DLC Protocols, Medium Access Protocols: Random Access, Controlled Access, Channelization, Link Layer Addressing, Wired LANS: Ethernet Protocol; IEEE Project 802, Standard Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet, 10-Gigabit Ethernet, Virtual LANs, Other Wired Networks: Point-to-Point Networks, SONET, Switched Network: ATM, Connecting Devices: Repeaters or Hubs, Link-Layer Switches, Routers, Sliding Window Compression.	09	CO1 CO5
VI	Physical Layer	Data and Signals: Analog and Digital, Transmission Impairment, Data Rate Limits, Performance, Digital Transmission: Digital-to-Digital Conversion , Analog-to-Digital Conversion, Analog Transmission: Digital-to-Analog Conversion, Analog-to-Analog Conversion ,Bandwidth Utilization: Multiplexing, Spread Spectrum, Transmission Media: Guided Media, Unguided Media: Wireless, Real Time Interactive Protocols: Rationale for New Protocols, RTP, Session Initialization Protocol (SIP), H.323, SCTP.	05	CO1 CO6

Text Books:

1. Behrouz A. Forouzan, Forouzan Mosharrat , Computer Networks A Top down Approach, Mc Graw Hill education.
2. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.
3. Ranjan Bose, Information Theory, Coding and Cryptography, Ranjan Bose, Tata McGrawHill , Second Edition.

4. Diane Teare, “ Authorized Self- Study Guide Designing for CISCO Internetwork Solutions(DESIGN), Second Edition.

References:

1. Behrouz A. Forouzan, Data communications and Networking, Fifth edition TMH 2013.
2. James F. Kurose, K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Edition, Pearson Education.
3. L. L. Peterson and B. S. Davie, Computer Networks: A Systems Approach, 4th Ed, Elsevier India.
4. S. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
5. W. A. Shay, Understanding communications and Networks, 3rd Edition, W. A. Shay, Cengage Learning.
6. Khalid Sayood, Introduction to Data Compression, Third Edition, Morgan Kaufman.

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC403	Operating System	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory Marks					Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test1	Test 2	Avg. of two Tests						
ITC403	Operating System	20	20	20	80	--	--	--	100	

Course Objectives: Students will try:

1. To understand the main components of an OS & their functions.
2. To study the process management and scheduling.
3. To understand various issues in Inter Process Communication (IPC) and the role of OS in IPC.
4. To understand the concepts and implementation Memory management policies and virtual memory.
5. To understand the working of an OS as a resource manager, file system manager, process manager, memory manager and I/O manager and methods used to implement the different parts of OS
6. To study the need for special purpose operating system with the advent of new emerging technologies

Course Outcomes: Student will be able to

1. Describe the important computer system resources and the role of operating system in their management policies and algorithms.
2. Understand the process management policies and scheduling of processes by CPU
3. Evaluate the requirement for process synchronization and coordination handled by operating system
4. Describe and analyze the memory management and its allocation policies.
5. Identify use and evaluate the storage management policies with respect to different storage management technologies.
6. Identify the need to create the special purpose operating system.

Prerequisite: Programming Language C

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Programming Language C. Basic of Hardware i.e. ALU, RAM, ROM, HDD etc.	02	
I	Overview of Operating System	Introduction: Operating System Structure and operations, Process management, Memory management, storage management, Protection and security, Distributed and special purpose Systems; System Structure: Operating system services and interface, System calls and its types, System programs, Operating System Design and implementation, OS structure, Virtual machines, OS debugging and generation, System boot.	07	C01
II	Process Management	Process concept: Process Scheduling, Operation on process and Interprocess communication;, Multithreading, Process: Multithreading models and thread libraries, threading issues; Process Scheduling: Basic concepts, Scheduling algorithms and Criteria, Thread Scheduling and Multiple Processor Scheduling;	09	C02
III	Process coordination	Synchronization: The critical Section Problem, Peterson's Solution, synchronization Hardware and semaphores, Classic problems of synchronization, monitors, Atomic transactions; Deadlocks: System Model, Deadlock Characterization , Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance , Deadlock Detection, Recovery from Deadlock.	09	CO3
IV	Memory Management	Memory Management strategies: Background, Swapping, Contiguous Memory Allocation, Paging , Structure of the Page Table, Segmentation; Virtual Memory Management: Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files, Allocating Kernel Memory, Other Considerations.	10	C04
V	Storage Management	File system: File Concept , Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, Protection; Implementing file System: File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance, Recovery, NFS; Secondary Storage Structure: Overview of Mass-Storage Structure, Disk Structure, Disk Attachment, Disk Scheduling, Disk Management, RAID Structure, Stable-Storage Implementation, Tertiary-Storage Structure, Swap-Space Management; I/O systems: Overview I/O Hardware, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Requests to	09	C05

		Hardware Operations, STREAMS, Performance		
VI	Distributed Systems	Distributed operating System: Network based OS, Network Structure and Topology, Communication Structure and Protocols; Distributed File system: Naming and transparency, Remote file access, Stateful Versus Stateless Service, File Replication; Distributed Synchronization: Mutual Exclusion, Concurrency Control and Deadlock Handling,	06	C06

Text Books:

1. Operating System Concepts, Abraham Silberschatz, Greg Gagne, Peter Baer Galvin, 8th edition Wiley.
2. Modern Operating System, Tanenbaum, Pearson Education.
3. Operating Systems: Internal and Design Principles: William Stallings, PHI

Reference Books:

1. Operating System Design and Implementation, A Tanenbaum, Pearson
2. Real Time Systems Design and Analysis, Wiley, IEEE Press
3. Principles of Operating Systems: Naresh Chauhan, Oxford Higher Education

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC404	Computer Organization and Architecture	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of two Tests					
ITC404	Computer Organization and Architecture	20	20	20	80	--	--	100	

Course Objectives: Students will try to:

1. Conceptualize the basics of organizational and architectural issues of a digital computer.
2. Analyze processor performance improvement using instruction level parallelism.
3. Learn the function of each element of a memory hierarchy.
4. Study various data transfer techniques in digital computer.
5. Articulate design issues in the development of processor or other components that satisfy design requirements and objectives.
6. Learn microprocessor architecture and study assembly language programming.

Course Outcomes: Students will be able to:

1. Describe basic organization of computer and the architecture of 8086 microprocessor.
2. Implement assembly language program for given task for 8086 microprocessor.
3. Demonstrate control unit operations and conceptualize instruction level parallelism.
4. Demonstrate and perform computer arithmetic operations on integer and real numbers.
5. Categorize memory organization and explain the function of each element of a memory hierarchy.
6. Identify and compare different methods for computer I/O mechanisms.

Prerequisite: Fundamentals of Computer, Digital Logic Design

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	basic combinational and sequential logic circuits, binary numbers and arithmetic, basic computer organizations	02	
I	Overview of Computer Architecture &	Introduction of Computer Organization and Architecture. Basic organization of computer and block level description of the functional	07	CO1

	Organization	units. Evolution of Computers, Von Neumann model. Performance measure of Computer Architecture. Architecture of 8086 family, 8086 Hardware Design, Minimum mode & Maximum mode of Operation. Study of bus controller 8288 & its use in Maximum mode.		
II	Programming 8086	Addressing modes, Instruction Set, Assembly Language Programming, Mixed Language Programming, Programs based on Stacks, Strings, Procedures, Macros, Timers, Counters & delay.	10	CO2
III	Processor Organization and Architecture	CPU Architecture, Register Organization, Instruction formats, basic instruction cycle. Instruction interpretation and sequencing. Control Unit: Soft wired (Micro-programmed) and hardwired control unit design methods. Microinstruction sequencing and execution. Micro operations, concepts of nano programming. Introduction to parallel processing concepts, Flynn's classifications, pipeline processing, instruction pipelining, pipeline stages, pipeline hazards.	11	CO3
IV	Data Representation and Arithmetic Algorithms	Number representation: Binary Data representation, two's complement representation and Floating-point representation. Integer Data arithmetic: Addition, Subtraction. Multiplication: Unsigned & Signed multiplication- Add & Shift Method, Booth's algorithm. Division of integers: Restoring and non-restoring division, signed division, basics of floating point representation IEEE 754 floating point(Single & double precision) number representation. Floating point arithmetic: Addition, subtraction	10	CO4
V	Memory Organization	Introduction to Memory and Memory parameters. Classifications of primary and secondary memories. Types of RAM and ROM, Allocation policies, Memory hierarchy and characteristics. Cache memory: Concept, architecture (L1, L2, L3), mapping techniques. Cache Coherency, Interleaved and Associative memory.	07	CO5
VI	I/O Organization	Input/output systems, I/O modules and 8089 IO processor. Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA.	05	CO6

Text Books:

1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization”, Fifth Edition, Tata McGraw-Hill.
2. William Stallings, “Computer Organization and Architecture: Designing for Performance”, Eighth Edition, Pearson.
3. 8086/8088 family: Design Programming and Interfacing: By John Uffenbeck (Pearson Education)
4. Microprocessor and Interfacing: By Douglas Hall (TMH Publication).

References:

1. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, Tata McGraw-Hill.
2. Dr. M. Usha, T. S. Srikanth, “Computer System Architecture and Organization”, First Edition, Wiley-India.
3. John P. Hayes, “Computer Architecture and Organization”, McGraw-Hill., Third Edition.
4. K Bhurchandi, “Advanced Microprocessors & Peripherals”, Tata McGraw-Hill Education

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should cover **maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC405	Automata Theory	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Oral & Practical	Oral	Total
		Internal assessment								
		Test 1	Test 2	Avg. of two Tests						
ITC405	Automata Theory	20	20	20	80	--	--	--	100	

\$ 3 hours shown as theory to be taken class wise and 1 hour to be taken tutorial as batch wise

Course Objectives: Students will try:

1. To learn fundamentals of Regular and Context Free Grammars and Languages
2. To understand the relation between Regular Language and Finite Automata and machines.
3. To learn how to design Automata's and machines as Acceptors, Verifiers and Translators.
4. To understand the relation between Contexts free Languages, PDA and TM.
5. To learn how to design PDA as acceptor and TM as Calculators.
6. To learn how to co-relate Automata's with Programs and Functions.

Course Outcomes: The students will be able to:

1. Understand, design, construct, analyze and interpret Regular languages, Expression and Grammars.
2. Design different types of Finite Automata and Machines as Acceptor, Verifier and Translator.
3. Understand, design, analyze and interpret Context Free languages, Expression and Grammars.
4. Design different types of Push down Automata as Simple Parser.
5. Design different types of Turing Machines as Acceptor, Verifier, Translator and Basic computing machine.
6. Compare, understand and analyze different languages, grammars, Automata and Machines and appreciate their power and convert Automata to Programs and Functions

Prerequisite: Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction and Regular	Languages: Alphabets and Strings. Regular Languages: Regular Expressions, Regular Languages, Regular Grammars, RL and LL	06	CO1

	Languages	grammars, Closure properties		
II	Finite Automata and machines	Finite Automata: FA as language acceptor or verifier, NFA (with and without ϵ), DFA, RE to NFA, NFA to DFA, Reduced DFA , NFA-DFA equivalence, FA to RE. Finite State Machines: m/c with output Moore and Mealy machines. M/c as translators. Melay and Moore m/c conversion	09	CO2
III	Context Free Grammars	Context Free Languages: CFG, Leftmost and Rightmost derivations, Ambiguity, Simplification and Normalization (CNF) and Chomskey Hierarchy (Types 0 to 3)	08	CO3
IV	Push Down Automata	Push Down Automata: Deterministic (single stack)PDA, Equivalence between PDA and CFG.	05	CO4
V	Turing Machine	Turing Machine: Deterministic TM , Multi-track and Multi-tape TMs, concept of UTM and idea of system program. Issue and concept of Halting Problem	07	CO5
VI	Applications of Automata	1.Power and Limitations of Regular and Context Free Grammars and Machines 2.Designing Functions: FA: Acceptor and Verifier. FSM: Translator PDA: Simple Parser for WF parenthesis, palindromes etc. TM: Basic bit wise calculator(+ /- /AND/OR) and Translator (Note Added)	04	CO2 CO4 CO5 CO6

Text books

1. J.C.Martin, "Introduction to languages and the Theory of Computation", TMH.
2. Kavi Mahesh, "Theory of Computation A Problem Solving Approach", Wiley India

References

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Education.
2. Daniel I.A. Cohen, "Introduction to Computer Theory", John Wiley & Sons.
3. Theory of Computation - By Vivek Kulkarni from Oxford University.
4. N.Chandrashekhar & K.L.P. Mishra, "Theory of Computer Science, Automata Languages & Computations", PHI publications.

Sample Example for Tutorial: Applications of Automata

An automata can be easily converted to functions by converting *States* to *functions* and *Transitions* to *function calls* or *gotos* beginning with Starting state and *Accepting* in a terminating state.

A simple example of DFA is:

<pre> graph TD Start(()) --> S((S)) S -- a --> A((A)) A -- a --> A A -- b --> B(((B))) B -- a --> A </pre>	Functions
	<p>S(x)</p> <pre> { if(x == 'a') goto A(next); else print("Error"); } </pre>
	<p>A(x)</p> <pre> { if(x == 'a') goto A(next); else if(x == 'b') goto B(next); else print("Error"); \} </pre>
<p>B(x)</p> <pre> { if(x == 'a') goto A(next); else if(x == 'b') goto B(next); else if(end) print("Accept"); else print("Error"); \} </pre>	

Suggested Tutorials:

Sr. No.	Module	Detailed Content
I	Introduction and Regular Languages	1 Tutorial on design of RE, RG, RLG and LLG for given Regular Language.
II	Finite Automata and machines	3 Tutorials for converting RE to NFA, NFA to DFA to Reduced DFA, FA to RE. 1 Tutorial on design of Moore and Mealy machines.
III	Context Free Grammars	1 Tutorial on design of CFG and Leftmost and Rightmost derivations. 1 Tutorial for converting CFG to CNF.
IV	Push Down Automata	1 Tutorial on design of Push Down Automata.
V	Turing Machine	1 Tutorial on design of single tape Turing Machine. 1 Tutorial on design of Multi-track and Multi-tape TMs.
VI	Applications of Automata	2 Tutorials for converting Automata to Functions: a. FA to Acceptor / Verifier. b. FSM to Translator. c. PDA to Simple Parser for WF parenthesis, palindromes etc. d. TM to Basic bit wise calculator(+ /- /AND/OR) / Translator

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ITL401	Networking Lab	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of 2 Tests				
ITL401	Networking Lab	--	--	--	--	25	25	50

Lab Objectives: Students will try:

1. To get familiar with the basic network administration commands.
2. To install and configure network simulator and learn basics of TCL scripting.
3. To understand the network simulator environment and visualize a network topology and observe its performance
4. To analyze the traffic flow and the contents of protocol frames.
5. To implement client-server socket programs.
6. To design and configure a network for an organization.

Lab Outcomes: Student will be able to

1. Execute and evaluate network administration commands and demonstrate their use in different network scenarios
2. Demonstrate the installation and configuration of network simulator.
3. Demonstrate and measure different network scenarios and their performance behavior.
4. Analyze the contents the packet contents of different protocols.
5. Implement the socket programming for client server architecture.
6. Design and setup a organization network using packet tracer.

<p>Hardware Requirement:</p> <p>PC i3 processor and above</p>	<p>Software requirement:</p> <p>NS2.34, Protocol Analyzer (eg. Wireshark), Packet tracer (Eg. CISCO packet tracer)</p>
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Prerequisite: C Programming Language

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Programming Language (C/java), Basic commands of windows and unix operating system, editor commands (eg nano/vi editor etc)	02	
I	Fundamentals of Computer Network	Understanding Basic networking Commands: Ping, Tracert, tracert, ipconfig, ifconfig, nslookup, netstat	02	LO1
II	Basics of Network simulation	Installation and configuration of NS2 Introduction to Tcl Hello Programming	03	LO2
III	Simulation of Network Topology	Implementation of Specific Network topology with respect to 1. Number of nodes and physical layer configuration 2. Graphical simulation of network with Routing Protocols and traffic consideration (TCP, UDP) using NAM. 3. Analysis of network performance for quality of service parameters such as packet-delivery-ratio, delay and throughput 4. Comparative analysis of routing protocols with respect to QOS parameters using Xgraph/gnuplot for different load conditions.	05	LO3
IV	Protocol Analyzer	Installation of Wire shark Analysis of Packet headers,	04	LO4
V	Socket Programming	Socket Programming with C/Java 1.TCP Client, TCP Server	04	LO5

		2. UDP Client, UDP Server		
VI	Case study on designing network topology	A case study to design and configure any organization network eg. College network or campus network, using any packet tracer or network topology design software based on infrastructure requirements, servers and clients, traffic consideration and application requirements.	06	L06

Text Books:

1. Computer Network: Top Down approach, Behrouz Forouzan, Firoz Mossharraf. MGH
2. Packet analysis with Wire shark, Anish Nath, PACKT publishing

Reference Books:

1. NS2.34 Manual
2. Introduction to Network Simulator NS2, 2nd Edition, Teerawat Issariyakul, Ekram Hossain, Springer

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ITL402	Unix Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of two Tests				

ITL402	Unix Lab	--	--	--	--	25	25	50
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Lab Objectives: Students will try:

1. To introduce Basic Unix general purpose Commands
2. To learn network Unix commands.
3. To learn C programming in Unix editor environment.
4. To learn shell script and sed concepts.
5. To learn file management and permission advance commands.
6. To learn awk, grap, perl scripts.

Lab Outcomes: Student will be able to:

1. Identify the basic Unix general purpose commands.
2. Apply and change the ownership and file permissions using advance Unix commands.
3. Use the awk, grep, perl scripts.
4. Implement shell scripts and sed.
5. Apply basic of administrative task.
6. Apply networking Unix commands.

Prerequisite: C Programming Language and Operating System

Hardware requirement:

PC i3 and above.

Software requirement:

Unix, Editor, Bash shell, Bourne shell and C shell.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Programming syntax, Installation of Unix, concepts of operating system	02	--
I	Basic Commands	A brief history of UNIX, Unix Architecture. Logging into (and out of) UNIX systems, Changing your password, General format of UNIX commands. a) Installation of Unix operating system. b) User management in Unix. c) Study of Unix general purpose	04	LO1

		utility command list obtained from (cd, cp, ps, ls, mv, rm, mkdir, rmdir, man, who, cat, echo, more, date, time, kill, history, chmod, passwd, who am i, who, time, bc, history, clear, man, lost, chown, finger, pwd, cal, logout, shutdown) commands.		
II	Advance Commands	<p>a) Study of Unix networking commands (ifconfig, ping, traceroute, netstat, nslookup, whois, hostname, tcpdump).</p> <p>b) Study of Unix file system (tree structure).</p> <p>c) Study of .bashrc, /etc/bashrc and Environment variables.</p> <p>d) Study File and directory permissions.</p> <p>e) Study of Editor Vi/other editor.</p> <p>f) Study of Bash shell, Bourne shell and C shell in Unix operating system.</p>	04	LO1 LO2 LO5 LO6
III	Basic System administrative task	<p>Process management</p> <p>Memory management</p> <p>File system management</p> <p>User management</p>	04	LO1 LO2 LO5
IV	Shell scripts	<p>a) Write a shell script program to display list of user currently logged in.</p> <p>b) Write a shell script program to display “HELLO WORLD”.</p> <p>c) Write a shell script program to develop a scientific calculator.</p> <p>d) Write a shell Script program to check whether the given number is</p>	04	LO1 LO4

		<p>even or odd.</p> <p>e) Shell script Program to search whether element is present is in the list or not.</p>		
V	Shell scripts and sed	<p>a) Shell script program to check whether given file is a directory or not.</p> <p>b) Shell script program to count number of files in a Directory.</p> <p>c) Shell script program to copy contents of one file to another.</p> <p>d) Create directory, write contents on that and Copy to a suitable location in your home directory.</p> <p>e) Use a pipeline and command substitution to set the length of a line in file to a variable.</p> <p>f) Write a program using sed command to print duplicated lines of Input.</p>	06	LO1 LO4
VI	grep, awk, perl scripts	<p>a) Write a grep/egrep script to find the number of words character, words and lines in a file.</p> <p>b) Write an awk script to develop a Fibonacci series.</p> <p>c) Write a perl script to compute the power of a given number.</p> <p>d) Write an awk script to display the pattern of given string or number.</p> <p>e) Write a perl script to check a number is prime or not.</p> <p>f) Write an egrep script to display</p>	04	LO1 LO2 LO3

		list of files in the directory.		
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Text Books:

1. Unix, concepts and applications by Sumitabha Das, McGraw-Hill
2. Mastering Shell Scripting, Randal. K. Michael , Second Edition, Wiley Publication

References:

1. Unix Shell Programming by Yashwant Kanetkar
2. Unix shell programming by forozun

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral & Practical Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ITL403	Microprocessor Programming Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of two Tests				
ITL403	Microprocessor Programming Lab	--	--	--	--	25	25	50

Lab Objectives: Students will try to:

1. Learn assembling and disassembling of PC.
2. Get hands on experience with Assembly Language Programming.
3. Study interfacing of peripheral devices with 8086 microprocessor.
4. Understand techniques for faster execution of instructions and improve speed of operation and performance of microprocessors.
5. Learn fundamentals of designing embedded systems
6. Write and debug programs in TASM/MASM/hardware kits

Lab Outcomes: Students will be able to :

1. Apply the fundamentals of assembly level programming of microprocessors.
2. Build a program on a microprocessor using arithmetic & logical instruction set of 8086.
3. Develop the assembly level programming using 8086 loop instruction set.
4. Write programs based on string and procedure for 8086 microprocessor.
5. Analyze abstract problems and apply a combination of hardware and software to address the problem
6. Make use of standard test and measurement equipment to evaluate digital interfaces.

Prerequisite: Logic Design, Programming Languages(C, C++), COA

Hardware Requirement:

- Motherboard, RAM, Processor, Connectors, Cables, SMPS, HDD, Monitor, Graphics card (optional), Cabinet.
- 8086 microprocessor experiment kits with specified interfacing study boards.

Software Requirement:

- Microsoft Macro Assembler (TASM)/Turbo Assembler(TASM)

NOTE: Programs can be executed on assembler or hardware boards,

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	PC Assembly	<ol style="list-style-type: none"> 1. Study of PC Motherboard Technology (South Bridge and North Bridge). 2. Disassembling the System Unit & Identifying Internal Components and Connections. 3. Study of various connections and ports used in computer communication. 	06	LO1
II	Arithmetic and logical operations in 8086 Assembly language programming	<ol style="list-style-type: none"> 1. Program for 16 bit BCD addition 2. Program to evaluate given logical expression. 3. Convert two digit Packed BCD to Unpacked BCD. <p>(any two)</p>	04	LO2 LO6
III	Loop operations in 8086 Assembly language programming	<ol style="list-style-type: none"> 1. Program to move set of numbers from one memory block to another. 2. Program to count number of 1's 	06	LO3 LO6

		and 0;s in a given 8 bit number 3. Program to find the smallest/largest number from a given set of numbers. 4. Program to search for a given number (any three)		
IV	String and procedure in 8086 Assembly language programming	1. Check whether a given string is a palindrome or not.	04	LO4 LO6
V	Procedure in 8086 Assembly language programming	1. Compute the factorial of a positive integer 'n' using recursive procedure. 2. Generate the first 'n' Fibonacci numbers. (any one)	02	LO4 LO6
VI	Interfacing with 8086 microprocessor	3. Interfacing Seven Segment Display 4. Interfacing keyboard matrix 5. Interfacing DAC (any two)	04	LO5 LO6

Text Books:

1. Scott Mueller, "Upgrading and repairing PCs", Pearson,
2. John Uffenbeck, "8086/8088 family: Design Programming and Interfacing:" Pearson Education

Reference Books:

1. K Bhurchandi, "Advanced Microprocessors & Peripherals", Tata McGraw-Hill Education

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ITL404	Python lab	--	2+2*	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of two Tests				
ITL404	Python lab	--	--	--	--	50	50	100

*2 hours shown as practical's to be taken class wise lecture and other 2 hours to be taken as batch wise practicals in Lab.

Lab Objectives: The course will help the students to get familiar with:

1. Basics of Python programming
2. Decision Making and Functions in Python
3. Object Oriented Programming using Python
4. Files Handling in Python
5. GUI Programming and Databases operations in Python
6. Network Programming in Python

Lab Outcomes: Upon Completion of the course the learner should be able to:

1. Describe the Numbers, Math functions, Strings, List, Tuples and Dictionaries in Python
2. Express different Decision Making statements and Functions
3. Interpret Object oriented programming in Python
4. Understand and summarize different File handling operations
5. Explain how to design GUI Applications in Python and evaluate different database operations
6. Design and develop Client Server network applications using Python

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel PIV Processor 2. 2 GB RAM 3. 500 GB Harddisk 4. Network interface card	1. Windows or Linux Desktop OS 2. Python 3.6 or higher 3. Notepad ++ 4. Python IDEs like Pydev, Netbeans or Eclipse 5. Mysql	1. Internet Connection for installing additional packages

Prerequisite Subjects: Structured Programming Approach & Java Programming**Detailed Syllabus:**

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic Programming syntax of Java/C. Installation and configuration of python.	02	
I	Basics of Python	<p>Theory: Numbers in Python, Basic & Built-in Math functions, Number Formats, Strings, Quotes, print() Function, Assigning Values to Names & Changing Data Through Names, Copying Data, Tuples — Unchanging Sequences of Data, Lists — Changeable Sequences of Data, Dictionaries — Groupings of Data Indexed by Name, Special String Substitution Using Dictionaries , Arrays, Treating a String Like a List, Special Types, Ranges of Sequences, Working with Sets, Arrays.</p> <p>Lab Experiment:</p> <p>Write python programs to understand Expressions, Variables, Quotes, Basic Math operations, Strings: Basic String Operations & String Methods, List, Tuples, Dictionaries, Arrays.</p> <p>(Minimum Three Programs based on math operations, Strings and List/Tuples/ Dictionaries)</p>	10	LO 1
II	Decision Making and Functions	<p>Theory: If statement, if-elif-else, Repetition using while loop, for loop, break statement, Handling Errors- try: statement, except: statement, Functions-Grouping Code under a Name, defining a Function, describing a</p>	10	LO 2

		<p>function in the function, Checking & Setting Your Parameters, Calling Functions from within Other Functions, Functions Inside of Functions, Layers of Functions</p> <p>Lab Experiment:</p> <p>Write python programs to understand different decision making statements and Functions.</p> <p>(Minimum Three Programs based on Decision making, Looping Statements and Functions)</p>		
III	Object Oriented Programming using Python programming	<p>Theory: Creating a Class, Self Variables, Constructors, Types of Methods, Inner Classes, Constructors in Inheritance, Polymorphism,, The super() Method, Method Resolution Order (MRO), Operator Overloading, Method Overloading & Overriding, Interfaces in Python. Exceptions Handling: Errors in a Python Program, Exceptions, Exception Handling, Types of Exceptions, The Except Block, The assert Statement.</p> <p>Modules and Packages: Creating Modules and Packages, Documenting & Viewing Module, Basics of Testing Your Modules and Packages, Importing & exporting Modules.</p> <p>Lab Experiment:</p> <p>Write python programs to understand different Object oriented features in Python</p> <p>(Minimum four programs based on</p> <p>a) Classes & objects,</p>	10	LO 3

		<p>b) Constructors,</p> <p>c) Inheritance & Polymorphism,</p> <p>d) Exception handling</p>		
IV	Files Handling	<p>Theory: Types of Files in Python, Opening a File, Closing a File. Writing Text Files, Knowing Whether a File Exists or Not, Working with Binary Files, Appending Text to a File, Reading Text Files, File Exceptions, The with Statement</p> <p>Pickle in Python, Lambda and Filter, Map & range functions.</p> <p>Lab Experiment:</p> <p>Write python programs to understand different File handling operations</p>	07	LO 4
V	GUI Programming and Databases	<p>Theory: GUI Programming - Writing a GUI with Python: GUI Programming Toolkits, Creating GUI Widgets with Tkinter, Creating Layouts, Radio Buttons and Checkboxes, Dialog Boxes.</p> <p>Database Access - Python's Database Connectivity, Types of Databases Used with Python, Mysql database Connectivity with Python, Performing Insert, Deleting & Update operations on database</p> <p>Lab Experiment:</p> <p>Write python programs to understand GUI designing and database operations</p> <p>(Minimum Three programs based on</p> <p>GUI designing using Tkinter, Mysql database creation & Database connectivity with DML</p>	07	LO 5

		operations using python		
VI	Web Programming	<p>Theory: Understanding Protocols, Introduction to Sockets, TCP/IP Server, TCP/IP Client, UDP Server, UDP Client, File Server, File Client, Two-Way Communication between Server and Client, Multithreaded Client-Server Chat Application</p> <p>Lab Experiment:</p> <p>Write python programs to understand TCP and UDP Sockets in Python</p> <p>(Minimum One programs based on TCP or UDP Sockets)</p>	06	LO 6

Text Books:

1. James Payne, "Beginning Python: Using Python 2.6 and Python 3.1", Wrox Publication
2. Dr. R. Nageswara Rao, "Core Python Programming", Dreamtech Press, Wiley Publication.
3. Magnus Lie Hetland, "Beginning Python From Novice to Professional", Second Edition", Apress Publication.

Reference Books:

1. Wesley J Chun, "Core Python Applications Programming", Third Edition, Pearson Publication.
2. E. Balguruswamy, "Introduction to Computing and Problem Solving using Python", McGraw Hill Publication
3. Learn to Master Python, from Star EDU solutions, by ScriptDemics

Term Work:

Term Work shall consist of at least 12 to 15 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 50 Marks (Total marks) = 40 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral & Practical Exam: An Oral & Practical exam will be held based on the above syllabus.

University of Mumbai

Program Structure B.E. Information Technology, (Rev. 2016)

T. E. Information Technology (Semester-V)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
ITC501	Microcontroller and Embedded Programming	4	-	-	4	-	-	4
ITC502	Internet Programming	4	-	-	4	-	-	4
ITC503	Advanced Data Management Technology	4	-	-	4	-	-	4
ITC504	Cryptography & Network Security	4	-	-	4	-	-	4
ITDLO-I	Department Level Optional Course-I	4	-	-	4	-	-	4
ITL501	Internet Programming Lab	-	2	-	-	1	-	1
ITL502	Security Lab	-	2	-	-	1	-	1
ITL503	OLAP Lab	-	2	-	-	1	-	1
ITL504	IOT (Mini Project) Lab	-	2	-	-	1	-	1
ITL505	Business Communication and Ethics	-	2+2*	-	-	2	-	2
	Total	20	14	-	20	7	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
Test 1	Test 2	Avg.								
ITC501	Microcontroller and Embedded Programming	20	20	20	80	3	-	-	-	100
ITC502	Internet Programming	20	20	20	80	3	-	-	-	100
ITC503	Advanced Data Management Technology	20	20	20	80	3	-	-	-	100
ITC504	Cryptography & Network Security	20	20	20	80	3	-	-	-	100
ITDLO-I	Department Level Optional Course-I	20	20	20	80	3	--	-	-	100
ITL501	Internet Programming Lab	-	-	-	-	-	25	--	25	50
ITL502	Security Lab	-	-	-	-	-	25	25	--	50
ITL503	OLAP Lab	-	-	-	-	-	25	25	--	50

ITL504	IOT (Mini Project) Lab	-	-	-	-	-	25	25	--	50
ITL505	Business Communication and Ethics	-	-	-	-	-	50	--	--	50
Total		100	100	100	400	-	150	75	25	750

Department Level Optional Course (DLO)

Every student is required to take one Department Elective Course for Semester V. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

(DLO-I subjects will have no Labs only Theory)

Subject Code	Department Level Optional Course (DLO)
Semester V	
ITDLO5011	Advanced Data Structures & Analysis of Algorithms
ITDLO5012	Image Processing
ITDLO5013	E-Commerce & E-Business
ITDLO5014	IT Enabled Services
ITDLO5015	Computer Graphics & Virtual Reality

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC501	Microcontroller and Embedded Programming	04	--		04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC501	Microcontroller and Embedded Programming	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

1. The concepts and architecture of embedded systems
2. Basic of microcontroller 8051.
3. The concepts of microcontroller interface.
4. The concepts of ARM architecture
5. The concepts of real-time operating system
6. Different design platforms used for an embedded systems application

Course Outcomes: Students will be able to:

1. Explain the embedded system concepts and architecture of embedded systems
2. Describe the architecture of 8051 microcontroller and write embedded program for 8051 microcontroller.
3. Design the interfacing for 8051 microcontroller.
4. Understand the concepts of ARM architecture.
5. Demonstrate the open source RTOS and solve the design issues for the same.
6. Select elements for an embedded systems tool.

Prerequisite: COA, Microprocessors and Assembly Programming languages

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Revision of microcomputer system terminologies, High level, Machine level and Assembly level programming language , difference between microprocessor and microcontroller	02	

I	Introduction to Embedded systems	Overview of Embedded System Architecture, Application areas, Categories of embedded systems, specialties of embedded systems. Recent trends in embedded systems. Brief introduction to embedded microcontroller cores CISC, RISC, ARM, DSP and SoC.	05	CO1
II	The Microcontroller Architecture and Programming of 8051:	Introduction to 8051 Microcontroller, Architecture, Pin configuration, Memory organization, Input /Output Ports, Counter and Timers, Serial communication, Interrupts. Instruction set, Addressing modes, Development tools, Assembler Directives, Programming based on Arithmetic & Logical Operations, I/O parallel and serial ports, Timers & Counters, and ISR.	14	CO2
III	Interfacing with 8051Microcontroller	Interfacing ADC, DAC, Stepper motor, LCD, KBD matrix, 8255 PPI	06	CO3
IV	ARM 7 Architecture	Architectural inheritance, Detailed study of Programmer's model, ARM Development tools, Instruction set: Data processing, Data Transfer, Control flow. Addressing modes. Writing simple assembly language programs. Pipelining, Brief introduction to exceptions and interrupts handling.	10	CO4
V	Open source RTOS	Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, differences between general purpose OS & RTOS, basic architecture of an RTOS, scheduling systems, inter-process communication, performance Matrix in scheduling models, interrupt management in RTOS environment, memory management, file systems, I/O systems, advantage and disadvantage of RTOS. POSIX standards, RTOS issues – selecting a Real Time Operating System, RTOS comparative study.	07	CO5
VI	Introduction to Embedded target boards	Introduction to Arduino, Raspberry Pi, ARM Cortex, Intel Galileo etc. Open-source prototyping platforms. Basic Arduino programming; Extended Arduino libraries; Arduino-based Internet communication; Raspberry pi; ARM	08	CO6

		Cortex Processors; Intel Galileo boards; Sensors and Interfacing: Temperature, Pressure, Humidity		
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Text Books:

1. M. A. Mazidi, J. G. Mazidi, R. D., McKinlay ,”The 8051 microcontroller & Embedded systems Using Assembly and C”, Pearson, 3rd edition
2. Embedded / real – time systems: concepts, design & programming, Black Book, Dr. K. V. K. K. Prasad, Dreamtech press, Reprint edition 2013
3. Shibu K. V., “Introduction to embedded systems”, McGraw Hil

References:

1. Laya B. Das, “Embedded systems an integrated approach”, Pearson, Third impression, 2013
2. Steve Furber, “ARM System on chip Architecture”, Pearson, edition second
3. Michael Margolis, “Arduino Cookbook”, O’reilly
4. Simon Monk,” Raspberry Pi Cookbok”, O’reilly
5. Raspberry Pi User Guide.
6. Massimo Banzi, “Getting Started with Arduino: The Open Source Electronics Prototyping Platform (Make)”, O’Reilly Media.

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC502	Internet Programming	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC502	Internet Programming	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

- 1 To get familiar with basics of the Internet Programming.
2. To acquire knowledge and skills for creation of web site considering both client and server side programming
3. To gain ability to develop responsive web applications
4. To explore different web extensions and web services standards
5. To learn characteristics of RIA –Web Mashup Eco System
6. To be familiarized with Python web framework-Django.

Course Outcomes: Students will be able to:

1. Implement interactive web page(s) using HTML,CSS and JavaScript.
2. Design a responsive web site using HTML5 and CSS3.
3. Demonstrate Rich Internet Application .
4. Build Dynamic web site using server side PHP Programming and Database connectivity.
5. Describe and differentiate different Web Extensions and Web Services.
6. Demonstrate web application using Python web Framework-Django

Prerequisite: Basic Java Programming and Python Programming.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Introduction to web technologies: Introduction to OSI layers,	02	---
I	Client Side Programming :HTML, CSS and JavaScript	Basic of HTML: Web System architecture-1,2,3 and n tier architecture, URL, domain name system, overview of HTTP and FTP, Cross browser compatibility issues, W3C Validators. Formatting and Fonts, Anchors, images, lists, tables, frames and forms. Introduction to CSS: Evolution of CSS, Syntax of CSS, Exploring CSS Selectors, Inserting CSS in an HTML Document, Defining Inheritance in CSS. Introduction to JavaScript: JavaScript language constructs, Objects in JavaScript- Built in, Browser objects and DOM objects, event handling, form validation and cookies.	09	CO1
II	HTML5 and Responsive Web Design with CSS3	HTML 5 : Fundamental Syntax and Semantics, Native Audio and Video, Micro data and Custom data, Accessibility, Geo-location, Canvas CSS3 and Responsive Web Design Media Queries: Supporting Differing Viewports, Embracing Fluid Layout. CSS3: Selectors, Typography and color Modes, Stunning Aesthetics with CSS3, CSS3 Transitions, Transformations and Animations, Conquer Forms HTML5 and CSS3	12	CO1 CO2
III	Rich Internet Application(RIA)	Characteristics of RIA, Introduction to AJAX : AJAX design basics, AJAX vs Traditional Approach, , Rich User Interface using Ajax. Working with JavaScript Object Notation(JSON): Create data in JSON format, JSON Parser .	09	CO3

		Web Mashup Eco Systems –Mashup Techniques: Mashing on the Web Server, Mashing with JSON		
IV	Server Side Programming: PHP	Introduction to PHP- Data types, control structures, built in functions, Building web applications using PHP- tracking users, PHP and Mysql database connectivity with example. Introduction to PHP Framework.	08	CO4
V	Web Extensions and Web Services	Web Extensions: Introduction to XML, Introducing XSL. Web services: Evolution and differences with Distributed computing, WSDL, SOAP, UDDI. REST-ful web services, Resource Oriented Architecture	07	CO5
VI	Python Web Framework: Django	Introduction, Web Frameworks, Introduction to Django ,Projects and Apps, “Hello World” Application.	05	CO6

Text Books:

1. HTML 5 Black Book: Kogent Learning solutions
2. “Learning PHP 5”, David Sklar, O’Reilly Publication
3. Rich Internet Application AJAX and Beyond WROX press
4. Responsive Web Design with HTML5 and CSS3, Ben Frain, PACKT Publication

References:

1. “Web Technologies: Black Book”, Dreamtech publication
2. HTML5 Cookbook, By Christopher Schmitt, Kyle Simpson, O’Reilly Media
3. Core Python Applications Programming by Wesley J Chun Third edition Pearson Publication
4. Advanced Internet Technologies (includes practicals), Deven Shah, Dreamtech publication

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC503	Advanced Data Management Technology	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC503	Advanced Data Management Technology	20	20	20	80	--	--	--	100

Course Objectives: Students will try to learn:

1. To introduce advanced concepts of transaction management and recovery techniques.
2. To impart knowledge related to query processing and query optimizer phases of a database management system
3. To introduce concepts of advanced access control techniques like role based and discretionary methods
4. To introduce advanced database models like distributed databases.
5. To impart an overview of emerging data models like temporal, mobile and spatial databases.
6. To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse.

Course Outcomes: Students will be able to:

1. Explain and understand the concept of a transaction and how ACID properties are maintained when concurrent transaction occur in a database
2. Measure query costs and design alternate efficient paths for query execution.
3. Apply sophisticated access protocols to control access to the database.
4. Implement alternate models like Distributed databases and Design applications using advanced models like mobile, spatial databases.
5. Organize strategic data in an enterprise and build a data Warehouse.
6. Analyze data using OLAP operations so as to take strategic decisions.

Prerequisite: Database Management System.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Reviewing basic concepts of a Relational database, SQL concepts	02	
I	Query Processing and Optimization:	<p>Overview, Measures of Query Cost Selection Operation, Sorting, Join Operation, Other Operations Evaluation of Expressions.</p> <p>Query Optimization Overview, Transformation of Relational Expressions Estimating Statistics of Expression Results Choice of Evaluation Plans</p>	06	CO1
II	Transactions Management and Concurrency:	Transaction concept, Transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, Implementation of isolation, Concurrency Control: Lock-based, Time-stamp based Deadlock handling, Recovery System: Failure Classification, Storage structure, Recovery & atomicity, Log based recovery, Checkpoints, Shadow Paging, ARIES Algorithm.	10	CO2
III	Advanced Data Management techniques	<p>Advanced Database Access protocols: Discretionary Access Control Based on Granting and Revoking Privileges; Mandatory Access Control and Role-Based Access Control.</p> <p>Overview of Advanced Database models like Mobile databases, Temporal databases, Spatial databases.</p>	09	CO3 CO4
IV	Distributed Databases	<p>Introduction : Distributed Data Processing, What is a Distributed Database System? Design Issues . Distributed DBMS Architecture. Distributed Database Design : Top-Down Design Process, Distribution Design Issues, Fragmentation , Allocation . Overview of Query Processing : Query Processing Problem, Objectives of Query Processing, Complexity of Relational Algebra Operations, Characterization of Query Processors, Layers of Query Processing, Query Optimization in Distributed Databases;</p>	09	CO4

		Overview of Transaction Management in DDB; Overview of Concurrency Control in DDB; Overview of Recovery in DDB		
V	Data Warehousing, Dimensional Modeling and OLAP	The Need for Data Warehousing; Data Warehouse Defined; Benefits of Data Warehousing ; Features of a Data Warehouse; Data Warehouse Architecture; Data Warehouse and Data Marts; Data Warehousing Design Strategies. Dimensional Model Vs ER Model; The Star Schema; How Does a Query Execute? The Snowflake Schema; Fact Tables and Dimension Tables; Factless Fact Table; Updates To Dimension Tables, Primary Keys, Surrogate Keys & Foreign Keys; Aggregate Tables; Fact Constellation Schema or Families of Star Need for Online Analytical Processing; OLTP vs OLAP; OLAP Operations in a cube: Roll-up, Drill-down, Slice, Dice, Pivot ; OLAP Models: MOLAP, ROLAP, HOLAP.	10	CO5
VI	ETL Process	Challenges in ETL Functions; Data Extraction; Identification of Data Sources; Immediate Data Extraction, Deferred Data Extraction; Data Transformation: Tasks Involved in Data Transformation, Techniques of Data Loading, Loading the Fact Tables and Dimension Tables	06	CO6

Text Books:

1. Korth, Silberchatz, Sudarshan, :”Database System Concepts”, 6th Edition, McGraw – Hill
2. Elmasri and Navathe, “Fundamentals of Database Systems”, 6th Edition, PEARSON Education.
3. Theraja Reema, “Data Warehousing”, Oxford University Press, 2009.
4. Raghu Ramakrishnan and Johannes Gehrke, “Database Management Systems” 3rd Edition - McGraw Hill

References:

1. Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals", Wiley India.
2. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom "Database System Implementation", Pearson Ltd. 1/ e
3. Thomas M. Connolly Carolyn Begg, Database Systems : A Practical Approach to Design, Implementation and Management, 4/e, Pearson Ltd.
4. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide To Dimensional Modeling", 3rd Edition. Wiley India.
5. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition.

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC504	Cryptography & Network Security	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory Marks					Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. of two Tests						
ITC504	Cryptography & Network Security	20	20	20	80	--	--	--	100	

Course Objectives: Students will try to learn:

1. The concepts of classical encryption techniques and concepts of finite fields and number theory.
2. And explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
3. And explore the design issues and working principles of various authentication protocols, PKI standards.
4. And explore various secure communication standards including Kerberos, IPsec, and SSL/TLS and email.
5. The ability to use existing cryptographic utilities to build programs for secure communication.
6. The concepts of cryptographic utilities and authentication mechanisms to design secure applications

Course Outcomes: Students will be able to:

1. Identify information security goals, classical encryption techniques and acquire fundamental knowledge on the concepts of finite fields and number theory.
2. Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
3. Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes
4. Apply different digital signature algorithms to achieve authentication and create secure applications
5. Apply network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPsec, and PGP.
6. Apply the knowledge of cryptographic utilities and authentication mechanisms to design secure applications

Prerequisite: Computer Networks

Detailed syllabus:

Sr No	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Basic concepts of OSI Layer	02	--
I	Introduction & Number Theory	Services, Mechanisms and attacks-the OSI security architecture-Network security model-Classical Encryption techniques (Symmetric cipher model, mono-alphabetic and poly-alphabetic substitution techniques: Vignere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers, steganography).	09	CO1
II	Block Ciphers & Public Key Cryptography	Data Encryption Standard-Block cipher principles-block cipher modes of operation-Advanced Encryption Standard (AES)-Triple DES-Blowfish-RC5 algorithm. Public key cryptography: Principles of public key cryptosystems-The RSA algorithm, The knapsack algorithm, El-Gamal Algorithm. Key management – Diffie Hellman Key exchange	09	CO2 CO6
III	Cryptographic Hashes, Message Digests and Digital Certificates	Authentication requirement – Authentication function , Types of Authentication, MAC – Hash function – Security of hash function and MAC –MD5 – SHA – HMAC – CMAC, Digital Certificate: X.509, PKI	09	CO3
IV	Digital signature schemes and authentication Protocols	Digital signature and authentication protocols : Needham Schroeder Authentication protocol, Digital Signature Schemes – RSA, EI Gamal and Schnorr, DSS.	07	CO4
V	Network Security	Network security basics: TCP/IP vulnerabilities (Layer wise), Packet Sniffing, ARP spoofing, port scanning, IP spoofing, TCP syn flood, DNS Spoofing. Denial of Service: Classic DOS attacks, Source Address spoofing, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service, Defenses against Denial of Service Attacks.	10	CO5

		Firewalls, Intrusion Detection Systems: Host Based and Network Based IDS, Honey pots.		
VI	Network Security Applications	Authentication Applications, Kerberos, Internet Security Protocols: SSL, TLS, IPSEC:AH, ESP, Secure Email: PGP and S/MIME, Key Management.	06	CO5 CO6

Text Books:

1. Mark Stamp's Information Security Principles and Practice, Wiley
2. William Stallings, Cryptography and Network Security, Principles and Practice, 6th Edition, Pearson Education, March 2013
3. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata Mc Graw Hill
4. Bernard Menezes, "Cryptography & Network Security", Cengage Learning

Reference Books:

1. Applied Cryptography, Protocols Algorithms and Source Code in C, Bruce Schneier, Wiley.
2. Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill.

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW /Practical	Tutorial	Total
ITL501	Internet Programming Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of two Tests				
ITL501	Internet Programming Lab	--	--	--	--	25	25	50

Lab Objectives: Students will try:

1. To Acquire knowledge and Skills for creation of Web Site considering both client- and server-side Programming.
2. To create Web application using tools and techniques used in industry.
3. To learn the characteristics of RIA
4. To Demonstrate Amazon/Google or Yahoo mashup
5. To be well versed with XML and web services Technologies.
6. To be familiarized with open source Frameworks for web development.

Lab Outcomes: Students will learn to;

1. Design a basic web site using HTML5 and CSS3 to demonstrate responsive web design.
2. Implement dynamic web pages with validation using JavaScript objects by applying different event handling mechanism.
3. Use AJAX Programming Technique to develop RIA
4. Develop simple web application using server side PHP programming and Database Connectivity using MySQL.
5. Build well-formed XML Document and implement Web Service using Java.
6. Demonstrate simple web application using Python Django Framework.

Hardware and Software requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel Core i3/i5/i7 Processor 2. 4 GB RAM 3. 500 GB Harddisk	1. Windows or Linux Desktop OS 2. HTML5 compatible web browsers(Chrome, Opera, Firefox, Safari etc) 3. HTML,CSS editors like Dreamweaver, Notepad++ etc. 4. Netbeans or Eclipse IDE 5. XAMPP	1. Internet Connection installation of web frameworks

Prerequisite: Basics of Java and Python Programming

Guidelines

1. The mini project work is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students may do will visit different websites to identify their website topic for the mini project.
4. Each group will identify the Hardware and software requirement for their mini project problem statement.
5. Mini Project consists of Responsive Website Development.
6. Which includes following points
 - a. Introduction to RWD frame work?
 - b. Identify tools
 - c. CSS preprocessor
 - d. Construction and design of skeleton for website
 - e. Enhancing CSS3 and HTML5 in website
 - f. Server Side Programming: website using server side scripting in PHP and database connectivity using MySQL (PHP framework like Laravel/Joomla can be used)
 - g. XML ,XSL and Web Services

- h. Developing RIA using AJAX including -A browser built-in XMLHttpRequest object (to request data from a web server) and JavaScript and HTML DOM (to display or use the data) Building Amazon/Yahoo /Google Web Mashups for the website.
- i. Website Security
- j. Develop full website and launch it.

7. Each group may present their work in various project competitions and paper presentations.

8. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Responsive Web Design by Example Beginner's Guide by Thoriq Firdaus, PACKT
2. Responsive Web Design with HTML5 and CSS3 PACKT
3. Professional Rich Internet Application : AJAX and Beyond WROX press

References:

1. Laravel: Up and Running, By Matt Stauffer O'Reilly Media.
2. Advanced Internet Technologies (includes practicals) ,Deven Shah ,Dreamtech publication
3. Django By Example By Antonio Melé,Pakt Publication

Term Work:

Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW /Practical	Tutorial	Total
ITL502	Security Lab	--	2	-	--	1	-	1

Course Code	Course Name	Examination Scheme								
		Theory Marks					Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test1	Test2	Avg. of two Tests						
ITL502	Security Lab	--	--	--	--	25	--	25	50	

Lab Objectives: Students will try:

1. To be able to apply the knowledge of symmetric cryptography to implement simple ciphers
2. To be able to analyze and implement public key algorithms like RSA and El Gamal
3. To analyze and evaluate performance of hashing algorithms
4. To explore the different network reconnaissance tools to gather information about networks
5. To explore and use tools like sniffers, port scanners and other related tools for analyzing packets in a network.
6. To be able to set up firewalls and intrusion detection systems using open source technologies and to explore email security.

Lab Outcome: Students will learn to:

1. Apply the knowledge of symmetric cryptography to implement simple ciphers
2. Analyze and implement public key algorithms like RSA and El Gamal
3. Analyze and evaluate performance of hashing algorithms
4. Explore the different network reconnaissance tools to gather information about networks
5. Use tools like sniffers, port scanners and other related tools for analyzing packets in a network.
6. Apply and set up firewalls and intrusion detection systems using open source technologies and to explore email security.

Hardware and Software requirements:

Hardware Requirements	Software Requirements
PC With following Configuration 1. Intel Core i3/i5/i7 Processor 2. 4 GB RAM 3. 500 GB Harddisk	1. Windows or Linux Desktop OS 2. Wireshark 3. ARPWATCH 4. Kismet, NetStumbler 5. NESSUS

Prerequisite: Computer Networks, Operating System, Basics of Java and Python Programming

Detail Syllabus:

Module No.	Description	Hours	CO mapping
I	<p>a) Design and Implementation of a product cipher using Substitution and Transposition ciphers</p> <p>b) Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal</p>	4	<p>LO1</p> <p>LO2</p>
II	<p>a) Implementation of Diffie Hellman Key exchange algorithm</p> <p>b) For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs</p> <p>c) Exploring wireless security tools like Kismet, NetStumbler etc.</p>	4	<p>LO2</p> <p>LO3</p>
III	<p>a) Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.</p> <p>b) Study of packet sniffer tools wireshark, :-</p> <ol style="list-style-type: none"> 1. Observe performance in promiscuous as well as non-promiscuous mode. 2. Show the packets can be traced based on different filters. 	4	<p>LO4</p> <p>LO5</p>
IV	<p>Download and install nmap.</p> <p>Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc.</p>	4	LO5
V	<p>a) Detect ARP spoofing using nmap and/or open source tool ARPWATCH and wireshark.</p> <p>b) Simulate DOS attack using Hping and other tools</p> <p>c) Use the NESSUS/ISO Kaali Linux tool to scan the network for vulnerabilities.</p>	6	<p>LO4</p> <p>LO5</p>

VI	a) Set up IPSEC under LINUX. b) Set up Snort and study the logs. c) Explore the GPG tool of linux to implement email security	4	LO6
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Text Books:

1. Build your own Security Lab, Michael Gregg, Wiley India
2. CCNA Security, Study Guide, Tim Boyles, Sybex

Reference Books:

1. Network Security Bible, Eric Cole, Wiley India

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITL503	OLAP Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test	Test2	Avg. of two Tests					
ITL503	OLAP Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To introduce advanced concepts of transaction management and recovery techniques.
2. To impart knowledge related to query processing and query optimizer phases of a database management system
3. To initiate awareness about the potential security threats that exists in database systems and how to tackle them.
4. To introduce advanced database models like distributed databases.
5. To impart an overview of emerging data models like temporal, mobile and spatial databases.
6. To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse.

Lab Outcomes: Student should be able:

1. Implement simple query optimizers and design alternate efficient paths for query execution.
2. Simulate the working of concurrency protocols, recovery mechanisms in a database
3. Design applications using advanced models like mobile, spatial databases.
4. Implement a distributed database and understand its query processing and transaction processing mechanisms
5. Build a data warehouse
6. Analyze data using OLAP operations so as to take strategic decisions.

Hardware and Software requirements:

Hardware Requirements	Software Requirements
PC With following Configuration 1. Intel Core i3/i5/i7	1. ETL tools 2. Warehouse tools 3. Java/Python compiler

Processor	
2. 4 GB RAM	
3. 500 GB Harddisk	

Prerequisite: DBMS.

Detailed syllabus:

Module No.	Detailed Content	Hours	CO Mapping
I	a) Implementation of any Query optimizer (Java/Python) b) Assignments for query evaluation path expressions.	4	LO 2
II	c) Simulation of Concurrency Control Algorithm, Recovery Algorithm (Java/Python)	4	LO1
III	a) Design of a distributed database for a real life application - Fragmentation, Query Processing b) Simulation of Recovery methods.	4	LO 4
IV	Advanced Database Models Case study based assignments for Temporal, Mobile or Spatial databases	4	LO 3
V	Data Warehouse Construction a) Real life Problem to be defined for Warehouse Design b) Construction of star schema c) ETL Operations.	6	LO 4
VI	OLAP Exercise a) Construction of Cubes b) OLAP Operations, OLAP Queries	4	LO 6

Text Books:

1. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
2. Theraja Reema, "Data Warehousing", Oxford University Press, 2009.
3. Data Warehousing, Data Mining, & OLAP by Alex Berson McGraw Hill.

References:

1. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom "Database System Implementation", Pearson Ltd. 1/ e
2. Thomas M. Connolly Carolyn Begg, Database Systems : A Practical Approach to Design, Implementation and Management, 4/e Pearson Ltd

3. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide To Dimensional Modeling", 3rd Edition. Wiley India.

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITL504	IOT (Mini Project) Lab	--	2	--	--	1	--	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL504	IOT (Mini Project) Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try to:

1. Address the real world problems and find the required solution.
2. Design the problem solution as per the requirement analysis done.
3. Study the basic concepts of programming/ hardware/ emulator for Raspberry pi/Arduino/ ARM Cortex/ Intel Galileo etc.
4. Fabricate and implement the mini project intended solution for project based learning.
5. Build and test the mini project successfully.
6. Improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Identify the requirements for the real world problems.
2. Conduct a survey of several available literatures in the preferred field of study.
3. Study and enhance software/ hardware skills.
4. Demonstrate and build the project successfully by hardware requirements, coding, emulating and testing.
5. To report and present the findings of the study conducted in the preferred domain
6. Demonstrate an ability to work in teams and manage the conduct of the research study.

Guidelines

1. The mini project work is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students may do survey for different application using Raspberry pi/Arduino/ ARM Cortex/ Intel Galileo etc topics for the mini project.

4. Each group will identify the Hardware and software requirement for their mini project problem statement.
5. Prototype/Design your own circuit board using Raspberry pi/Arduino/ ARM Cortex/ Intel Galileo etc.
6. Installation, configure and manage your Raspberry pi/Arduino/ ARM Cortex/ Intel Galileo etc board/kit.
7. Work with operating system and do coding to for input devices on board.
8. The project assessment for term work will be done at least two times at department level by giving presentation to panel members which consist of at least three (3) members as Internal examiners (including the project guide/mentor) appointed by the Head of the department of respective Programme.
9. Create and interface using Web to publish or remotely access the data on Internet.
10. Each group along with the concerned faculty shall identify a potential problem statement, on which the study and implementation is to be conducted.
11. Each group may present their work in various project competitions and paper presentations.
12. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Massimo Banzi, "Getting Started with Arduino", O'reilly, 2nd edition
2. Simon Monk, "Raspberry Pi Cookbook", O'reilly
3. Raspberry Pi User Guide

References:

1. Internet of Things (A Hands-on-Approach) , Vijay Madiseti , Arshdeep Bahga

Term Work:

Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITL505	Business Communication and Ethics	2	2*	--	--	2	--	2

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL505	Business Communication and Ethics	--	--	--	--	50	--	--	50

* Batch wise practical's

Pre-requisite

- Communication Skills

Course Objective: Students will try:

1. To inculcate professional and ethical attitude at the workplace
2. To enhance effective communication and interpersonal skills
3. To build multidisciplinary approach towards all life tasks
4. To hone analytical and logical skills for problem-solving

Course Outcomes: Students will learn to:

1. Design a technical document using precise language, suitable vocabulary and apt style.
2. Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
4. Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
5. Deliver formal presentations effectively implementing the verbal and non-verbal skills.

Module	Detailed Contents	Hrs.
01	Report Writing	05
1.1	Objectives of Report Writing	
1.2	Language and Style in a report	
1.3	Types : Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports (Memo, Letter, Short and Long Report)	
02	Technical Writing	03
2.1	Technical Paper Writing (IEEE Format)	
2.2	Proposal Writing	
03	Introduction to Interpersonal Skills	08
3.1	Emotional Intelligence	
3.2	Leadership and Motivation	
3.3	Team Building	
3.4	Assertiveness	
3.5	Conflict Resolution and Negotiation Skills	
3.6	Time Management	
3.7	Decision Making	
04	Meetings and Documentation	02
4.1	Strategies for conducting effective meetings	
4.2	Notice, Agenda and Minutes of a meeting	
4.3	Business meeting etiquettes	
05	Introduction to Corporate Ethics	02
5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.)	
5.2	Introduction to Intellectual Property Rights	
5.4	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
06	Employment Skills	06

6.1	Group Discussion	
6.2	Resume Writing	
6.3	Interview Skills	
6.4	Presentation Skills	
6.5	Statement of Purpose	
		26

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

1. Term Work:

2. Term work shall consist of all assignments from the list. The distribution of marks for term
3. work shall be as follows:
4. Book Report.....(10) Marks
5. Assignments (10) Marks
6. Project Report Presentation..... (15) Marks
7. Group Discussion..... (10) Marks
8. Attendance(05) Marks
- 9. TOTAL:(50) Marks**

The final certification and acceptance of term work ensures the satisfactory performance of work assigned and minimum passing in the term work.

References

1. Fred Luthans, “*Organizational Behavior*”, McGraw Hill, edition
2. Lesiker and Petit, “*Report Writing for Business*”, McGraw Hill, edition
3. Huckin and Olsen, “*Technical Writing and Professional Communication*”, McGraw Hill

4. Wallace and Masters, "*Personal Development for Life and Work*", Thomson Learning, 12th edition
5. Heta Murphy, "*Effective Business Communication*", Mc Graw Hill, edition
6. Sharma R.C. and Krishna Mohan, "*Business Correspondence and Report Writing*", Tata McGraw-Hill Education
7. Ghosh, B. N., "*Managing Soft Skills for Personality Development*", Tata McGraw Hill. Lehman,
8. Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
9. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
10. Dr. Alex, K., "Soft Skills", S Chand and Company
11. Subramaniam, R., "Professional Ethics" Oxford University Press.
12. Robbins Stephens P., "Organizational Behavior", Pearson Education
13. <https://grad.ucla.edu/asis/agep/advtopstem.pdf>

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITDLO5011	Advanced Data Structures & Analysis of Algorithms	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO5011	Advanced Data Structures & Analysis of Algorithms	20	20	20	80	--	--	100	

Course Objectives: Students will try:

1. To learn mathematical background for analysis of algorithm
2. To learn various advanced data structures.
3. To understand the concept of designing an algorithm.
4. To learn dynamic programming and greedy method.
5. To understand the concept of pattern matching
6. To learn advanced tree and graph applications.

Course Outcomes:

1. Students will be able to choose appropriate advanced data structure for given problem.
2. Students will be able to calculate complexity.
3. Students will be able to select appropriate design techniques to solve real world problems.
4. Students will be able to apply the dynamic programming technique to solve the problems.
5. Students will be able to apply the greedy programming technique to solve the problems.
6. Students will be able to select a proper pattern matching algorithm for given problem.

Prerequisite: Knowledge Any Programming Language, Data structures and Analysis

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
	Prerequisite	Data structures and analysis	02	--
I	Introduction	<p>Introduction</p> <ul style="list-style-type: none"> • Introduction to advanced data structures: • Introduction/Fundamentals of the analysis of algorithms <ul style="list-style-type: none"> ○ Recurrences: <ul style="list-style-type: none"> ▪ The substitution method ▪ Recursive tree method ▪ Masters method ○ Probabilistic analysis ○ Amortized analysis ○ Randomized algorithms ○ Mathematical aspects and analysis of algorithms 	10	CO1 CO2
II	Advanced Data Structures	<ul style="list-style-type: none"> • Introduction • AVL tree • Huffman algorithm • B/B+ tree • 2-3 tree operations • Red-Black Trees • tries • Heap operations • Implementation of priority queue using heap • Topological sort <p>Analysis of All problems</p>	11	CO1 CO2 CO3
III	Divide and Conquer	<ul style="list-style-type: none"> • Introduction • Binary search • Finding the minimum and maximum • Merge sort • Quick sort • Strassen's matrix multiplication <p>Analysis of All problems</p>	7	CO2 CO3
IV	Greedy algorithms	<ul style="list-style-type: none"> • Introduction • Knapsack problem • Job sequencing with deadlines • Minimum cost spanning trees 	8	CO2 CO3

		<ul style="list-style-type: none"> ○ Kruskal's algorithm ○ Prim's algorithm ● Optimal storage on tapes ● Optimal merge pattern ● Subset cover problem ● Container loading problem <p>Analysis of All problems</p>		CO5
V	Dynamic algorithms And NP-Hard and NP-Complete	<p>Introduction Dynamic algorithms</p> <ul style="list-style-type: none"> ● All pair shortest path ● 0/1 knapsack ● Travelling salesman problem ● Coin Changing Problem ● Matrix Chain Multiplication ● Flow shop scheduling ● Optimal binary search tree (OBST) ● Analysis of All problems ● Introduction to NP-Hard And NP-Complete Problems 	8	CO2 CO3 CO4
VI	String Matching	<ul style="list-style-type: none"> ● introduction ● The naïve string matching algorithm ● Rabin Karp algorithm ● Knuth-Morris-Pratt algorithm (KMP) ● Longest common subsequence(LCS) ● Analysis of All problems ● Genetic algorithms 	6	CO2 CO3 CO6

Text Books:

1. Introduction to ALGORITHMS, Cormen, Leiserson, Rivest, Stein, PHI.
2. Algorithms: Design and Analysis, Harsh Bhasin, OXFORD.
3. Fundamentals of Computer Algorithms, Horowitz, Sahani, Rajsekaran, Universities Press.
4. C and Data structures, Deshpande, Kakde, Dreamtech Press.

Reference Books:

1. Data Structures and Algorithms in C++, Goodritch, Tamassia, Mount, WILEY.
2. Data Structures using C, Reema Thareja, OXFORD.
3. Data Structures and Algorithm Analysis in C, Mark A. Weiss, Pearson.

Assessment:

Internal Assessment for 20 marks:**Consisting of Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITDLO5012	Image Processing	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO5012	Image Processing	20	20	20	80	--	--	100

Course Objectives: The course will help the students to get familiar with

1. Fundamental concepts of a digital image processing system.
2. Concepts of image enhancement techniques.
3. Various Image Transforms.
4. Compression techniques and Morphological concepts
5. Various segmentation techniques, and object descriptors.
6. Color models and various applications of image processing.

Course Outcomes: Students should be able to:

1. Remember the fundamental concepts of image processing.
2. Explain different Image enhancement techniques
3. Understand and review image transforms
4. Analyze the basic algorithms used for image processing & image compression with morphological image processing.
5. Contrast Image Segmentation and Representation
6. Design & Synthesize Color image processing and its real world applications.

Prerequisite: Mathematics and Statistics.

Detail Syllabus:

Sr. No	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	As images are two dimensional signals, the single dimensional Digital Signal Processing fundamentals.	02	

I	Introduction to digital image processing system	Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationships between Pixels.	07	CO 1
II	Image enhancement	Intensity Transformations and Spatial Filtering, Histogram processing, Filtering in Frequency Domain	09	CO 2
III	Image transforms	Discrete Fourier transform - Properties of two dimensional DFT, DCT, DST, Walsh, Hadamard, Haar Transform and their properties.	07	CO 3
IV	Image compression and morphological image processing	Fundamentals of compression, Basic compression Methods, Huffman Coding, Arithmetic Coding , LZW Coding , Run-Length Coding , Symbol-Based Coding, Bit-Plane Coding, Block Transform Coding , Predictive Coding. Image morphology, Opening & Closing, Hit or Miss Transform, Basic Morphological Algorithms	11	CO 4
V	Image segmentation and representation	The detection of discontinuities - Point, Line and Edge detections , Hough Transform, Thresholding Region based segmentation Chain codes, Polygon approximation, Shape numbers, Fourier descriptors, statistical Moments.	08	CO 5

VI	Color Image Processing and Applications	Color Fundamentals and Models, Pseudocolor Image Processing, Smoothing and Sharpening, Image Segmentation Based on Color. Biometric Authentication, Digital watermarking, Content Base Image Retrieval. Vector quantization	08	CO 6
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Text Books:

1. Rafael C. Gonzalez and Richard E.woods, “Digital Image Processing”, Addition - Wesley Publishing Company, New Delhi, Third Edition, 2007.
2. William K. Pratt, “Digital Image Processing”, John Wiley, NJ, Fourth Edition 2007.

Reference Books:

1. Sid Ahmed M.A., “Image Processing Theory, Algorithm and Architectures”, McGraw-Hill, 1995.
2. Kenneth R Castleman, “Digital Image Processing”, Prentice Hall, New Delhi, 1996.
3. Anil.K.Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India Pvt Ltd., New Delhi, 1995.
4. S. Sridhar, “ Digital Image Processing”, second Edition, Oxford university press, New Delhi, 2016.
5. S. Jayaraman, S. Esakkirajan, T. Veerakumar “ Digital Image Processing”, McGraw-Hill, 2016

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory and should cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITDLO5013	E-Commerce & E-Business	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO5013	E-Commerce	20	20	20	80	--	--	100

Course Objectives: Students will try to :

1. Understand concept of Ecommerce and its types.
2. Be familiarized with technologies for Ecommerce.
3. Understand different types of Online Payment systems.
4. Understand Selling and marketing on web.
5. Be familiarized with concept of E-business and E-business Models.
6. Understand various E-business Strategies.

Course Outcomes: Students will be able to:

1. Define and differentiate various types of E-commerce.
2. Describe Hardware and Software Technologies for E-commerce.
3. Explain payment systems for E-commerce.
4. Describe the process of Selling and Marketing on web.
5. Define and Describe E-business and its Models.
6. Discuss various E-business Strategies.

Prerequisite: Internet Technologies, Internet Security, Middleware technologies, web services

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Internet Technologies, Internet Security, Middleware technologies, web services	02	
I	Introduction to E	E-commerce :Definition of e commerce , different types of E-commerce ,Examples	04	CO1

	-commerce	of E- commerce, E-commerce trade cycle , advantages and disadvantages of E-commerce , Traditional commerce Vs E-commerce		
II	Overview of Hardware and Software Technologies for Ecommerce	Overview of Client side programming (Dream weaver , Front page) Hardware and , Server side Programming (PHP) , Database Software connectivity , session tracking, middleware technologies for ecommerce perspective and security aspects with respect to e commerce, integration of web services	08	CO2
III	Payment System for Ecommerce	Traditional payment model , Characteristics of payment, Online Payment Basics, Payment Cards, Electronic Cash, Electronic Wallets, Stored-Value Cards, SET Protocol for credit card payment, Internet Technologies and the Banking Industry	10	CO3
IV	Selling and Marketing on Web	Selling on the Web: Revenue Models and Building a Web Presence: Revenue Models, Revenue Models in Transition, Revenue Strategy Issues, Creating an Effective Web Presence, Web Site Usability, Connecting with Customers Marketing on the Web: Web Marketing Strategies, Communicating with Different Market Segments, Beyond Market Segmentation: Customer Behavior and Relationship Intensity, Advertising on the Web, E-Mail Marketing, Technology-Enabled Customer Relationship Management, Creating and Maintaining Brands on the Web Online Auctions, Virtual Communities, and Web Portals	10	CO4
V	E business :- Introduction to e business and Developing E-business models	Definition of e- business , Characteristics , elements of e business , e business roles , Impact of e business , challenges of e business , difference between e business and e commerce , E-business structure, Evolution of E –business and stages , E –business models , Characteristics of Internet based software and e business solutions	10	CO5
VI	E business strategies	Strategic planning process, SCM , CRM , ERP , procurement	08	CO6

Text Books:

- 1 E -Commerce Fundamentals and application (Henry Chan) Wiley publication
2. Electronics Commerce (Gary Schneider) Thomson Course technology
- 3.E –Business , Parag Kulkarni , Sunita Jahirabadkar, Pradip Chande , Oxford Higher Education , Oxford University Press
4. E –business and E –commerce Management , Dave Chaffey , Pearson , 3rd edition
5. E commerce by Laudon

References:

1. E-Commerce Strategies, Technology and applications (David Whitley) Tata McGrawHill
2. Introduction to E-commerce Elias Awad

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ITDLO5014	IT Enabled Services	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO5014	IT Enabled Services	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To understand importance of IT enabled services and challenges for the same.
2. To understand strategic IT planning for industries.
3. To develop enterprise IT architecture for Information technology.
4. To encourage the use of Information Technology so as to enable students to improve their skills, knowledge and job prospects and enable them to obtain employment in sunrise industries.
5. To develop the ability to integrate various resources for optimization in the industry as well as for strategic utilization of IT enabled services and functions.
6. To develop competence in global sourcing: strategy and management to gain a perspective on the global services sourcing landscape: past, present, and future.

Course Outcomes: Students will be able to:

1. Describe the importance of IT enabled services and challenges.
2. Identify strategic IT planning for software development.
3. Recognize enterprise IT architecture for Information technology.
4. Use of Information Technology so as to enable them for job in sunrise industries.
5. Illustrate various IT web services for betterment of knowledge.
6. Use their skills to find out various current IT trends in ITES.

Prerequisite: Internet Programming.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Information Technology and Project Management, Web Engineering and Technology.	02	
I	Business strategy: challenges and opportunities for IT	Business Strategy: Challenges and Opportunities in the Globalized, Interconnected, Convergent World, Establish Principles before Practice, IT Strategy, Application Strategy, Technology Strategy for IT, IT Management Strategy, Developing IT Strategy for Competitive Advantage, Stages of IT Strategy Development and Implementation, Challenges of IT and Business Strategy Alignment, Inhibitors of Business and IT Strategy Alignment, Three-D Framework for Business and IT Strategy Alignment.	09	CO1
II	Strategic IT planning	Business Implications for IT Strategic and Planning, Strategic IT Planning Motivations, SITP Process: Prevalent Planning Approaches, Difficulties in Developing and Executing SITP, Best Practices for Achieving Good SITP, SITP Approaches-Prevalent Researches.	09	CO2
III	Enterprise IT architecture	Defining EITA, Contents of a Typical Enterprise IT Architecture, Standard for Enterprise IT Architecture, Technology Management strategy Framework, Prevalent Technology Reference Architectures Framework and Standards, Program Management, Benefits of PMO, Desired Qualities of a Program Office Manager, Maturity of PMO, Implementation of PMO Strategy, Measuring PMO Performance, Success Factors for PMO, Project Scope Management, PMO Dashboard and Reporting.	08	CO3

IV	IT service management strategy	Information Technology Infrastructure Library (ITIL), ITIL Overview, ITIL Service Support Processes, Incident Management, Problem Management, Service Delivery, Service Level Management, Financial Management, Capacity Management, IT Service Continuity Management (ITSCM), Availability Management, Imperatives for Outsourcing, IT Management Layers, Variants of Outsourcing, Business Process Outsourcing, In sourcing.	08	CO4
V	IT enabled web services	Overview of basic features of PHP: arrays, functions and state management, working with PHP forms, More advanced PHP, OOP's concept in PHP, Portable database supported with different, exception handling, concepts of UDDI, WSDL, SOAP.	08	CO5
VI	Current trends in ITES	Current Employment in the IT and ITES industry: Newly emerging area and requirement of IT enabled service sector. Industry Oriented Human Resource Requirement: Outlook of the IT and ITES Industry. Barriers to Trade in ITES Role of International Bodies (WTO & UNCTAD) in facilitating Trade in ITES/ITES, experiences and Case studies of ITES-call centers, ERP, google.	08	CO6

Text Books:

1. Sanjiva Shankar Dubey, "IT strategy and Management", PHI.
2. K. Venkatesh, "Marketing of Information Technology", TMH.
3. Steve Suehring, Timconverse, Joyoe Park, "PHP 6 and MySQL Bible", Wiley.

References:

1. Shiro Uesugi, "IT Enabled Services", Springer; 2013 edition, 2013.
2. Sanjiva Shankar Dubey, "IT Services Business Management: Concepts, Processes and Practices", PHI, 2012.
3. Nikhil Treebhoo, "Promoting IT Enabled Services", Addison-Wesley, 2013.

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ITDLO5015	Computer Graphics & Virtual Reality	04	--	---	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				End Sem. Exam	Term Work	Oral & Practical	Total
		Internal assessment			Avg. of two Tests				
		Test1	Test2						
ITDLO5015	Computer Graphics & Virtual Reality	20	20	20	80	----	--	100	

Course Objectives: Students will try:

1. To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them.
2. To learn the basic principles of 3-dimensional computer graphics.
3. Provide an understanding of how to scan convert the basic geometrical primitives, how to transform the shapes to fit them as per the picture definition.
4. Provide an understanding of mapping from a world coordinates to device coordinates, clipping, and projections.
5. To be able to discuss the application of computer graphics concepts in the development of computer games, information visualization, and business applications.
6. To comprehend and analyze the fundamentals of animation, virtual reality, underlying technologies, principles, and applications.

Course Outcomes: Students will be able to:

1. To list the basic concepts used in computer graphics.
2. To implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping.
3. To describe the importance of viewing and projections.
4. To define the fundamentals of animation, virtual reality and its related technologies.
5. To understand a typical graphics pipeline
6. To design an application with the principles of virtual reality

Prerequisite: Basic Mathematics

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Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Knowledge of Mathematics	2	
I.	Introduction to Computer graphics and Output primitives	<p>Introduction: Display Devices, Bitmap and Vector based graphics, Overview of Coordinate System.</p> <p>Scan Conversion of: point, line using Digital differential analyzer & Bresenham's algorithm, circle using midpoint approach,</p> <p>Curve Generation: Bezier and B-Spline curves.</p> <p>Introduction to fractals: generation procedure, classification, dimension and Koch Curve.</p>	7	CO1
II.	Area Filling, Transformations (2D and 3D)	<p>Area filling: Inside/Outside Test, Scan line Polygon Fill Algorithm, Boundary Fill and Flood Fill algorithm.</p> <p>Basic Geometrical 2D Transformations: Translation, Rotation, Scaling, Reflection, Shear, their homogeneous Matrix representation and Composite transformation.</p> <p>Three Dimensional transformations: Translation, Scaling, Rotations, Composite.</p>	8	CO1 CO2
III.	Viewing (2D and 3D) Projection and Clipping	<p>Viewing: Introduction, Viewing Pipeline, View Coordinate reference frame, Window to viewport transformation.</p> <p>Three-Dimensional Viewing: 3D Pipeline, Viewing transformation, Projections: Parallel (Oblique and orthographic), Perspective (one Point)</p> <p>Clipping: Point clipping, Line clipping: Cohen Sutherland Algorithm, Liang Barsky algorithms, Polygon clipping: Sutherland Hodgeman polygon clipping and Weiler Atherton. Text Clipping.</p>	10	CO1 CO2 CO3

IV.	Introduction To Animation	Animation: Key Frame Animation, Animation Sequence, Motion Control Methods, Morphing, Warping- Mesh Warping.	4	CO1 CO2 CO4 CO5
V.	Introduction to Virtual Reality	Virtual Reality: Basic Concepts, Overview and perspective on virtual reality, Human sensation and perception. Classical Components of VR System, Types of VR Systems, Three-Dimensional Position Trackers, Navigation and Manipulation Interfaces, Gesture Interfaces, Input Devices, Graphical Display, Sound displays, and Haptic Feedback. Graphical Rendering Pipeline, Haptic Rendering Pipeline, Open GL rendering pipeline. Applications of Virtual Reality.	9	CO1 CO2 CO4 CO6
VI.	VR Modeling and Programming	Geometric Modeling: Virtual Object Shape, Object Visual Appearance. Kinematics Modeling: Object Position, Transformation Invariants, Object Hierarchies, Physical Modeling: Collision Detection, Surface Deformation, Force Computation. Behavior Modeling. Programming through VRML/X3D: Defining and Using Nodes and Shapes, VRML Browsers, Java 3D, OpenCV for augmented reality	12	CO1 CO2 CO4 CO6

Text Books

- 1 Donald Hearn and M. Pauline Baker, "Computer Graphics", Pearson Education.
- 2 R. K Maurya, "Computer Graphics with Virtual Reality", Wiley India.

Reference Books

1. Grigore Burdea, Philippe Coiffet, "Virtual Reality Technology", Wiley.
2. Steven Harrington, "Computer Graphics", McGraw Hill.
3. Rogers, "Procedural Elements of Computer Graphics", Tata McGraw Hill.
4. Vince, "Virtual Reality Systems", Pearson Education.
5. F.S. Hill, Stephen M. Kelley , "Computer Graphics using Open GL" Prentice Hall
6. Samyak Datta , "Learning OpenCV 3 Application Development", Packt

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

T. E. Information Technology (Semester-VI)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
ITC601	Software Engineering with Project Management	4	-	-	4	-	-	4
ITC602	Data Mining and Business Intelligence	4	-	-	4	-	-	4
ITC603	Cloud Computing & Services	4	-	-	4	-	-	4
ITC604	Wireless Networks	4	-	-	4	-	-	4
ITDLO-II	Department Level Optional Course -II	4	-	-	4	-	-	4
ITL601	Software Design Lab	-	2	-	-	1	-	1
ITL602	Business Intelligence Lab	-	2	-	-	1	-	1
ITL603	Cloud Service Design Lab	-	2	-	-	1	-	1
ITL604	Sensor Network Lab	-	2	-	-	1	-	1
ITM605	Mini-project	-	4	-	-	2	-	2
	Total	20	12	-	20	6	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
ITC601	Software Engineering with Project Management	20	20	20	80	3	-	-	-	100
ITC602	Data Mining and Business Intelligence	20	20	20	80	3	-	-	-	100
ITC603	Cloud Computing & Services	20	20	20	80	3	-	-	-	100
ITC604	Wireless Networks	20	20	20	80	3	-	-	-	100
ITDLO-II	Department Level Optional Course -II	20	20	20	80	3	-	-	-	100
ITL601	Software Design Lab	-	-	-	-	-	25	25	--	50
ITL602	Business Intelligence Lab	-	-	-	-	-	25	25	--	50
ITL603	Cloud Service Design Lab	-	-	-	-	-	25	25	--	50
ITL604	Sensor Network Lab	-	-	-	-	-	25	25	--	50
ITM605	Mini-Project	-	-	-	-	-	25	25	--	50
Total		100	100	100	400	-	125	125	--	750

Department Level Optional Course (DLO)

Every student is required to take one Department Elective Course for Semester VI. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

(DLO-I subjects will have no Labs only Theory)

Subject Code	Department Level Optional Course (DLO)
Semester VI	
ITDLO6021	Advance Internet Programming
ITDLO6022	Software Architecture
ITDLO6023	Digital Forensics
ITDLO6024	Multimedia Systems
ITDLO6025	Green IT

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC601	Software Engineering with Project Management	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC601	Software Engineering with Project Management	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To understand the nature of software development and software life cycle process models, agile software development, SCRUM and other agile practices.
2. To Explain methods of capturing, specifying, visualizing and analyzing software requirements.
3. To understand concepts and principles of software design and user-centric approach and principles of effective user interfaces.
4. To know basics of testing and understanding concept of software quality assurance and software configuration management process.
5. To understand need of project management and project management life cycle.
6. To understand project scheduling concept and risk management associated to various type of projects.

Course Outcomes: Students will be able to:

1. Define various software application domains and remember different process model used in software development.
2. Explain needs for software specifications also they can classify different types of software requirements and their gathering techniques.
3. Convert the requirements model into the design model and demonstrate use of software and user-interface design principles.
4. Distinguish among SCM and SQA and can classify different testing strategies and tactics and compare them.
5. Justify role of SDLC in Software Project Development and they can evaluate importance of Software Engineering in PLC.
6. Generate project schedule and can construct, design and develop network diagram for different type of Projects. They can also organize different activities of project as per Risk impact factor.

Prerequisite: Programming and Networking.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Nature of Software, Software Definition, Software Characteristics, Software Application Domains	02	
I	The Software Process	Generic view of Process, Prescriptive Models: Waterfall Model, Incremental-RAD Model, Evolutionary Process Model- Prototyping, Spiral and Concurrent Development Model, Specialized Models: Component based, Aspect Oriented Development, Agile Methodology, Scrum and Extreme Programming	07	CO1
II	Requirements Engineering and Cost Estimation	Requirement, Types of Requirements, Requirement gathering, Requirement Engineering Task, Identifying Stakeholders, Multiple viewpoints, SRS (Software Requirement Specification) Project Estimation, LOC based, FP based and Use case based estimation.	07	CO1 CO2
III	Analysis and Design Engineering	Introduction of Analysis elements, Scenario based, Flow based, behavior and class based Design Concepts and Principles, Architecture Design, Component Level Design, System Level Design, User Interface Design.	09	CO1 CO2 CO3
IV	Quality & Configuration Management	Need for Testing, Testing Tactics, Testing strategies, McCall's Quality Factor, Software Configuration Management, SCM Process	07	CO4
V	IT Project Management	Introduction, 4 P's, W5HH Principle, Need for Project Management, Project Life cycle and ITPM, Project Feasibility, RFP, PMBOK Knowledge areas, Business Case, Project Planning, Project Charter and Project Scope.	10	CO5

VI	Project Scheduling and Risk Management	WBS, Developing the Project Schedule, Network Diagrams (AON, AOA), CPM and PERT, Gantt Chart, Risk Identification, Risk Projection and RMMM	10	CO1 CO2 CO3 CO4 CO6
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Text Books:

1. Roger S Pressman “Software Engineering : A Practitioner’s Approach” 7th Edition Mcgraw-Hill ISBN:0073375977
2. Jack T. Marchewka, “Information Technology Project Management” 4th Edition ,Wiley India

References:

1. “Software Engineering : A Precise Approach” Pankaj Jalote , Wiley India
2. Ian Sommerville “ Software Engineering” 9th edition Pearson Education SBN-13: 978-0- 13-703515-1, ISBN-10: 0-13-703515-2
3. John M. Nicholas, Project Management for Business and Technology, 3rd edition, Pearson Education.
4. Software Project management by Bob Hughes, Mike Cotterell , Rajib Mall

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC602	Data Mining and Business Intelligence	04		--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC602	Data Mining and Business Intelligence	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To introduce the concept of data Mining as an important tool for enterprise data management and as a cutting edge technology for building competitive advantage.
2. To enable students to effectively identify sources of data and process it for data mining
3. To make students well versed in all data mining algorithms, methods of evaluation.
4. To impart knowledge of tools used for data mining
5. To provide knowledge on how to gather and analyze large sets of data to gain useful business understanding.
6. To impart skills that can enable students to approach business problems analytically by identifying opportunities to derive business value from data.

Course Outcomes: Student will be able to:

1. Demonstrate an understanding of the importance of data mining and the principles of business intelligence
2. Organize and Prepare the data needed for data mining using pre preprocessing techniques
3. Perform exploratory analysis of the data to be used for mining.
4. Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on large data sets.
5. Define and apply metrics to measure the performance of various data mining algorithms.
6. Apply BI to solve practical problems : Analyze the problem domain, use the data collected in enterprise apply the appropriate data mining technique, interpret and visualize the results and provide decision support.

Prerequisite: Database Management System, Advanced Data Management Technology.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Knowledge of databases, and Data warehousing, OLAP	02	--
I	Introduction to Data Mining	What is Data Mining; Kind of patterns to be mined; Technologies used; Major issues in Data Mining	03	CO1
II	Data Exploration and Data Preprocessing	Types of Attributes; Statistical Description of Data; Data Visualization; Measuring similarity and dissimilarity. Why Preprocessing? Data Cleaning; Data Integration; Data Reduction: Attribute subset selection, Histograms, Clustering and Sampling; Data Transformation & Data Discretization: Normalization, Binning, Histogram Analysis and Concept hierarchy generation.	09	CO2 CO3
III	Classification	Basic Concepts; Classification methods: 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naïve Bayes Classifier. Prediction: Structure of regression models; Simple linear regression, Multiple linear regression. Accuracy and Error measures, Precision, Recall, Holdout, Random Sampling, Cross Validation.	09	CO4 CO5
IV	Clustering	Cluster Analysis: Basic Concepts; Partitioning Methods: K-Means, K-Medoids; Hierarchical Methods: Agglomerative, Divisive, BIRCH; Density-Based Methods: DBSCAN What are outliers? Types, Challenges; Outlier Detection Methods: Supervised, Semi Supervised, Unsupervised, Proximity based, Clustering Based.	10	CO4 CO5
V	Frequent Pattern	Market Basket Analysis, Frequent Itemsets, Closed Itemsets, and	10	CO4

	Mining	Association Rules; Frequent Pattern Mining, Efficient and Scalable Frequent Itemset Mining Methods, The Apriori Algorithm for finding Frequent Itemsets Using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemsets; Mining Frequent itemsets using vertical data formats; Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules; From Association Mining to Correlation Analysis, lift, ; Introduction to Constraint-Based Association Mining.		CO5
VI	Business Intelligence	What is BI? Business intelligence architectures; Definition of decision support system; Development of a business intelligence system using Data Mining for business Applications like Fraud Detection, Clickstream Mining, Market Segmentation, retail industry, telecommunications industry, banking & finance CRM etc.	09	CO6

Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition.
2. P. N. Tan, M. Steinbach, Vipin Kumar, "Introduction to Data Mining", Pearson Education.
3. Business Intelligence: Data Mining and Optimization for Decision Making by Carlo Verellis ,Wiley India Publications.
4. G. Shmueli, N.R. Patel, P.C. Bruce, "Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner", 2nd Edition, Wiley India.

References:

1. Michael Berry and Gordon Linoff "Data Mining Techniques", 2nd Edition Wiley Publications.
2. Michael Berry and Gordon Linoff "Mastering Data Mining- Art & science of CRM", Wiley Student Edition.
3. Vikram Pudi & Radha Krishna, "Data Mining", Oxford Higher Education.

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC603	Cloud Computing & Services	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC603	Cloud Computing & Services	20	20	20	80	--	--	100

Course Objectives: Students will try to learn:

1. Basics of cloud computing.
2. Key concepts of virtualization.
3. Different Cloud Computing services
4. Cloud Implementation, Programming and Mobile cloud computing
5. Key components of Amazon Web Services
6. Cloud Backup and solutions

Course Outcomes: Students should be able to:

1. Define Cloud Computing and memorize the different Cloud service and deployment models
2. Describe importance of virtualization along with their technologies.
3. Use and Examine different cloud computing services
4. Analyze the components of open stack & Google Cloud platform and understand Mobile Cloud Computing
5. Describe the key components of Amazon web Service
6. Design & develop backup strategies for cloud data based on features.

Prerequisite Subjects: Computer Network, Operating System

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	OSI Layers, Basics of OS.	02	--
I	Introduction	Defining Cloud Computing, Cloud and other similar configurations, Components of Cloud	06	CO1

		Computing, Cloud types: NIST and Cloud Cube Models, Cloud Deployment Models and Service Models, Cloud computing architecture, Advantages and Disadvantages of Cloud Computing.		
II	Virtualization	Virtualization: Characteristics of virtualized environment, Understanding the importance of Hypervisors, Type I & Type II Hypervisors, Taxonomy of virtualization, Implementation Levels of Virtualization, Virtualization of CPU, Memory and I/O Devices , Virtualization and Cloud Computing, Pros and Cons of virtualization, Technology Examples: KVM, Xen, Vmware and HyperV	10	CO2
III	Cloud Computing Services	Exploring Cloud Computing Services: SPI Model: Software as a service, Platform as a service, and Infrastructure as a service. Anything as a service or Everything as a service (XaaS): Security as a Service, Identity management as a Service, Database as a Service, Storage as a Service, Collaboration as a Service, Compliance as a Service, Monitoring as a Service, Communication as a Service, Network as a Service, Disaster recovery as a service, Analytics as a Service, Backup as a Service.	09	CO1 CO2 CO3
IV	Cloud Implementation, Programming and Mobile Cloud Computing	Open Stack Cloud Architecture: Feature of Open stack, Components of Open stack, mode of operations. Programming support for Google apps engine-GFS, Bigtables, Chubby, Google APIs. Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile	09	CO1 CO2 CO3 CO4

		cloud computing		
V	Exploring the Components of Amazon Web Services	<p>AWS cloud computing Platform,</p> <p>a) Elastic Compute Cloud(EC2): Compute Basics, Instance types, Life cycle of instances.</p> <p>b) Simple Storage Service (S3): Basics and Operations, Features, Amazon Glacier, Glacier vs S3.</p> <p>c) Elastic Block Storage (EBS):Basics and Types of EBS Volumes</p> <p>d)Amazon Virtual Private Cloud (Amazon VPC): Subnets, Route tables, Elastic IP Addresses (EIP), Elastic Network Interfaces (ENIs) & Security groups & ACL.</p> <p>e) Exploring Elastic Load Balancing (ELB): Basics, Types of load balancers, Configuring Elastic Load Balancing, Basics of Cloud Watch & Auto Scaling.</p>	11	CO1 CO2 CO3 CO4 CO5
VI	Cloud Backup & Solutions	Cloud Backup Solutions and their features, Cloud data management interface (CDMI), Cloud Storage gateways (CSG), Comparison between different cloud platforms: Amazon web services & Open stack (Based on Type of deployment, Services supported and their components).	05	CO1 CO2 CO3 CO4 CO5 CO6

Text Books:

1. Barrie Sosinsky ,”Cloud Computing Bible”,Wiley Publication.
2. Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven Shah, ”Cloud Computing Black Book”, Dreamtech Press.
3. Joe Baron et.al ,”AWS certified solution Architect”, Sybex publication.
4. Mastering Cloud Computing, Rajkumar Buyya, MGH publication

Reference Books:

1. Thomas Erl, Robert Cope, Amin naserpour, "Cloud Computing Design Patterns", Pearson Publication.
2. Judith Hurwitz, "Cloud Computing for Dummies", Wiley Publication.

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Oral & Practical	Tutorial	Total
ITC604	Wireless Network	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC604	Wireless Network	20	20	20	80	--	--	100

Course Objectives: Students will try to:

- 1 Understand the fundamentals of wireless networks.
- 2 Learn and analyze the different wireless technologies.
- 3 Evaluate Ad-hoc networks and wireless sensor networks.
- 4 Understand and evaluate emerging wireless technologies and standards
- 5 Understand design considerations for wireless networks
- 6 Learn and analyze and evaluate the security threats and related security standards

Course Outcomes: Students will be able to:

1. Explain the basic concepts of wireless network and wireless generations.
2. Demonstrate the different wireless technologies such as CDMA, GSM, GPRS etc
3. Appraise the importance of Ad-hoc networks such as MANET and VANET and Wireless Sensor networks
4. Describe and judge the emerging wireless technologies standards such as WLL, WLAN, WPAN, WMAN.
5. Explain the design considerations for deploying the wireless network infrastructure.
6. Differentiate and support the security measures, standards. Services and layer wise security considerations.

Prerequisite: Computer Networks.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Modulation and Demodulation Techniques, PSTN	02	
I	Fundamentals Wireless Communication	Fundamentals of Wireless Communication, Advantages, limitations and application, wireless media, Infrared Modulation Techniques, DSSS and FHSS, Frequency Spectrum: Radio and Infrared; Wireless generations: 1G: Cellular, 2G: Mobile Radio, 3G: UMTS- Security related Encryption Algorithm, 4G	07	CO1
II	Evolution of Wireless Technologies	Multiple Access Technique: TDMA, FDMA, CSMA, CDMA Wireless Technologies: GSM, GPRS, EDGE, CDMA, LTE, UMTS	10	CO1 CO2
III	Types of Wireless Networks	Ad-hoc: MANET & VANET, Application, Advantage and limitations; Wireless Sensor Network: Application, advantages and limitations	09	CO1 CO3
IV	Emerging Wireless Technologies and standards	WLL , WLAN- 802.11 (Wi-Fi), WPAN- 802.15.1/3/4 (Bluetooth, Zigbee), WMAN-802.16a (Wi-max) , Wi-max and LTE /3GPP comparison, Mi-fi, Ly-fi,	10	CO1 CO2 CO4
V	Wireless Network Design Considerations	Wireless technology, Cisco Unified Wireless Network, Designing Wireless Networks with Lightweight Access Points and Wireless LAN Controllers	07	CO1 CO2 CO3 CO4 CO5
VI	Wireless Network Security	The need, attacks, security serviced, WEP, Mobile IP, VPN(PPTP, LLTP, IPsec), Network Layer Security, Transport Layer Security, Email Security: PGP, S/ MIME, Internet Firewalls for Trusted System	07	CO1 CO2 CO3 CO6

Text Books:

1. Cellular Communications: A Comprehensive and Practical Guide, Nishith Tripathi, Jeffery H Reed, Wiley
2. Wireless Mobile Internet Security, 2nd Edition, Man, Young Rhee, Wiley- IEEE press
3. Designing for Cisco Internetwork Solutions (DESIGN), 2nd Edition, CCDA, Diane Teare, Cisco Press.

References:

1. Introduction to Digital mobile communication, 2nd Edition, Yoshihiko Akaiwa
2. "Wireless Communications and networks", William Stallings, Pearson / Prentice Hall
3. Wireless communication and networking, Vijay Garg

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITL601	Software Design Lab	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL601	Software Design Lab	--	--	--	--	25	--	25	50

Course Objectives: Students will try to:

- 1 Learn basic concepts of UML.
- 2 Master the vocabulary, rules, and idioms of the UML and learn how to model it effectively.
- 3 Understand how to apply the UML to solve a number of common modeling problems.
- 4 Model the systems, from concept to executable artifact, using object-oriented techniques.
- 5 Apply the knowledge of Software engineering and project management.
- 6 Understand the software development process using tool.

Course Outcomes: Students will be able to:

1. Sketch a Modeling with UML.
2. Deploy Structural Modeling.
3. Deploy Behavioral Modeling.
4. Deploy Architectural Modeling.
5. Examine estimation about schedule and cost for project development.
6. Select project development tool.

Prerequisite: Object oriented Concept, Java programming language.

Requirement:-

Hardware	Software
PC i3 or above.	IBM Rational Rose Modeler, Dia, StarUML (Any One) Orange Scrum, Xampp , GitHub

Guidelines

1. Students should take one case study as a mini project work which is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students must be able to identify Object oriented Technologies, Basic expression of Classes, Attributes and operations.
4. Students must develop a Conceptual Model of the UML for above case study.
5. Students should define Classes, Relationships, Class Diagrams, Advanced Classes and Relationship, Object Diagrams for above case study.
6. Students should define Use Cases, Use case Diagrams, Activity Diagrams, Interaction Diagrams, State Chart Diagrams for above case study.
7. Students should define Components, Deployment, Collaborations, Component Diagrams, Deployment Diagrams for above case study
8. Students should define SRS, WBS, Network Diagram, Gantt Chart, Cost Estimation Techniques
9. Demonstration it using Scrum Tool
10. Each group may present their work in various project competitions and paper presentations.
11. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. “The Unified Modeling Language User Guide” by Grady Booch, James Rumbaugh, Ivar Jacobson, Pearson Publication, ISBN 978-81-7758-372-4
2. Jack T. Marchewka, Information Technology Project Management, 4th edition, Wiley India, 2009.

References:

1. UML – Tutorial “www.tutorialspoints.com/uml/”
2. “An Introduction to Object-Oriented Analysis: Objects and UML in plain English” by Davis William Brown, Wiley, Second Edition
3. “Fundamentals of Object-Oriented Design in UML”, Meilir Page-Jones, Pearson Education
4. UML in 24 Hours
5. UML Basics— an Introduction to the Unified Modeling Language – IBM
“www.ibm.com > Learn > Rational”

Term Work:

Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Case Study) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Case Study and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITL602	Business Intelligence lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL602	Business Intelligence Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To introduce the concept of data Mining as an important tool for enterprise data management and as a cutting edge technology for building competitive advantage.
2. To enable students to effectively identify sources of data and process it for data mining
3. To make students well versed in all data mining algorithms, methods, and tools.
4. To learn how to gather and analyze large sets of data to gain useful business understanding.
5. To impart skills that can enable students to approach business problems analytically by identifying opportunities to derive business value from data.
6. To identify and compare the performance of business.

Lab Outcomes: Students should be able to:

1. Identify sources of Data for mining and perform data exploration
2. Organize and prepare the data needed for data mining algorithms in terms of attributes and class inputs, training, validating, and testing files.
3. Implement the appropriate data mining methods like classification, clustering or association mining on large data sets using open source tools like WEKA
4. Implement various data mining algorithms from scratch using languages like Python/ Java etc.
5. Evaluate and compare performance of some available BI packages
6. Apply BI to solve practical problems : Analyze the problem domain, use the data collected in enterprise apply the appropriate data mining technique, interpret and visualize the results and provide decision support.

Prerequisite: Object oriented Concept, Java programming language.

Requirement:-

Hardware	Software
PC i3 or above.	Open source data mining and BI tools like WEKA, Rapid Miner, Pentaho.

Detailed syllabus:

Module	Detailed Content	Hours	LO Mapping
I & II	2 tutorials a) Solving exercises in Data Exploration b) Solving exercises in Data preprocessing	04	LO 1 LO 2
III	Using open source tools Implement a) Classifiers b) Clustering Algorithms c) Association Mining Algorithms	06	LO 3
IV	a) Implementation of any one classifier using languages like JAVA/ python/R b) Implementation of any one clustering algorithm using languages like JAVA/ python c) Implementation of any one association mining algorithm using languages like JAVA/ python	06	LO 4
V	Detailed case study of any one BI tool (open source tools like Pentaho can be used) (paper Assignment)	04	LO 5
VI	Business Intelligence Mini Project: Each group assigned one new case study for this; A BI report must be prepared outlining the following steps: a) Problem definition, Identifying which data mining task is needed b) Identify and use a standard data mining dataset available for the problem. Some links for data mining datasets are: WEKA site, UCI Machine Learning Repository, KDD site, KDD Cup etc. c) Implement the data mining algorithm of choice	06	LO 6

	d) Interpret and visualize the results e) Provide clearly the BI decision that is to be taken as a result of mining.		
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Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition.
2. G. Shmueli, N.R. Patel, P.C. Bruce, "Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner", 1st Edition, Wiley India.

References:

1. P. N. Tan, M. Steinbach, Vipin Kumar, "Introduction to Data Mining", Pearson Education.
2. WEKA, RapidMiner Pentaho resources from the Web.

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the below list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITL603	Cloud Service Design Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL603	Cloud Service Design Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students to get familiar with:

1. Key concepts of virtualization & different types of Hypervisors used in virtualization along with implementation
2. Concept of On demand Application Delivery like SaaS using Ulteo
3. Open source cloud implementation and administration using Open Stack
4. Various Cloud services provided by Amazon Web Services
5. Programming on Platform as a Service cloud
6. Implementation of Storage as a service using Own Cloud.

Lab Outcomes: Students should be able to:

1. Define & implement Virtualization using different types of Hypervisors
2. Describe steps to perform on demand Application delivery using Ulteo .
3. Examine the installation and configuration of Open stack cloud
4. Analyze and understand the functioning of different components involved in Amazon web services cloud platform.
5. Describe the functioning of Platform as a Service
6. Design & Synthesize Storage as a service using own Cloud

Prerequisite Subjects: Computer Network, Operating System, Java Programming

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
a)Hardware Configuration for server 1.Intel or AMD Multi Core processors (like i3/i5/i7/Quad core/Octa core) with Intel VT-X or AMD-V support	a) Software Requirements for Server 1.Server OS for Physical Sever like CentOS /Fedora/Ubuntu/ Redhat Server 2.Pre-configured OpenSSH	1. Internet Connection for each PC with at least 2 MBPS bandwidth and LAN bandwidth of 1 GBPS.

2. 6 GB RAM 3. 500 GB Harddisk 4. Gigabit Ethernet (GbE) network interface card (NIC) b)Hardware Configuration for Cloud Client PC/Laptop/Smart phone/Thin Client or Any device which has built-in Wifi, Ethernet or data connection facility.	3.Xen Server DVD 4.Ulteo DVD a) Software Requirements for Clients 1. JDK 1.8 or higher & .NET Framework 4 2. Netbeans or Eclipse IDEs 3. OpenSSH client or putty 4.Vmware Workstation, 5.Oracle Virtualbox 6. Built-in web browser.	
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Suggested List of Experiments

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Virtualization	1. Creating and running virtual machines on Hosted Hypervisors like KVM Type 1 ,Vmware Workstation,Oracle Virtualbox 2. Creating and running virtual machines on Bare-Metal Hypervisors Type 0 like Xen,Vmware ESXI or HyperV	06	LO1
II	On demand Application Delivery and Virtual Desktop infrastructure	Installation and Configuration of Ulteo to demonstrate on demand Application delivery over web browser to explore SaaS Environment.	04	LO2
III	Open source cloud implementation and administration	To demonstrate installation and Configuration of Open stack Private cloud.	04	LO3
IV	Amazon Web Services	Like auto scaling, elastic load balancing, virtual private computing & Networking. Security service provided by Amazon web services. Accessing AWS using	06	LO4

		web services API provided by Amazon.		
V	Platform as a Service	To Demonstrate Platform as a Service using Googleapp Engine/IBM BlueMix/tSuru	04	LO5
VI	Storage as a Service	Explore Storage as a service using own Cloud for remote file access using web interfaces. S3 storage and glacier storage and understand the storage LC management provided by AWS.	02	LO6

Text Books:

1. Barrie Sosinsky ,”Cloud Computing Bible”,Wiley Publication.
2. Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr.Deven Shah, ”Cloud Computing Black Book”, Dreamtech Press.
3. Joe Baron et.al ,”AWS certified solution Architect”, Sybex publication.
4. Mastering Cloud Computing, Rajkumar Buyya, MGH publication

Reference Books:

1. Learn to Master Cloud Computing by Star EduSolutions
2. Kai Hwang,”Distributed and Cloud Computing”,MK Publication
3. Thomas Erl,Robert Cope,Amin naserpour,”Cloud Computing Design Patterns”,Pearson Publication.
4. Judith Hurwitz ,”Cloud Computing for Dummies” , Wiley Publication.

Web Resources:

1. <http://fosshelp.blogspot.in>
2. <https://aws.amazon.com/>
3. <https://docs.openstack.org/>
4. <https://owncloud.org/>
5. <https://appengine.google.com>

Term Work:

Term Work shall consist of at least 10 to 12 practical’s based on the below list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL604	Sensor Network Lab	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. of twoTests					
ITL604	Sensor Network Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To learn different types of sensors from Motes families.
2. To design the problem solution as per the requirement analysis done using Motes sensors.
3. To study the basic concepts of programming/sensors/ emulator like cooja etc.
4. To design and implement the mini project intended solution for project based learning.
5. To build and test the mini project successfully.
6. To improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Identify the requirements for the real world problems.
2. Conduct a survey of several available literatures in the preferred field of study.
3. Study and enhance software/ hardware skills.
4. Demonstrate and build the project successfully by hardware/sensor requirements, coding, emulating and testing.
5. To report and present the findings of the study conducted in the preferred domain
6. Demonstrate an ability to work in teams and manage the conduct of the research study.

Guidelines

1. The mini project work is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students may do survey for different application using different types of sensors for their mini project.

4. Each group will identify the Hardware (Motes from different Motes families) & sensor configuration and software requirement for their mini project problem statement.
5. Design your own circuit board using multiple sensors etc.
6. Installation, configure and manage your sensors in such away so that they can communicate with each other.
7. Work with operating system, emulator like contiki cooja and do coding to for input devices on sensors.
8. Create and interface using Mobile/Web to publish or remotely access the data on Internet.
9. Each group along with the concerned faculty shall identify a potential problem statement, on which the study and implementation is to be conducted.
10. Each group may present their work in various project competitions and paper presentations.
11. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Fundamentals of Sensor Network Programming: Applications and Technology, By S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley publication.
2. Contiki Cooja User Guide.

References:

1. Internet of Things (A Hands-on-Approach) , Vijay Madiseti , Arshdeep Bahga
2. A comparative review of wireless sensor network mote technologies, IEEE paper 2009

Term Work:

Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical / Oral	Tutorial	Total
ITM605	Mini-Project	--	04	--	--	2	--	2

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITM605	Mini-Project	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To offer students a glimpse into real world problems and challenges that need IT based solutions
2. To enable students to create very precise specifications of the IT solution to be designed.
3. To introduce students to the vast array of literature available of the various research challenges in the field of IT
4. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used.
5. To enable students to use all concepts of IT in creating a solution for a problem
6. To improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Discover potential research areas in the field of IT
2. Conduct a survey of several available literature in the preferred field of study
3. Compare and contrast the several existing solutions for research challenge
4. Demonstrate an ability to work in teams and manage the conduct of the research study.
5. Formulate and propose a plan for creating a solution for the research plan identified
6. To report and present the findings of the study conducted in the preferred domain

Guidelines

1. The project work is to be conducted by a group of three students
2. Each group will be associated with a project mentor/guide. The group should meet with the project mentor/guide periodically and record of the meetings and work discussed must be documented.

3. Department has to allocate half day for the project work in VI semester, 1 day in VII semester and 2 day in VIII semester every week.
4. To encourage project based learning in the curriculum students may identify their technical domain area in semester VI and can perform the Mini-project in the VI semester or students may do literature survey
5. Each group along with its guide/mentor shall identify a potential research area/problem domain, on which the study is to be conducted.
6. Each team will do a rigorous literature survey of the problem domain by reading and understanding at least 3-5 research papers from current good quality national/international journals/conferences. (Papers selected must be indexed by Scopus/IEEE/Springer/ACM etc.). The list of papers surveyed must be clearly documented.
7. The project assessment for term work will be done at least two times at department level by giving presentation to panel members which consist of at least three (3) members as Internal examiners (including the project guide/mentor) appointed by the Head of the department of respective Programme.
8. A report is to be prepared summarizing the findings of the literature survey. A comparative evaluation of the different techniques surveyed is also to be done.
9. Teams must analyze all the results obtained by comparing with other standard techniques.
10. Every team must publish their work in national / international conference/journals (if possible publish in Scopus indexed journals).
11. The team will finally propose a plan for project work to be continued in the final year.
12. Semester VII to carry out the project good quality project and all these project part

Evaluation

1. Each team has to give presentation/demo to the Internal Panel and External examiner.
2. Each team will prepare a report that will summarize the results of the literature survey and the project proposal. The list of papers surveyed must be clearly documented.
3. Each group will be jointly evaluated by a team of Internal and External Examiners approved by the University of Mumbai.
4. Oral exam will be conduct on the project done by the students.

Term Work:

Term Work shall consist of full Mini Project on above guidelines/syllabus.

Term Work Marks: 25 Marks (Total marks) = 20 Marks (Mini Project) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO6021	Advance Internet Programming	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				End Sem. Exam	Term Work	Oral & Practical	Total
		Internal assessment			Avg. of two Tests				
		Test1	Test2						
ITDLO6021	Advance Internet Programming	20	20	20	80	--	--	100	

Course Objectives: Students will try:

1. To get familiar with the concept of Search Engine Basics.
2. To Understand Search Engine Optimization Techniques.
3. To Learn Web Service Essentials.
4. To gain knowledge of Rich Internet Application Technologies.
5. To be familiarized with Web Analytics 2.0
6. To explore Web 3.0 and Semantic web standards.

Course Outcomes: Students will be able to:

1. Determine SEO Objectives and Develop SEO plan prior to Site Development.
2. Explain Search Engine Optimization Techniques and Develop Keyword Generation.
3. Describe different Web Services Standards.
4. Develop Rich Internet Application using proper choice of Framework.
5. Apply multiple quantitative and qualitative methods for web analytics 2.0.
6. Explain Web 3.0 and Semantic web standards

Prerequisite: Basics of Internet Programming – HTML5, CSS3, XML.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Introduction to HTML 5 & CSS3 basics, XML basics	02	
I	Search Engine Basics	<p>Search Engine Basics Algorithm based Ranking Systems – Determining Searcher Intent and Delivering Relevant, Fresh Content, Analyzing Ranking Factors, Using Advanced Search Techniques, Vertical Search Techniques, Country Specific search engines. Determining SEO Objective and Finding Your Site’s Audience – Setting SEO Goals and Objective</p> <p>Developing SEO plans Prior to Site Development, SEO for Raw traffic ; E-commerce Sales; Mindshare/Branding; Direct Marketing; Reputation Management; Ideological Influence</p>	09	CO1
II	Search Engine Optimization	<p>Getting started SEO: Defining Your Site’s Information Architecture, Auditing an Existing Site to identify SEO Problems, Identifying Current Server Statistic Software and Gaining Access – Determining Top competitors, Benchmarking Current Indexing Status, Current Rankings, Benchmarking Current Traffic Source and Volumes, Conduct SEO/Website SWOT analysis.</p> <p>Keyword Generation – Creating Pages – Website Structure- Creating Content-Creating Communities- building Links-Using Google Analytics-Social Media Optimization-Creating Pay-per-click Campaigns- Optimizing PPC Campaigns through Quality Score optimization - Tracking Results and Measuring Success.</p>	09	CO1 CO2
III	Web Services	<p>Web Services: Introduction to Web Services, XML, XSL, XSLT, WSDL, SOAP, UDDI, Transaction, Business Process Execution Language for web Services, WS-Security and web service security specification, WS-Reliable Messaging, WS-Policy, WS-Attachments. REST-ful web services, Resource Oriented Architecture, Comparison of REST, SOA, SOAP.</p>	08	CO1 CO2 CO3
IV	Rich Internet Application	<p>Introduction to AJAX, Blogs, Wikis, RSS feeds</p> <p>Working with Java Script Object Notation (JSON), Implement JSON on server side,</p>	08	CO4

		<p>Implementing Security and Accessibility in AJAX Applications: Secure AJAX application, Accessible Rich Internet Applications</p> <p>Developing RIA using AJAX Techniques: CSS, HTML, DOM, XMLHttpRequest, JavaScript, PHP, AJAX as REST Client</p> <p>Introduction to Open Source Frameworks and CMS for RIA: Django, Drupal, Joomla introduction and comparison.</p>		
V	Web Analytics 2.0	<p>Introduction to Web Analytics 2.0 1: State of the Analytics Union, State of the Industry, Rethinking Web Analytics: Meet Web Analytics 2.0, Optimal Strategy for Choosing Your Web Analytics Soul Mate. The Awesome World of Clickstream Analysis: Metrics. The Key to Glory: Measuring Success. Failing Faster: Unleashing the Power of Testing and Experimentation.</p>	08	CO4 CO5
VI	Web 3.0 and Semantic Web	<p>Web 3.0 and Semantic Web: Challenges, Components, Semantic Web Stack: RDF, RDF Schema (RDFS), Simple Knowledge Organization System (SKOS), SPARQL as RDF query language, N-Triples as a format for storing and transmitting data, Turtle (Terse RDF Triple Language), Web Ontology Language (OWL) a family of knowledge representation languages, Rule Interchange Format (RIF), a framework of web rule language dialects supporting rule interchange on the Web</p>	08	CO4 CO5 CO6

Text Books:

1. The Art of SEO O'Reilly Publication
2. Web Services Essentials by Ethan Cerami O'Reilly Media
3. Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, by Avinash Kaushik, ISBN: 978-0-470-52939-3, wiley publication.
4. "Semantic Web Technologies: Trends and Research in Ontology-based Systems", by John Davies, Rudi Studer, and Paul Warren John, Wiley & Son'
5. Advance Internet Technology by Dr. Deven Shah Dreamtech.

References:

1. RESTful Web Services, By Leonard Richardson, Sam Ruby, O'Reilly Media
2. Rich Internet Application AJAX and Beyond WROX press
3. Handbook of Semantic Web Technologies, by John Domingue, Dieter Fensel, Springer Reference
4. Tim O'Reilly, What is Web 2.0? : Design Patterns and Business Models for the Next Generation of Software, O'REILLY

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDLO6022	Software Architecture	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO6022	Software Architecture	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To understand importance of architecture in building effective, efficient, competitive software product.
2. To understand principal design decisions governing the system.
3. To understand role of architecture in software engineering
4. To understand designing application from architectural perspective
5. To understand different notations used for capturing design decisions.
6. To understand different functional and non-functional properties of complex software systems.

Course Outcomes Students will be able to:

1. Students will cite knowledge of various approaches to document a software system (Remembering)
2. Students will be able to describe functional and non-functional requirements (Understanding)
3. Students will be able to use proper architecture for software (Applying)
4. Students will be able to categorize different components used in the software system (Analyzing)
5. Students will be able to choose from different architectural styles (Evaluating)
6. Students will be able to improve quality of software by selecting proper architecture (Creating)

Prerequisite: Programming Language, UML

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Power of analogy: Architecture of the building, limitations of analogy, The reorientation of software engineering,	02	CO1
I	Introduction to Software Architecture and Software Product Life Cycle	Evolution of Software Development, Fundamentals of Software Engineering, Elements of Software Architecture. Management View, Software Engineering View, Engineering Design View, Architectural View,	07	CO1 CO2
II	Architectural Design Process and Introduction to Software Design	Understanding the problem, Identifying design elements and their relationship, Evaluating the Architecture, Transforming the Architecture, Problems in Software Architectural Design, Function form and Fabrication, The scope of Design, Psychology and Philosophy of Design, General Methodology of Design	09	CO1 CO2 CO3
III	Complexity, Modularity, Models and Knowledge Representation	Complexity, Modularity, What are Models, What are Models used for, What roles do Models Play, Modeling the Problem and Solution Domain, Views,	09	CO1 CO4
IV	Architecture Representation and Architectural Design Principles	Goals of Architecture Representation, Foundation of Architectural Representation, Architectural Description Language, Architectural Level of Design, Architecting with Design Operators, Functional Design Strategies.	09	CO4
V	Architectural Styles, Patterns and Meta models	Defining Architectural Patterns and Style, Common Architectural Styles, Understanding Metamodels, Applying Reference Models, Fundamental Metamodel for describing Software Component	08	CO4 CO5
VI	Architectural Description and Architectural	Standardizing Architectural Description, Creating an Architectural Description, Applying	08	CO1

	Framework, Architecture Quality	Architectural Description, Software Architecture Framework, 4+1 View Model of Architecture, Reference Model for Open Distributed Processing, Importance of Assessing Software Quality, How to improve Quality. DevOps practice and Architecture.		CO6
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Text Books:

1. The Art of Software Architecture: Design Methods and Techniques, Stephen T.Albin, Wiley India Private Limited.
2. Software Architecture, Foundations, Theory, and Practise, Richard Taylor, Nenad Medvidovic, Eric M Dashofy, Wiley Student Edition.

References:

1. Software Architecture in Practice by Len Bass, Paul Clements, Rick Kazman, Pearson.
2. DevOps A Software Architect’s Perspective, Len Bass, Ingo Weber, Liming Zhu, Addison Wesley

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITDLO6023	Digital Forensics	04	--	-	04	--	-	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				End Sem. Exam	Term Work	Oral & Practical	Total
		Internal assessment			Avg. of two Tests				
		Test1	Test2						
ITDLO6023	Digital Forensics	20	20	20	80	--	--	100	

Course Objectives: Students will try:

1. To understand underlying principles and many of the techniques associated with the digital forensic practices and cyber crime
2. To explore practical knowledge about ethical hacking Methodology.
3. To learn the importance of evidence handling and storage for various devices
4. To develop an excellent understanding of current cyber security issues (Computer Security Incident) and analyzed the ways that exploits in securities.
5. To investigate attacks, IDS .technical exploits and router attacks and “Trap and Trace” computer networks.
6. To apply digital forensic knowledge to use computer forensic tools and investigation report writing.

Course Outcomes: Student will able to:

1. Define the concept of ethical hacking and its associated applications in Information Communication Technology (ICT) world.
2. Underline the need of digital forensic and role of digital evidences .
3. Explain the methodology of incident response and various security issues in ICT world, and identify digital forensic tools for data collection .
4. Recognize the importance of digital forensic duplication and various tools for analysis to achieve adequate perspectives of digital forensic investigation in various applications /devices like Windows/Unix system.
5. Apply the knowledge of IDS to secure network and performing router and network analysis
6. List the method to generate legal evidence and supporting investigation reports and will also be able to use various digital forensic tools .

Prerequisite: Cryptography and Security, Computer Networks

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Cryptography and Security ,Computer Networks	2	
I	Introduction to Cyber Crime and Ethical Hacking	<p>Introduction of Cybercrime: Types of cybercrime ,categories of cybercrime , Computers' roles in crimes, Prevention from Cyber crime, Hackers, Crackers, Phreakers</p> <p>Ethical Hacking :Difference between Hacking and Ethical hacking : Steps of Ethical Hacking, Exploring some tools for ethical hacking: reconnaissance tools, scanning tools</p>	6	CO1
II	Introduction to Digital Forensics and Digital Evidences	<p>Digital Forensic ,Rules for Digital Forensic The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics,</p> <p>Digital Evidences : Types and characteristics and challenges for Evidence Handling</p>	6	CO2
III	Computer Security Incident Response Methodology	<p>Introduction to Computer Security Incident Goals of Incident response, Incident Response Methodology, Formulating Response Strategy,</p> <p>IR Process – Initial Response, Investigation, Remediation, Tracking of Significant ,Investigative Information, Reporting</p> <p>Pre Incident Preparation, Incident Detection and Characterization.</p> <p>Live Data Collection : Live Data Collection on Microsoft Windows Systems: Live Data</p>	11	CO3

		Collection on Unix-Based Systems		
IV	Forensic Duplication and Disk Analysis, and Investigation	<p>Forensic Duplication</p> <p>Forensic Image Formats, Traditional Duplication, Live System Duplication, Forensic Duplication tools</p> <p>Disk and File System Analysis: Media Analysis Concepts, File System Abstraction Model</p> <p>The Sleuth Kit : Installing the Sleuth Kit , Sleuth Kit Tools</p> <p>Partitioning and Disk Layouts : Partition Identification and Recovery, Redundant Array of Inexpensive Disks</p> <p>Special Containers : Virtual Machine Disk Images , Forensic Containers Hashing, Carving : Foremost , Forensic Imaging : Deleted Data , File Slack , dd , dcfldd , dc3dd</p> <p>Data Analysis</p> <p>Analysis Methodology Investigating Windows systems , Investigating UNIX systems , Investigating Applications, Web Browsers, Email, Malware Handling: Static and Dynamic Analysis</p>	11	CO4
V	Network Forensics	<p>Technical Exploits and Password Cracking ,</p> <p>Introduction to Intrusion Detection systems, Types of IDS</p> <p>Understanding Network intrusion and attacks , Analyzing Network Traffic, Collecting Network based evidence, Evidence Handling.</p> <p>Investigating Routers, Handling Router Table Manipulation Incidents, Using Routers as Response Tools</p>	9	CO5
VI	Forensic Investigation	Report :Goals of Report, Layout of an		

	Report and Forensic Tools	Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report . Computer Forensic Tools : need and types of computer forensic tools, task performed by computer forensic tools . Study of open source Tools like SFIT, Autopsy etc. to acquire, search, analyze and store digital evidence	7	CO6
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Text Books:

1. Jason Luttgens, Matthew Pepe, Kevin Mandia, "Incident Response and computer forensics", 3rd Edition Tata McGraw Hill, 2014.
2. Nilakshi Jain, Dhananjay Kalbande, "Digital Forensic : The fascinating world of Digital Evidences " Wiley India Pvt Ltd 2017.
3. Cory Altheide, Harlan Carvey "Digital forensics with open source tools "Syngress Publishing, Inc. 2011.
4. Chris McNab, Network Security Assessment, By O'Reily.

References:

1. Clint P Garrison "Digital Forensics for Network, Internet, and Cloud Computing A forensic evidence guide for moving targets and data , Syngress Publishing, Inc. 2010
2. Bill Nelson, Amelia Phillips, Christopher Steuart, "Guide to Computer Forensics and Investigations" . Cengage Learning, 2014
3. Debra Littlejohn Shinder Michael Cross "Scene of the Cybercrime: Computer Forensics Handbook", 2nd Edition Syngress Publishing, Inc.2008.
4. Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory and should cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITDLO6024	Multimedia Systems	04	--	---	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO6024	Multimedia Systems	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To learn and understand technical aspect of Multimedia Systems.
2. To understand the standards available for different audio, video and text applications.
3. To Design and develop various Multimedia Systems applicable in real time.
4. To learn various multimedia authoring systems.
5. To understand various networking aspects used for multimedia applications.
6. To develop multimedia application and analyze the performance of the same.

Course Outcomes: Students will be able to:

1. Developed understanding of technical aspect of Multimedia Systems.
2. Understand various file formats for audio, video and text media.
3. Develop various Multimedia Systems applicable in real time.
4. Design interactive multimedia software.
5. Apply various networking protocols for multimedia applications.
6. To evaluate multimedia application for its optimum performance.

Prerequisite: Knowledge of computer graphics, computer networking and database systems.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic of database, computer networks and computer graphics.	2	--
I	Multimedia Systems Design: An Introduction	Multimedia Elements. Multimedia Systems Architecture, Evolving Technologies for Multimedia Systems, Defining Objects For	9	CO1

		Multimedia Systems. Multimedia Data Interface Standards. The Need for Data Compression. Multimedia applications including digital libraries, system software , streaming videos and its applications.		
II	Compression and Decompression Data and File Format Standards	Types of Compression. Image Compression Schemes. Video Compression. Audio Compression. Rich-Text Format. TIFF File Format. Resource Interchange File Format (RIFF), MIDI File Format. JPEG DIB File Format for Still and Motion Images. JPEG Still Image. AVI video File Format. MPEG Standards.	10	CO1 CO2
III	Multimedia Application Design	Multimedia Application Classes. Types of Multimedia Systems. Virtual Reality Design. Components of Multimedia Systems. Multimedia database issues and solutions. Organizing Multimedia Databases.	8	CO1 CO2 CO3
IV	Multimedia Authoring, User Interface and	Multimedia Authoring Systems. Hypermedia Application Design Considerations. User Interface Design. Information Access. Object Display/Playback Issues	7	CO4
V	Distributed Multimedia Systems	Components of a Distributed Multimedia System. Distributed Client-Server Operation. Middleware in Distributed Workgroup Computing. Multiserver Network Topologies. Distributed Multimedia Databases. Managing Distributed Objects. Application Workflow Design Issues. Distributed Application Design Issues	8	CO4 CO5
VI	System Design: Methodology and Considerations.	Fundamental Design Issues. Determining Enterprise Requirements. Examining Current Architecture and Feasibility. Performance Analysis. Designing for Performance Multimedia System Design. System Extensibility. Multimedia Systems Design Example.	8	CO5 CO6

Text Books:

1. **Prabhat K. Andleigh, Kiran Thakrar** “Multimedia Systems Design” 1/e, Pearson , ISBN 978-93-325-4938-8
2. Fundamentals of Multimedia by Ze-Nian Li& Mark.S.Drew
3. Introduction to Multimedia Communication, Application, Middleware, Networking by K.R.Roa, Zoran S,Bojkovic & Dragorad A. Milovanovic.

References:

1. Organization of Multimedia Resources: Principles and Practice of Information Retrieval by Mary A. Burke
2. Multimedia Systems Design by Prabhat K. Andleigh/ Kiran Thakrar

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO6025	Green IT	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITDLO6025	Green IT	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To understand what Green IT is and How it can help improve environmental Sustainability
2. To understand the principles and practices of Green IT.
3. To understand how Green IT is adopted or deployed in enterprises.
4. To understand how data centres, cloud computing, storage systems, software and networks can be made greener.
5. To measure the Maturity of Sustainable ICT world.
6. To implement the concept of Green IT in Information Assurance in Communication and Social Media and all other commercial field.

Course Outcomes: Students will be able to:

1. Describe awareness among stakeholders and promote green agenda and green initiatives in their working environments leading to green movement
2. Identify IT Infrastructure Management and Green Data Centre Metrics for software development
3. Recognize Objectives of Green Network Protocols for Data communication.
4. Use Green IT Strategies and metrics for ICT development.
5. Illustrate various green IT services and its roles.
6. Use new career opportunities available in IT profession, audits and others with special skills such as energy efficiency, ethical IT assets disposal, carbon footprint estimation, reporting and development of green products, applications and services.

Prerequisite: Environmental Studies

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Environmental Studies	2	
I	Introduction	Environmental Impacts of IT, Holistic Approach to Greening IT, Green IT Standards and Eco-Labeling, Enterprise Green IT Strategy , Green IT: Burden or Opportunity? Hardware: Life Cycle of a Device or Hardware, Reuse, Recycle and Dispose. Software: Introduction, Energy-Saving Software Techniques, Evaluating and Measuring Software Impact to Platform Power.	9	CO1
II	Software development and data centers	Sustainable Software, Software Sustainability Attributes, Software Sustainability Metrics, Sustainable Software Methodology, Data Centres and Associated Energy Challenges, Data Centre IT Infrastructure, Data Centre Facility Infrastructure: Implications for Energy Efficiency, IT Infrastructure Management, Green Data Centre Metrics	9	CO1 CO2
III	Data storage and communication	Storage Media Power Characteristics, Energy Management Techniques for Hard Disks, System-Level Energy Management, Objectives of Green Network Protocols, Green Network Protocols and Standards.	9	CO1 CO3
IV	Information systems, green it strategy and metrics	Approaching Green IT Strategies, Business Drivers of Green IT Strategy, Business Dimensions for Green IT Transformation, Multilevel Sustainable Information, Sustainability Hierarchy Models, Product Level Information, Individual Level Information, Functional Level Information, Organizational Level Information, Regional/City Level Information, Measuring the Maturity of Sustainable ICT.	8	CO1 CO4

V	Green it services and roles	Factors Driving the Development of Sustainable IT, Sustainable IT Services (SITS), SITS Strategic Framework, Sustainable IT Roadmap, Organizational and Enterprise Greening, Information Systems in Greening Enterprises, Greening the Enterprise: IT Usage and Hardware, Inter-organizational Enterprise Activities and Green Issues, Enablers and Making the Case for IT and the Green Enterprise.	9	CO1 CO4 CO5
VI	Managing and regulating green it	Strategizing Green Initiatives, Implementation of Green IT, Information Assurance, Communication and Social Media, The Regulatory Environment and IT Manufacturers, Nonregulatory Government Initiatives, Industry Associations and Standards Bodies, Green Building Standards, Green Data Centres, Social Movements and Greenpeace.	6	CO1 CO5 CO6

Text Books:

1. San Murugesan, G. R. Gangadharan, Harnessing Green IT, WILEY 1st Edition-2013
2. Mohammad Dastbaz Colin Pattinson Babak Akhgar, Green Information Technology A Sustainable Approach , Elsevier 2015
3. Reinhold, Carol Baroudi, and Jeffrey Hill Green IT for Dummies, Wiley 2009

References:

1. Mark O'Neil , Green IT for Sustainable Business Practice: An ISEB Foundation Guide, BCS
2. Jae H. Kim, Myung J. Lee Green IT: Technologies and Applications, Springer, ISBN: 978-3-642-22178-1
3. Elizabeth Rogers, Thomas M. Kostigen The Green Book: The Everyday Guide to Saving the Planet One Simple Step at a Time, Springer

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
ITC701	Enterprise Network Design	4	-	-	4	-	-	4
ITC702	Infrastructure Security	4	-	-	4	-	-	4
ITC703	Artificial Intelligence	4	-	-	4	-	-	4
ITDLO-II	Department Level Optional Course -III	4	-	-	4	-	-	4
ILO-I	Institute Level Optional Course-I	3	-	-	3	-	-	3
ITL701	Network Design Lab	-	2	-	-	1		1
ITL702	Advanced Security Lab	-	2	-	-	1		1
ITL703	Intelligence System Lab	-	2	-		1		1
ITL704	Android Apps Development Lab	-	2			1		1
ITM705	Project-I	-	6/8			3	-	3
	Total	19	14	-	19	7	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
ITC701	Enterprise Network Design	20	20	20	80	3	-	-	-	100
ITC702	Infrastructure Security	20	20	20	80	3	-	-	-	100
ITC703	Artificial Intelligence	20	20	20	80	3	-	-	-	100
ITDLO-II	Department Level Optional Course -III	20	20	20	80	3	-	-	-	100
ILO-I	Institute Level Optional Course-I	20	20	20	80	3	--	-	-	100
ITL701	Network Design Lab	-	-	-	-	-	25	25	--	50
ITL702	Advanced Security Lab	-	-	-	-	-	25	25	--	50
ITL703	Intelligence System Lab	--	-	-	-	--	25	25	--	50
ITL704	Android Apps Development Lab						25	25	--	25
ITM705	Project-I	-	-	-	-	-	50	25	--	75
Total		100	100	100	400		150	125	--	750

Department Level Optional Course (DLO)

Every student is required to take one Department Elective Course for Semester VII. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

(DLO-I subjects will have no Labs only Theory)

Institute Level Optional Course (ILO)

Every student is required to take one Institute Elective Course for Semester VII, which is not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

Subject Code	Department Level Optional Course (DLO)	Subject Code	Institute Level Optional Course (ILO)
Semester VII			
ITDLO7031	Storage Area Networks	ILO7011	Product Lifecycle Management
ITDLO7032	Mobile Application Development	ILO7012	Reliability Engineering
ITDLO7033	High Performance Computing	ILO7013	Management Information System
ITDLO7034	Software Testing and Quality Assurance	ILO7014	Design of Experiments
ITDLO7035	Soft Computing	ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC701	Enterprise Network Design	04	--		04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC701	Enterprise Network Design	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To be familiarized with the methodologies and approaches of the network design for an enterprise network.
2. To understand the network hierarchy and use modular approach to network design for an enterprise network.
3. To understand the campus design and data center design considerations for designing an enterprise campus.
4. To study Enterprise Edge WAN Technologies and design a WAN using them
5. Designing an IP addressing plan and selecting a Route protocol for an enterprise network.
6. To design enterprise network for given user requirements in an application.

Course Outcomes: Student should be able to:

1. Understand the customer requirements and Apply a Methodology to Network Design
2. Structure and Modularize the Network
3. Design Basic Campus and Data Center Network.
4. Design Remote Connectivity
5. Design IP Addressing and Select suitable Routing Protocols for the Network
6. Compare Openflow controllers and switches with other enterprise networks.

Pre-requisite: Computer Networks

Detailed syllabus:

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Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	<ol style="list-style-type: none"> 1. OSI Reference Model and TCP/IP Protocol Suite 2. Routing IP Addresses 3. Internetworking Devices 	02	
I	Applying a Methodology to Network Design:	The Cisco Service Oriented Network Architecture, Network Design Methodology, Identifying Customer Requirements, Characterizing the Existing Network and Sites, Using the Top-Down Approach to Network Design, The Design Implementation Process.	08	CO1, CO6
II	Structuring and Modularizing the Network:	Network Hierarchy, Using a Modular Approach to Network Design, <i>Services Within Modular Networks, Network Management Protocols and Features</i>	09	CO2, CO6
III	Designing Basic Campus and Data Center Networks	Campus Design Considerations, Enterprise Campus Design, Enterprise Data Center Design Considerations	09	CO3, CO6
IV	Designing Remote Connectivity	Enterprise Edge WAN Technologies, WAN Design, Using WAN Technologies, Enterprise Edge WAN and MAN Architecture, Selecting Enterprise Edge Components, Enterprise Branch and Teleworker Design.	09	CO4, CO6
V	Designing IP Addressing in the Network & Selecting Routing Protocols	Designing an IP Addressing Plan, Introduction to IPv6, Routing Protocol Features, Routing Protocols for the Enterprise, Routing Protocol Deployment, <i>Route</i> Redistribution, Route Filtering, Redistributing and Filtering with BGP, Route Summarization	10	CO5
VI	Software Defined	Understanding SDN and Open Flow : SDN – SDN Building		CO6

	Network	Blocks, OpenFlow messages – Controller to Switch, Symmetric and Asynchronous messages, Implementing OpenFlow Switch, OpenFlow controllers , POX and NOX, Open Flow in Cloud Computing, Case study: how SDN changed Traditional Enterprise network Design	05	
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Text Books:

1. Authorized Self-Study Guide, Designing for Cisco Internetwork Solutions (DESGN), Second Edition, Cisco Press-Diane Teare.
2. Network Analysis, Architecture, and Design 3rd Edition, Morgan Kaufman, James D.
3. CCDA Cisco official Guide
4. Software Defined Networking with Open Flow : PACKT Publishing Siamak Azodolmolky

References:

1. Top-Down Network Design (Networking Technology) 3rd Edition, [Priscilla Oppenheimer](#) ,Cisco Press Book
2. Network Planning and Design Guide Paperback – 2000, [Shaun Hummel](#)

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory and should cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC702	Infrastructure Security	04	--	-	04	--	-	04

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC702	Infrastructure Security	20	20	20	80	--	--	100	

Course Objectives: Students will try :

1. To understand underlying principles of infrastructure security
2. To explore software vulnerabilities, attacks and protection mechanisms
To learn security aspects of wireless network infrastructure and protocols
3. To investigate web server vulnerabilities and their countermeasures
4. To develop policies for security management and mitigate security related risks in the organization
5. To Learn the different attacks on Open Web Applications and Web services.
6. To Learn the different security policies.

Course Outcomes: Students will be able to:

1. Understand the concept of vulnerabilities, attacks and protection mechanisms
2. Analyze and evaluate software vulnerabilities and attacks on databases and operating systems
3. Explain the need for security protocols in the context of wireless communication
4. Understand and explain various security solutions for Web and Cloud infrastructure
5. Understand, and evaluate different attacks on Open Web Applications and Web services
6. Design appropriate security policies to protect infrastructure components

Prerequisite: Computer Networks, Cryptography and Network Security

Detail Syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction	Cyber-attacks, Vulnerabilities, Defense Strategies and Techniques, Authentication Methods- Password, Token and Biometric, Access Control Policies and Models (DAC,MAC, RBAC, ABAC, BIBA, Bell La Padula), Authentication and Access Control Services- RADIUS, TACACS, and TACACS+	6	CO1

II	Software Security	<p>Software Vulnerabilities:</p> <p>Buffer overflow, Format String, Cross-Site Scripting, SQL Injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits</p> <p>Operating System Security:</p> <p>Memory and Address Protection, File Protection Mechanism, User Authentication.</p> <p>Linux and Windows: Vulnerabilities, File System Security</p> <p>Database Security:</p> <p>Database Security Requirements, Reliability and Integrity, Sensitive Data, Inference Attacks, Multilevel Database Security</p>	12	CO2
III	Wireless Security	Mobile Device Security- Security Threats, Device Security, GSM, UMTS and 4G Security, IEEE 802.11xWireless LAN Security, VPN Security, Wireless Intrusion Detection System (WIDS)	9	CO3
IV	Cloud Security	Cloud Security Risks and Countermeasures, Data Protection in Cloud, Cloud Application Security, Cloud Identity and Access Management, Cloud Security as a Service, SAML, OAuth	8	CO4
V	Web Security	Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, Cross-Site Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, DNS Attacks, Web Service Security, Secure Electronic Transaction, Email Attacks, Web Server Security as per OWASP, Firewalls, Penetration Testing	12	CO4, CO5
VI	Information Security and Risk Management	Security Policies, Business Continuity Plan, Risk Analysis, Incident Management, Legal System and Cybercrime, Ethical Issues in Security Management.	5	CO6

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
3. Network Security and Cryptography, Bernard Menezes, Cengage Learning
4. Network Security Bible, Eric Cole, Second Edition, Wiley

Reference Books:

1. Web Application Hackers Handbook by Wiley.
2. Computer Security, Dieter Gollman, Third Edition, Wiley
3. CCNA Security Study Guide, Tim Boyle, Wiley
4. Introduction to Computer Security, Matt Bishop, Pearson.
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif , O’Riely

Assessment:**Internal Assessment for 20 marks:****Consisting of Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC703	Artificial Intelligence	04 Hr/Week		--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
ITC703	Artificial Intelligence	20	20	20	80	--	--	100

Course Objectives: Students will try:

1. To create appreciation and understanding of both the achievements of AI and the theory underlying those achievements.
2. To introduce the concepts of a Rational Intelligent Agent and the different types of Agents that can be designed to solve problems
3. To review the different stages of development of the AI field from human like behavior to Rational Agents.
4. To impart basic proficiency in representing difficult real life problems in a state space representation so as to solve them using AI techniques like searching and game playing.
5. To create an understanding of the basic issues of knowledge representation and Logic and blind and heuristic search, as well as an understanding of other topics such as minimal, resolution, etc. that play an important role in AI programs.
6. To introduce advanced topics of AI such as planning, Bayes networks, natural language processing and Cognitive Computing.

Course Outcomes: Students will be able to:

1. Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents.
2. Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them.
3. Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing
4. Attain the capability to represent various real life problem domains using logic based techniques and use this to perform inference or planning.
5. Formulate and solve problems with uncertain information using Bayesian approaches.
6. Apply concept Natural Language processing to problems leading to understanding of cognitive computing. .

Prerequisite: Programming, Data Structures.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Knowledge of any programming language, Data structures.	2	--
I	Introduction to Intelligent Systems and Intelligent Agents	Introduction to AI, AI Problems and AI techniques, Solving problems by searching, Problem Formulation. State Space Representation Structure of Intelligent agents, Types of Agents, Agent Environments PEAS representation for an Agent.	07	CO 1 CO 2
II	Search Techniques	Uninformed Search: DFS, BFS, Uniform cost search, Depth Limited Search, Iterative Deepening. Informed Search: Heuristic functions, Hill Climbing, Simulated Annealing, Best First Search, A*, Constraint Satisfaction Programming: Crypto Arithmetic, Map Coloring, N-Queens. Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning	11	CO 2 CO 3
III	Knowledge and Reasoning	A Knowledge Based Agent, Overview of Propositional Logic, First Order Predicate Logic, Inference in First Order Predicate Logic: Forward and Backward Chaining, Resolution.	10	CO 4
IV	Planning	Introduction to Planning, Planning with State Space Search, Partial Ordered planning, Hierarchical Planning, Conditional Planning.	06	CO 4
V	Uncertain Knowledge and Reasoning	Uncertainly, Representing Knowledge in an Uncertain Domain, Conditional Probability, Joint Probability, Bayes' theorem, Belief Networks, Simple Inference in Belief Networks.	06	CO 5
VI	Natural Language	Language Models, Natural Language for Communication:	10	CO 6

	Processing	Syntactic Analysis, Augmented Grammars and Semantic Interpretation, Machine Translation. Overview of Cognitive Computing: Foundation of Cognitive Computing, List of Design Principles for Cognitive Systems, Natural Language Processing in Support of a Cognitive System (First three chapters from Text book 3)		
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Text Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education.
2. Elaine Rich, Kevin Knight, Shivshankar B Nair, Artificial Intelligence, McGraw Hill, 3rd Edition
3. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley India

References:

1. George Lugar, .AI-Structures and Strategies for Complex Problem Solving., 4/e, 2002, Pearson Education.
2. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
3. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
4. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
5. John Kelly , Steve Hamm, Smart Machines - IBM's Watson and the Era of Cognitive Computing, Columbia Business School Publishing

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL701	Network Design Lab	--	2	--	--	2	--	02

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL701	Network Design Lab	--	--	--	--	25	25	--	50

Lab Objectives: Students will try:

1. To be familiarized with the requirements of an enterprise and address its major design areas
2. To recognize the hierarchical network model for the enterprise
3. Identify the networking devices and their configurations required for the design and also prepare a bill of materials
4. Propose a design for the Server Farm of an enterprise network and discuss up gradations if needed.
5. Provide suitable IP addressing plan and best possible routing protocol for an enterprise network.
6. Construct a suitable design for an enterprise network and test it using a tool.

Lab Outcomes: Students will be able to:

1. Understand the requirements of an enterprise and outline its major design areas
2. Identify functional areas to construct high level modules for enterprise architecture and analyze them.
3. Identify the networking devices, prepare a bill of materials and configure the devices as per the Core, Access and Distribution layers
4. Design the Server Farm for an enterprise network and discuss up gradations if needed.
5. Identify and select the technology for Remote site Connectivity, suitable IP addressing plan and routing protocol for an enterprise network.
6. Test and monitor the enterprise network using a tool

Prerequisite: Computer Networks.

Guidelines

1. The case study of College Campus Network must be designed as a mini project work which is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students must understand the requirements of a College campus enterprise network.
4. The students must outline the major design areas of a College campus enterprise network.
5. The students must identify the functional areas and construct high level modules for the College campus enterprise architecture.
6. The students must analyze the existing College campus enterprise network and propose up gradations to existing infrastructure.
7. The students must identify the network devices required and their locations to design a College campus enterprise network.
8. The students must configure the network devices required as per the Core Layer, Access Layer and Distribution Layer.
9. The students must Design the Server Farm for enterprise network using a configuration tool and also discuss if any other improvement is required.
10. The students must Prepare a bill of materials of all the networking devices. Develop a Request for Proposal-RFP for the enterprise network
11. The students must identify the technology for Remote Site connectivity and evaluate it as per the application requirements of the college campus enterprise network.
12. Propose a suitable IP addressing plan for the enterprise network.
13. Determine a suitable routing protocol for the enterprise network.
14. Create and Test the designed college campus enterprise network using a tool.
15. Use Nagios tool for enterprise infrastructure monitoring tool
16. Each group may present their work in various project competitions and paper presentations.
17. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Authorized Self-Study Guide, Designing for Cisco Internetwork Solutions (DESGN), Second Edition, Cisco Press-Diane Teare.
2. Designing and Supporting Computer Networks, CCNA Discovery Learning Guide (Cisco Systems Networking Academy Program) Paperback – 2008, [Kenneth Stewart](#) , [Aubrey Adams](#), [Allan Reid](#) , [Jim Lorenz](#).

References:

1. Top-Down Network Design (Networking Technology) 3rd Edition, [Priscilla Oppenheimer](#), Cisco Press Book
2. Network Planning and Design Guide Paperback – 2000, [Shaun Hummel](#)

Term Work:

Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITL702	Advance Security Lab	--	02	-	--	01	-	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL702	Advance Security Lab	--	--	--	--	25	--	25	50

Lab Objective: Students will try to:

1. Implement and analyze program and database vulnerabilities Buffer overflow and SQL Injection.
2. Explore and analyze different security tools to secure mobile devices, web browser, wireless network and router
3. Explore reconnaissance, attack and forensics tools in Kali Linux
4. Learn security of system using personal firewall installation
5. Understand AAA using RADUIS
6. Understand AAA using TACACS

Lab Outcome: Students will able to:

1. Implement and analyze program and database vulnerabilities Buffer overflow and SQL Injection.
2. Explore and analyze different security tools to secure mobile devices, web browser, wireless network and router
3. Explore reconnaissance, attack and forensics tools in Kali Linux
4. Learn security of system using personal firewall installation
5. Understand AAA using RADUIS
6. Understand AAA using TACACS

Prerequisite: Computer Networks, Cryptography and Network Security.

Hardware	Software
PC i3 or above configuration.	Kali Linux, Java, Snort, Kismet, Metasploit, Wireshark, Droidcrypt

Detail Syllabus:

Sr. No	Description	Hours	CO mapping
1	Exploring Kali Linux and the inbuilt tools for reconnaissance and ethical hacking.	2	LO3
2	Implementation and analysis of SQL injection Attack	4	LO1
3	Implementation of Buffer overflow attack and its analysis using Splint, Cppcheck etc.	2	LO1
4	Setting up personal Firewall using Iptables	2	LO4
5	Exploring wireless security tools like Kismet, NetStumbler etc.	2	LO2
6	Performing a penetration testing using Metasploit	2	LO3
7	Exploring Router security, access lists using packet tracer	2	LO2
8	Exploring VPN security using Packet tracer	2	LO2
9	Exploring Authentication and access control using RADIUS, TACACS and TACACS+	2	LO5

10	Install and use a security app on an Android mobile (e.g. Droidcrypt)	2	LO2
11	Explore forensics tools in Kali Linux for acquiring, analyzing and duplicating data	2	LO3
12	Configuration of mod Security, core rule set on apache server.	2	LO2

Text Books:

1. Build your own Security Lab, Michael Gregg, Wiley India
2. CCNA Security, Study Guide, Tim Boyles, Sybex

Reference Books:

1. Network Security Bible, Eric Cole, Wiley India

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITL703	Intelligence System Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL703	Intelligence System Lab	--	--	--	--	25	--	25	50

Course Objectives: Students will try:

1. To introduce the concepts of a Rational Intelligent Agent and the different types of Agents that can be designed to solve problems
2. To impart basic proficiency in representing difficult real life problems in a state space representation so as to solve them using AI techniques.
3. To make students understand various AI methods like searching and game playing and how to apply them to solve real applications
4. To explain to students the basic issues of knowledge representation and Logic so as to build inference engines
5. To impart a basic understanding of some of the more advanced topics of AI such as planning.
6. To understand Bayes networks, natural language processing and introduce concept of cognitive computing.

Course Outcomes: Students will be able to:

1. Design the building blocks of an Intelligent Agent using PEAS representation .
2. Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them.
3. Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing
4. Attain the capability to represent various real life problem domains using logic based techniques and use this to perform inference or planning.
5. Formulate and solve problems with uncertain information using Bayesian approaches.
6. Apply concept Natural Language processing and cognitive computing for creation of domain specific ChatBots.

Hardware	Software
PC i3 or above configuration.	Java Python

Detailed syllabus:

Module No.	Detailed Content	Hours	LO Mapping
1	Tutorial exercise for a) Design of Intelligent System using PEAS. b) Problem Definition with State Space Representation	2	LO 1, LO 2
11	Implementation of Uninformed and Informed Search Algorithms.	6	LO 2
111	Implementation of CSP and Game playing algorithms .	4	LO 3
IV	a) Assignment on Predicate Logic, for forward and backward reasoning and resolution. b) Design of a Planning system using STRIPS.	4	LO 4
V	Implementation of Bayes' Belief Network.	2	LO 5
VI	Mini project Construction of a domain specific ChatBot using Natural Language Processing techniques. (Applications can include : Medical Diagnosis, Personal Shopping Assistant, Travel Agent , Trouble shooting etc.)	8	LO6

Text Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education.
2. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley India

References:

1. George Lugar, .AI-Structures and Strategies for Complex Problem Solving., 4/e, 2002, Pearson Education.
2. John Kelly , Steve Hamm, Smart Machines - IBM's Watson and the Era of Cognitive Computing, Columbia Business School Publishing

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 20 Marks (Experiment + Mini-Project) + 5 Marks (Attendance) **Oral Exam:** An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL704	Android Apps Development Lab		2			1		1

Course Code	Course Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test1	Test2	Avg. of two Tests						
ITL704	Android Apps Development Lab	--	--	--	--	25	--	25	50	

Hardware	Software
PC i3 or above configuration.	Java Android SDK

Lab Objectives: Students will try:

1. To gain knowledge of installing Android Studio and Cross Platform Integrated Development Environment.
2. To learn designing of User Interface and Layouts for Android App.
3. To learn how to use intents to broadcast data within and between Applications.
4. To use Content providers and Handle Databases using SQLite.
5. To introduce Android APIs for Camera and Location Based Service.
6. To discuss various security issues with Android Platform.

Lab Outcomes: Students will be able to:

1. Experiment on Integrated Development Environment for Android Application Development.
2. Design and Implement User Interfaces and Layouts of Android App.
3. Use Intents for activity and broadcasting data in Android App.
4. Design and Implement Database Application and Content Providers.
5. Experiment with Camera and Location Based service.
6. Develop Android App with Security features.

Prerequisite: Java Programming, Internet Programming.

Guidelines

1. The mini project work is to be conducted by a group of three students

2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students may do survey for different application which they can create Apps using Android.
4. Students will do Installation, configuration of Android Studio & to create AVD and also try for Cross platform Integrated Development Environment (Any Open Source Tool).
5. Students will try to Design and implement following points in their Mini Project (Android Apps)
 - a. Widget box for Android phone.
 - b. Use Layouts
 - c. Use Intents
 - d. Use Activity
 - e. Use SQLite
 - f. Use Camera
 - g. Use Location API
 - h. Generate APK file
6. Each group along with the concerned faculty shall identify a potential problem statement for Apps development, on which the study and implementation is to be conducted.
7. Each group may present their work in various project competitions and paper presentations.
8. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Professional Android 4 Application Development by wrox publication
2. Android Cookbook by o'reilly
3. Beginning Android Development Wrox Press

References:

1. Android Application Development For Dummies, 2nd Edition by MichaelBurton, DonnFelker
2. Android Security –attack and defenses, AbhishekDubey and AnmolMisra by CRC Press

Term Work:

Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical / Oral	Tutorial	Total
ITM705	Project-I	--	06	--	--	3	--	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITM705	Project-I	--	--	--	--	50	--	25	75

Lab Objectives: Students will try:

1. To offer students a glimpse into real world problems and challenges that need IT based solutions
2. To enable students to create very precise specifications of the IT solution to be designed.
3. To introduce students to the vast array of literature available of the various research challenges in the field of IT
4. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used.
5. To enable students to use all concepts of IT in creating a solution for a problem
6. To improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Discover potential research areas in the field of IT
2. Conduct a survey of several available literature in the preferred field of study
3. Compare and contrast the several existing solutions for research challenge
4. Demonstrate an ability to work in teams and manage the conduct of the research study.
5. Formulate and propose a plan for creating a solution for the research plan identified
6. To report and present the findings of the study conducted in the preferred domain

Guidelines

1. The project work is to be conducted by a group of three students
2. Each group will be associated with a project mentor/guide. The group should meet with the project mentor/guide periodically and record of the meetings and work discussed must be documented.
3. Department has to allocate 1 day in VII semester and 2 day in VIII semester every week.
4. Students will do literature survey in Sem VI or Sem VII.
5. Students will do design, implementation and coding in Sem VII.

6. Each group along with its guide/mentor shall identify a potential research area/problem domain, on which the study is to be conducted.
7. Each team will do a rigorous literature survey of the problem domain by reading and understanding at least 3-5 research papers from current good quality national/international journals/conferences. (Papers selected must be indexed by Scopus/IEEE/Springer/ACM etc.). The list of papers surveyed must be clearly documented.
8. The project assessment for term work will be done at least two times at department level by giving presentation to panel members which consist of at least three (3) members as Internal examiners (including the project guide/mentor) appointed by the Head of the department of respective Programme.
9. A report is to be prepared summarizing the findings of the literature survey. A comparative evaluation of the different techniques surveyed is also to be done.
10. Students will do testing and analyze in Sem VIII
11. Teams must analyze all the results obtained by comparing with other standard techniques.
12. Every team must publish their work in national / international conference/journals (if possible publish in Scopus indexed journals).

Evaluation

1. Each team has to give presentation/demo to the Internal Panel and External examiner.
2. Each team will prepare a report that will summarize the results of the literature survey and implementation and coding as project proposal in SEM VII. The list of papers surveyed must be clearly documented.
3. Each group will be jointly evaluated by a team of Internal and External Examiners approved by the University of Mumbai.
4. Oral exam will be conduct on the project done by the students.

Term Work:

Term Work shall consist of full Project-I on above guidelines/syllabus.

Term Work Marks: 50 Marks (Total marks) = 45 Marks (Project-I) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Project-I and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO7031	Storage Area Network	04	--	--	04	--	01	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO7031	Storage Area Network	20	20	20	80	--	--	--	100

Course Objectives: Students will try to:

1. Understand the need for Storage Area Network and Data protection to satisfy the information explosion requirements
2. Study storage technologies: SAN, NAS, IP storage etc., which will bridge the gap between the emerging trends in industry and academics.
3. To get an insight of Storage area network architecture, protocols and its infrastructure.
4. To study and discuss the applications of SAN to fulfill the needs of the storage management in the heterogeneous environment..
5. Study and understand the management of Storage area Networks.
6. To understand and analyze case studies on the storage area network technology

Course Outcomes: Students will able to:

1. Students will analyze the limitations of the client-server architecture and evaluate the need for data protection and storage centric architectures such as Intelligent storage system..
2. Students will understand, interpret and examine various SAN technologies.
3. Students will describe and sketch the SAN architecture and its uses.
4. Students will classify the applications as per their requirements and select relevant SAN solutions.
5. Students will understand and evaluate different SAN management strategies to fulfill business continuity requirements.
6. Students will design case studies on NAS, SAN and SAN/ NAS

Prerequisite: Computer Networks, Operating System

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Networking Protocols, File system and Memory management	02	
I	Introduction to Storage System	Introduction: Storage oriented architecture, Storage Systems, Data center Infrastructure, Challenges in managing information, Information life cycle; Basics of Storage System: Components of Storage System, Disk Drive components and Performance, Components of Host; Data Protection: Raid Components and types, RAID technologies and RAID levels, RAID impact on disk performance; Intelligent Storage System” Components of ISS, Storage Provisioning and types of ISS	09	CO1
II	Network Attached Storage	Storage on Network: NAS hardware and software architecture, NAS connectivity, NAS as a Storage System; NAS Hardware devices; NAS software components; NAS connectivity options: NAS connectivity hardware and Software Architecture.	07	CO2
III	Storage Area Networks	Architecture Overview: Creating Network for storage; Hardware devices: Fibre Channel Switch, Host Bus Adaptors, Putting the Storage in SANs, Fabric Operation from a hardware perspective, SAN hardware considerations ; Software Components: The switch’s operating system, device drivers, the supporting components, considerations for SAN software ; Configuration options for SANs: Connecting into the data center, the evolving network and device connections, SAN configuration guidelines	10	CO3

IV	Applications- Putting it together	Defining the I/O workload: Storage planning and capacity planning, the definition and characterization of workloads, the business application, I/O content and workloads, Considerations for I/O workloads in storage networking ; Applying SAN solution: SAN workload characterization, applying SAN to OLTP workloads, transactional workloads; Applying NAS solution: NAS workload characterization, applying NAS to departmental workloads, enterprise web workloads and specialized workloads; Considerations when integrating SN and NAS: Differences and similarities, the need to integrate, future storage connectivity and integration	10	CO4
V	Management	Planning business continuity: Defining the environment, the role of storage networking in business continuity, storage design and implementation of the business continuity planning ; Managing availability: Availability Metrics, Implementing the plan ; Maintaining Serviceability: Tracking the configurations, Investigating the changes and closing the loop on serviceability; Capacity Planning: Storage Analysis, developing and implementing plan for storage, Modelling performance and capacity requirements ; Security considerations: Overview of Information security, Security methods, Storage Security challenges, FC SAN security, NAS security	09	CO5
VI	Case studies	Case studies on NAS, SAN, SAN/NAS	05	CO6

Text Books:

1. Storage Networks: The Complete Reference. Spalding, Robert ,Tata McGraw-Hill Education, 2003
2. “Storage Network Management and Retrieval”, Vaishali Khairnar, Nilima Dongre. Wiley

References:

1. Richard Barker, Paul Massiglia, “Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs”, Wiley India
2. Ulf Troppens, Wolfgang Muller-Friedt, Rainer Wolafka, “Storage Networks Explained” Wiley Publication
3. G. Somasundaram, Alok Shrivastava, “Information Storage and Management”, EMC Education services”, Wiley Publication

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITDLO7032	Mobile Application Development	04	-	-	04	-	-	04

Course Code	Course Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment								
		Test1	Test2	Avg. of two Tests						
ITDLO7032	Mobile Application Development	20	20	20	80	-	-	--	100	

Course Objectives: Students will try:

1. To introduce Android platform and its architecture.
2. To learn activity creation and Android UI designing.
3. To be familiarized with Intent, Broadcast receivers and Internet services.
4. To work with SQLite Database and content providers.
5. To integrate multimedia, camera and Location based services in Android Application.
6. To explore Mobile security issues.

Course Outcomes: Students will be able to:

1. Describe Android platform, Architecture and features.
2. Design User Interface and develop activity for Android App.
3. Use Intent , Broadcast receivers and Internet services in Android App.
4. Design and implement Database Application and Content providers.
5. Use multimedia, camera and Location based services in Android App.
6. Discuss various security issues in Android platform.

Prerequisite: Internet Programming, Database Management System.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basics of HTML5,CSS3 & XML	02	-
I	Introduction to Android and Architecture of	Introduction of Android platform, Android features ,Android Marketplace, Evolution of Android OS, Android	07	CO1

	Android	Application Architecture, Developing for Android, Developing for Mobile and Embedded Devices, Android Development Tools		
II	Applications, Activities and Building User Interface	Application: Application Manifest File, Externalizing Resources, Android Application Lifecycle and Android Application Class. Android Activity: Creating activities, Activity lifecycle and Android Activity classes. User Interface: Fundamental Android UI Design, Layouts, Fragments, Designing UI with views, Creating new views, widget toolbox, Adapters.	09	CO2
III	Intents, Broadcast receiver and Internet Resources	Introducing Intents, Linking Activities Using intents , Calling Built-in Applications Using intents , Displaying notifications, Creating Intent Filters and Broadcast Receivers, Downloading and Parsing Internet Resources, Using the Download Manager, Internet Services, Connecting to Google App Engine, Downloading Data Without Draining the Battery	09	CO3
IV	Data Persistence and Content Providers	Introducing Android Databases, Introducing SQLite, Content Values and Cursors, Working with SQLite Databases, Parsing an XML document , Parsing JSON data . Creating Content Providers, Using Content Providers, Adding Search to Your Application, Native Android Content Providers	09	CO4
V	Audio, Video , Camera, Maps, Geocoding and Location Based services	Playing Audio and Video, Manipulating Raw Audio, Using Audio , Using the Camera for Taking Pictures, Recording Video, Using Media Effects , Adding Media to the Media Store. Using Location-Based Services , Using the Emulator with Location-Based Services, Selecting a Location Provider, Finding Your Current Location, Location Updates, Proximity Alerts, Geocoder, Map-Based Activities, Displaying Maps	08	CO5
VI	Securing and Publishing Android Application	Android Security Model, Android's Manifest Permissions, Mobile Security Issues, Recent Android Attacks, Pen Testing Android. Preparing for Publishing, Deploying	08	CO6

		APK Files		
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Text Books:

1. Professional Android 4 Application Development, Retomeier, by wrox publication,
2. Android Security –attack and defenses, AbhishekDubey and AnmolMisra by CRC Press
3. Beginning Android Application Development, Wei-meng lee, by wrox publication

References:

1. Android Application Development For Dummies, 2nd Edition by Michael Burton, DonnFelker
2. Android Cookbook by o'reilly

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory and should cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDLO7033	High Performance Computing	04	--	-	04	--	-	04

Course Code	Course Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & oral	Oral	Total
		Internal assessment								
		Test1	Test2	Avg. of two Tests						
ITDLO7033	High Performance Computing	20	20	20	80	--	--	--	100	

Course Objectives: Students will try to:

1. Learn the concepts of parallel processing as it pertains to high-performance computing.
2. Learn to design parallel programs on high performance computing.
3. Discuss issues of parallel programming.
4. Learn the concepts of message passing paradigm using open source APIs.
5. Learn different open source tools.
6. Learn the concepts of Multi-core processor.

Course Outcomes: Students will be able to:

1. Memorize parallel processing approaches
2. Describe different parallel processing platforms involved in achieving High Performance Computing.
3. Discuss different design issues in parallel programming
4. Develop efficient and high performance parallel programming
5. Learn parallel programming using message passing paradigm using open source APIs.
6. Design algorithms suited for Multicore processor and GPU systems using OpenMP and CUDA

Prerequisite: Computer Organization

Detail Syllabus:

Sr. No.	Module	Detailed Content	Hours	CO mapping
1	Introduction	Introduction to Parallel Computing: Motivating Parallelism, Scope of Parallel Computing, Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation), Parallel Architectures: Interconnection network, Processor Array, Multiprocessor	7	CO1
2	Parallel Programming Platforms	Parallel Programming Platforms: Implicit Parallelism: Trends in Microprocessor & Architectures, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines	7	CO2
3	Parallel Algorithm Design	Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models, Basic Communication operations: Broadcast and Reduction Communication types	12	CO3
4	Performance Measures	Performance Measures : Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl's Law, Gustavson's Law, Performance Bottlenecks	5	CO4
5	Fundamental Design Issues in HPC	Programming Using the Message-Passing Paradigm: Principles of Message Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topology and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations,	12	CO5

		One-Dimensional Matrix-Vector Multiplication, Single-Source Shortest-Path, Sample Sort, Groups and Communicators, Two-Dimensional Matrix-Vector Multiplication, Introduction to OpenMP,		
6	General Purpose Graphics Processing Unit(GPGPU)	CUDA enabled GPGPU, GPGPU architecture, GPGPU programming using CUDA, Introduction to CUDA Programming	9	CO6

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , “Introduction to Parallel Computing”, Pearson Education, Second Edition, 2007.
2. Kai Hwang, Naresh Jotwani, “Advanced Computer Architecture: Parallelism, Scalability, Programmability”, McGraw Hill, Second Edition, 2010.
3. Edward Kandrot and Jason Sanders, “CUDA by Example – An Introduction to General Purpose GPU Programming”, Addison-Wesley Professional ©, 2010.
4. Georg Hager, Gerhard Wellein, “Introduction to High Performance Computing for Scientists and Engineers”, Chapman & Hall / CRC Computational Science series, 2011.

Reference Books:

1. Michael J. Quinn, “Parallel Programming in C with MPI and OpenMP”, McGraw-Hill International Editions, Computer Science Series, 2008.
2. Kai Hwang, Zhiwei Xu, “Scalable Parallel Computing: Technology, Architecture, Programming”, McGraw Hill, 1998.
3. Laurence T. Yang, MinyiGuo, “High- Performance Computing: Paradigm and Infrastructure” Wiley, 2006.

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO7034	Software Testing and Quality Assurance	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. of two Tests					
		Test1	Test2							
ITDLO7034	Software Testing and Quality Assurance	20	20	20	80	--	--	--	100	

Course Objectives: Students will try to learn:

- 1 Basic software debugging methods.
- 2 White box testing methods and techniques.
- 3 Black Box testing methods and techniques.
- 4 Designing test plans.
- 5 Different testing tools (familiar with open source tools)
- 6 Quality Assurance models.

Course Outcomes: Students will be able to:

1. Investigate the reason for bugs and analyze the principles in software testing to prevent and remove bugs.
2. Implement various test processes for quality improvement
3. Design test planning.
4. Manage the test process
5. Apply the software testing techniques in commercial environment
6. Use practical knowledge of a variety of ways to test software and an understanding of some of the trade-offs between testing techniques.

Prerequisite: Software Engineering.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Software Engineering Concepts	02	--
I	Testing Methodology	Introduction, Goals of Software Testing, Software Testing Definitions, Model for Software Testing, Effective Software Testing vs Exhaustive Software Testing, Software Failure Case Studies, Software Testing Terminology, Software Testing Life Cycle (STLC), Software Testing methodology, Verification and Validation, Verification requirements, Verification of high level design, Verification of low level design, validation.	09	CO1
II	Testing Techniques	Dynamic Testing: Black Box testing: boundary value analysis, equivalence class testing, state table based testing, cause-effect graphing based testing, error guessing. White box Testing Techniques: need, logic coverage criteria, basis path testing, graph matrices, loop testing, data flow testing, mutation testing. Static Testing. Validation Activities: Unit validation, Integration, Function, System, Acceptance Testing. Regression Testing: Progressive vs. Regressive, regression testing produces quality software, regression testability, objectives of regression testing, regression testing types, define problem, regression testing techniques.	08	CO2 CO3
III	Managing the Test Process	Test Management: test organization, structure and of testing group, test planning, detailed test design and test specification. Software Metrics: need, definition and classification of software matrices. Testing Metrics for Monitoring and Controlling the Testing Process: attributes and corresponding metrics, estimation model for testing effort, architectural design, information flow	08	CO4

		matrix used for testing, function point and test point analysis. Efficient Test Suite Management: minimizing the test suite and its benefits, test suite minimization problem, test suite prioritization its type , techniques and measuring effectiveness.		
IV	Test Automation	Automation and Testing Tools: need, categorization, selection and cost in testing tool, guidelines for testing tools. Study of testing tools: JIRA, Bugzilla, TestDirector and IBM Rational Functional Tester, Selenium etc.	09	CO1 CO5
V	Testing for specialized environment	Agile Testing, Agile Testing Life Cycle, Testing in Scrum phases, Challenges in Agile Testing Testing Web based Systems: Web based system, web technology evaluation, traditional software and web based software, challenges in testing for web based software, testing web based testing	08	CO2 CO3
VI	Quality Management	Software Quality Management, McCall's quality factors and Criteria, ISO 9126 quality characteristics, ISO9000:2000, Software quality management	06	CO6

Text Books :

1. Software Testing Principles and Practices Naresh Chauhan Oxford Higher Education
2. Software Testing and quality assurance theory and practice by Kshirasagar Naik, Priyadarshi Tripathy , Wiley Publication

References :

1. Effective Methods for Software Testing , third edition by Willam E. Perry, Wiley Publication
2. Software Testing Concepts and Tools by Nageswara Rao Pusuluri , Dreamtech press

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO7035	Soft Computing	04	--	01	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITDLO7035	Soft Computing	20	20	20	80	--	--	--	100

Course Objectives: Students will try:

1. To familiarize with soft computing concepts.
2. To introduce the fuzzy logic concepts, fuzzy principles and relations.
3. To Basics of ANN and Learning Algorithms.
4. Ann as function approximation.
5. Genetic Algorithm and its applications to soft computing.
6. Hybrid system usage, application and optimization.

Course Outcomes: Students will be able to:

1. List the facts and outline the different process carried out in fuzzy logic, ANN and Genetic Algorithms.
2. Explain the concepts and meta-cognitive of soft computing.
3. Apply Soft computing techniques the solve character recognition, pattern classification, regression and similar problems.
4. Outline facts to identify process/procedures to handle real world problems using soft computing.
5. Evaluate various techniques of soft computing to defend the best working solutions.
6. Design hybrid system to revise the principles of soft computing in various applications.

Prerequisite: NIL

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Probability and Statistics, C++/Java/ Matlab	02	

		programming.		
I	Fuzzy Set Theory	<p>Fuzzy Sets: Basic definition and terminology, Basic concepts of fuzzy sets, Fuzzy set operations, Fuzzy relations: Cardinality of fuzzy relations, operations on fuzzy relations, properties of fuzzy relations, Fuzzy composition Fuzzification and Defuzzification: Features of the membership Functions, Fuzzification, Lambda-Cuts for Fuzzy Sets, Lambda-Cuts for Fuzzy Relations, Defuzzification methods</p>	06	CO1 CO2
II	Fuzzy Rules, Reasoning, and Inference System	<p>Fuzzy Rules: Fuzzy If-Then Rules, Fuzzy Reasoning Fuzzy Inference System (FIS): Mamdani FIS, Sugeno FIS, Comparison between , Mamdani and Sugeno FIS.</p>	06	CO1 CO2
III	Neural Network-I	<p>Introduction: What is a Neural network? Fundamental Concepts, Basic Models of Artificial Neural Networks, Artificial Intelligence and Neural Networks, McCulloch-Pitts Neuron Learning: Error-Correction Learning, Memory based Learning, Hebbian learning, Competitive Learning, Boltzmann Learning Perceptron: Perceptron Learning Rule, Perceptron Learning Algorithm, Perceptron Convergence Theorem, Perceptron learning and Non-separable sets.</p>	09	CO1 CO2
IV	Neural Networks -II	<p>Back propagation: Multilayered Network Architecture, Back propagation Algorithm, Practical Consideration in implementing the Back propagation Algorithm. Back propagation and XOR problem. Adaptive resonance Theory: Noise-Saturation Dilemma, Solving the Noise-Saturation Dilemma, Recurrent On-center-Off-surround Networks, Building blocks of Adaptive Resonance, Substrate of resonance, Structural details of the resonance Model, Adaptive Resonance Theory I (ART I), Neurophysiological Evidence for ART Mechanism Character Recognition: Introduction, General Algorithm Architecture for Character Recognition: Binarization, Preprocessing, Filters, Smoothing, Skew Detection and Correction, Slant Correction, Character Normalization, Thinning, Segmentation, Multilingual OCR by Rule-Based Approach and ANN</p>	10	CO3 CO6

		Rule-Based Approach: Classification, Tests, Rules Artificial Neural Network: Inputs, Outputs, Identification Results of Multilingual OCR		
V	Genetic Algorithm	An Introduction to genetic Algorithms: What Are Genetic Algorithms? Robustness of Traditional Optimization and Search Methods, The Goals of Optimization, How Are Genetic Algorithms Different from Traditional Methods?, A Simple Genetic Algorithm Genetic Algorithms at Work—a Simulation by hand, Grist for the Search Mill—Important Similarities, Similarity Templates (Schemata), Learning the Lingo. Genetic Algorithms: Mathematical Foundations Who Shall Live and Who Shall Die? The Fundamental Theorem, Schema Processing at Work: An Example by Hand Revisited, The Two-armed and й-armed Bandit Problem, How Many Schemata Are Processed Usefully? The Building Block Hypothesis, Another Perspective: The Minimal Deceptive Problem, Schemata Revisited: Similarity Templates as Hyperplanes, Implementation of a Genetic Algorithm: Data Structures, Reproduction, Crossover, and Mutation, A Time to Reproduce, a Time to Cross, Get with the Main Program, How Well Does it Work? Mapping Objective Functions to Fitness Form, Fitness Scaling, Codings, A Multiparameter, Mapped, Fixed-Point Coding, Discretization, Constraints. Algorithm for Handwriting Recognition Using GA Generation of Graph, Fitness Function of GA: Deviation between Two Edges, Deviation of a Graph, Crossover: Matching of Points, Generate Adjacency Matrix, Find Paths, Removing and Adding Edges, Generation of Graph Results of Handwriting Recognition: Effect of Genetic Algorithms, Distance Optimization, Style Optimization	10	CO1 CO3 CO6
VI	Hybrid Computing	Introduction, Neuro-Fuzzy Hybrid Systems, Adaptive Neuro-Fuzzy Inference System (ANIFS): Introduction, ANFS Architecture, Hybrid Learning Algorithm, ANFIS as a Universal Approximator, Simulation Examples: Two-input Sinc Function and Three Input Nonlinear Function Genetic Neuro-Hybrid Systems: Properties of Genetic Neuro-Hybrid Systems, genetic Algorithm based Back-propagation Network, Advantages of Neuro-Genetic Hybrids, Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid Systems Genetic Fuzzy Rule based Systems, Advantages of Genetic Fuzzy Hybrids	09	CO4 CO6

Text Books:

1. . S.N. Sivanandan and S.N. Deepa, Principles of Soft Computing, Wiley India, 2007, ISBN: 10: 81-265-1075-7.
2. J.-S. R. Jang, C. –T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing, A Computational Approach to Learning and Machine Intelligence, PHI Learning Private Limited-2014
3. Neural Networks: A Classroom Approach, Satish Kumar, Tata McGraw-Hill Education, 2004/2007
4. Simon Haykin, Neural Networks A Comprehensive Foundation, Second Edition, Pearson Education-2004
5. David E. Goldberg, Genetic Algorithms, in search, optimization and Machine Learning, Pearson

References:

1. Anupam Shukla, Ritu Tiwari, Rahul Kala, Real Life Applications of Soft Computing, CRC Press, Taylor & Francis Group, 2010.
2. Genetic Algorithms and Genetic Programming Modern Concepts and Practical Applications © 2009 Michael Affenzeller, Stephan Winkler, Stefan Wagner, and Andreas Beham, CRC Press
3. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1 will be compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Credits
ILO7011	Product Life Cycle Management	03

Course Objectives: Students will try :

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Course Outcomes: Students will be able to :

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	ProductDesign: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques,	05

	Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to...

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to...

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to...

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	Introduction 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	Fitting Regression Models 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	Two-Level Factorial Designs 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	Two-Level Fractional Factorial Designs 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07

05	Response Surface Methods and Designs 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
06	Taguchi Approach 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to...

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	<p>Introduction to Operations Research: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research</p> <p>Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p>Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.</p> <p>Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem</p> <p>Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.</p>	14
02	<p>Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population</p>	05
03	<p>Simulation: Introduction, Methodology of Simulation, Basic Concepts,</p>	05

	Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	
04	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to...

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	Introduction to Cybercrime: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	Cyber offenses & Cybercrime: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Bot nets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	Tools and Methods Used in Cyber line Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	The Concept of Cyberspace E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	Indian IT Act. Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	Information Security Standard compliances SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008-TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Course Code	Course Name	Credits
ILO7017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to...

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of	06

	casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yongg – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to...

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	Energy Audit Principles: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	Energy Management and Energy Conservation in Electrical System: Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10

04	<p>Energy Management and Energy Conservation in Thermal Systems: Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.</p>	10
05	<p>Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.</p>	04
06	<p>Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources</p>	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Development Engineering	03

Objectives:

1. To familiarise the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To provide an exposure to implications of 73rdCAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To familiarise the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to...

1. Demonstrate understanding of knowledge for Rural Development.
2. Prepare solutions for Management Issues.
3. Take up Initiatives and design Strategies to complete the task
4. Develop acumen for higher education and research.
5. Demonstrate the art of working in group of different nature
6. Develop confidence to take up rural project activities independently

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	06
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development	07

4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
5	<p>Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education</p> <p>Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom</p>	10
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rdGoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington

9. How, E., Normative Ethics in Planning, *Journal of Planning Literature*, Vol.5, No.2, pp. 123-150
10. Watson, V. Conflicting Rationalities: -- Implications for Planning Theory and Ethics, *Planning Theory and Practice*, Vol. 4, No.4, pp.395 – 407

B. E. Information Technology (Semester-VIII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
ITC801	Big Data Analytics	4	-	-	4	-	-	4
ITC802	Internet of Everything	4	-	-	4	-	-	4
ITDLO-IV	Department Level Optional Course-IV	4	-	-	4	-	-	4
ILO-II	Institute Level Optional Course-II	3	-	-	3	-	-	3
ITL801	Big Data Lab	-	2	-	-	1		1
ITL802	Internet of Everything Lab		2			1		1
ITL803	DevOps Lab	-	2	-	-	1		1
ITL804	R Programming Lab	-	2	-		1		1
ITM805	Project-II	-	16			8	-	8
	Total	15	24	-	15	12	-	27

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in				
		Test 1	Test 2	Avg.						
ITC801	Big Data Analytics	20	20	20	80	3	-	-	-	100
ITC802	Internet of Everything	20	20	20	80	3	-	-	-	100
ITDLO-IV	Department Level Optional Course-IV	20	20	20	80	3	-	-	-	100
ILO-II	Institute Level Optional Course-II	20	20	20	80	3	-	-	-	100
ITL801	Big Data Lab						25	25	-	50
ITL802	Internet of Everything Lab	-	-	-	-	-	25	25		50
ITL803	DevOps Lab	-	-	-	-	-	25	--	25	50
ITL804	R Programming Lab	-	-	-	-	-	25	--	25	50
ITM805	Project-II						100	50	--	150
Total		80	80	80	320	--	200	100	50	750

Department Level Optional Course (DLO)

Every student is required to take one Department Elective Course for Semester VIII. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

(DLO-I subjects will have no Labs only Theory)

Institute Level Optional Course (ILO)

Every student is required to take one Institute Elective Course for Semester VIII, which is not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

Subject Code	Department Level Optional Course (DLO)	Subject Code	Institute Level Optional Course (ILO)
Semester VIII			
ITDLO8041	User Interaction Design	ILO8021	Project Management
ITDLO8042	Information Retrieval Systems	ILO8022	Finance Management
ITDLO8043	Knowledge Management	ILO8023	Entrepreneurship Development and Management
ITDLO8044	Robotics	ILO8024	Human Resource Management
ITDLO8045	Enterprise Resource Planning	ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC801	Big Data Analytics	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC801	Big Data Analytics	20	20	20	80	--	--	--	100

Course Objectives: Students will try:

1. To provide an overview of an exciting growing field of Big Data analytics.
2. To discuss the challenges traditional data mining algorithms face when analyzing Big Data.
3. To introduce the tools required to manage and analyze big data like Hadoop, NoSql Map-Reduce.
4. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
5. To introduce to the students several types of big data like social media, web graphs and data streams.
6. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Course Outcomes: Student will be able to:

1. Explain the motivation for big data systems and identify the main sources of Big Data in the real world.
2. Demonstrate an ability to use frameworks like Hadoop, NOSQL to efficiently store retrieve and process Big Data for Analytics.
3. Implement several Data Intensive tasks using the Map Reduce Paradigm
4. Apply several newer algorithms for Clustering Classifying and finding associations in Big Data
5. Design algorithms to analyze Big data like streams, Web Graphs and Social Media data.
6. Design and implement successful Recommendation engines for enterprises.

Prerequisites: Database Management System.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Data Mining, database Systems, Algorithms	02	--
I	Introduction to Big Data	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	03	CO 1
II	Introduction to Big Data Frameworks: Hadoop, NOSQL	What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; Overview of : Apache Spark, Pig, Hive, Hbase, Sqoop What is NoSQL? NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Mongo DB	10	CO 2
III	MapReduce Paradigm	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step . Illustrating use of MapReduce with use of real life databases and applications.	09	CO 3
IV	Mining Big Data Streams	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data in a Stream : Sampling Techniques. Filtering Streams: The Bloom Filter	07	CO 5

		<p>Counting Distinct Elements in a Stream : The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm.</p>		
V	Big Data Mining Algorithms	<p>Frequent Pattern Mining : Handling Larger Datasets in Main Memory Basic Algorithm of Park, Chen, and Yu. The SON Algorithm and MapReduce. Clustering Algorithms: CURE Algorithm. Canopy Clustering, Clustering with MapReduce Classification Algorithms: Parallel Decision trees, Overview SVM classifiers, Parallel SVM, K-Nearest Neighbor classifications for Big Data, One Nearest Neighbour.</p>	10	CO 4
VI	Big Data Analytics Applications	<p>Link Analysis : PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Topic sensitive Page Rank, link Spam, Hubs and Authorities, HITS Algorithm. Mining Social- Network Graphs : Social Networks as Graphs, Types , Clustering of Social Network Graphs, Direct Discovery of Communities, Counting triangles using Map-Reduce. Recommendation Engines: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.</p>	11	CO 4 CO 6

Text Books:

1. Radha Shankarmani, M Vijayalakshmi, "Big Data Analytics", Wiley Publications,
2. Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press.
3. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
4. Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press
5. MongoDB: The Definitive Guide Paperback, Kristina Chodorow (Author), Michael Dirolf, O'Reilly Publications

References:

1. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series.
2. Big Data Analytics with R and Hadoop by Vignesh Prajapati Paperback, Packt Publishing Limited
3. Hadoop: The Definitive Guide by Tom White, O'Reilly Publications

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC802	Internet of Everything	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITC802	Internet of Everything	20	20	20	80	--	--	--	100

Course Objectives: Students will try:

1. To learn the concepts of IOT.
2. To identify the different technology.
3. To learn different applications in IOT.
4. To learn different protocols used in IOT.
5. To learn the concepts of smart city development in IOT.
6. To learn how to analysis the data in IOT.

Course Outcomes: Student will be able to:

1. Apply the concepts of IOT.
2. Identify the different technology.
3. Apply IOT to different applications.
4. Analysis and evaluate protocols used in IOT.
5. Design and develop smart city in IOT.
6. Analysis and evaluate the data received through sensors in IOT.

Prerequisites: IOT Lab, Sensor Lab, Wireless Network.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	What are sensors, Sensor family, Architecture of single node sensor?	02	--
I	Introduction	Introduction, History of IOT, Objects in IOT, Identifier in the IOT, Technologies in IOT	03	CO 1
II	RFID Technology	Introduction, principle of RFID, components of RFID system: RFID tag, Reader, RFID middleware,	8	CO 2

		Issues etc.		
III	RFID Applications	Introduction, concepts and technology: RFID, transponder, RFID architecture, RFID applications i.e. logistics and supply chain, production, monitoring and maintenance, product safety, quality and information, access control and tracking and tracing of individuals, payment, loyalty, household etc. Hardware, Hardware issues, protocols: pure aloha, slotted aloha, frame slotted aloha, tree protocols, tree splitting algorithms, binary search algorithms, bitwise arbitration protocols. Main query tree protocols.	09	CO2 CO 3
IV	Wireless Sensor Networks	History and context, Node, connecting nodes, networking nodes, securing communication, standards and Fora. Networking and the Internet - IP Addressing, Protocols - MQTT, CoAP, REST Transferring data	09	CO2 CO3 CO4
V	Mobility and Settings.	Introduction, localization, mobility management, localization and handover management, technology considerations, performance evaluation, simulation setup, performance results. Identification of IOT (data formats. IPV6, identifiers and locators, tag etc.)	10	CO4 CO5
VI	Data Analytics for IoE	Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, Apache Storm, Using Apache Storm for Real-time Data Analysis, Structural Health Monitoring Case Study, Tools for IoT:- Chef, Chef Case Studies, Puppet, Puppet Case Study - Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generator.	11	CO5 CO6

Text Books:

- 1 Internet of Things connecting objects to the web, by Hakima Chaouchi, Wiley.
2. Internet of Things (A Hands-on-Approach) by Arshdeep Bhaga and Vijay Madiseti.

Reference Books:

- 1 The Internet of Things (MIT Press) by Samuel Greengard.
- 2 The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications).
- 3 RFID and the Internet of Things, by Herve chabanne, Wiley

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL801	Big Data Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL801	Big Data Lab	--	--	--	--	25	--	25	50

Lab Objectives: Students will try:

1. To introduce the tools required to manage and analyze big data like Hadoop, NoSql
2. To impart knowledge of Map reduce paradigm to solve complex problems Map-Reduce.
3. To introduce several new algorithms for big data mining like classification, clustering and finding frequent patterns.
4. To introduce to the students several types of big data like social media, web graphs and data streams.
5. To identify various sources of Big data
6. To enable students to have skills that will help them to solve complex real-world problems in for decision support.

Lab Outcomes: Students will be able to:

1. Demonstrate capability to use Big Data Frameworks like Hadoop
2. Program applications using tools like Hive, pig, , NO SQL and MongoDB for Big data Applications
3. Construct scalable algorithms for large Datasets using Map Reduce techniques
4. Implement algorithms for Clustering, Classifying and finding associations in Big Data
5. Design and implement algorithms to analyze Big data like streams, Web Graphs and Social Media data and construct recommendation systems.
6. Apply the knowledge of Big Data gained to fully develop a BDA applications for real life applications.

Prerequisite: Java, Python

Requirement

Hardware	Software
PC i3 or above, 8 GB RAM	Virtual Machine, Hadoop Frame work, NOSQL and MongoDB Compilers

Detailed syllabus:

Module	Detailed Content	Hours 2hrs	LO Mapping
1	Assignment on Study of Hadoop ecosystem	02	LO 1
2	Programming exercises on Hadoop Using Hive, Pig, Hbase Sqoop NOSQL, MongoDB	04	LO 2
3	Implementing simple algorithms in Map-Reduce Matrix multiplication, Aggregates, joins, sorting, searching etc.	04	LO3
4	Implementing Algorithms using MapReduce (Any 2) <ul style="list-style-type: none"> • Implementing Frequent Item set Mining • Implementing Clustering algorithms • Implementing Classification Algorithms 	06	LO 4
5	Big Data Applications (Any 2) <ul style="list-style-type: none"> • Implementing Analytics on data streams • Implementing Social Network Analysis Algorithms • Implementing Web Graph Algorithms • Implementing recommendation Engines 	05	LO 5
6	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web) a) Twitter data analysis b) Fraud Detection c) Text Mining d) Recommendation Engines (list of datasets also given in the text book)	05	LO 5 LO 6

Text Books:

1. Radha Shankarmani, M Vijayalakshmi, "Big Data Analytics", Wiley Publications,
2. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
3. Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press
4. MongoDB: The Definitive Guide Paperback, Kristina Chodorow (Author), Michael Dirolf, O'Reilly Publications

References:

1. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series.
2. Hadoop: The Definitive Guide by Tom White, O'Reilly Publications
3. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services
4. NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence by Pramod J. Sadalage, Addison Wesley

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL802	Internet of Everything Lab	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
ITL802	Internet of Everything Lab	--	--	--	--	25	--	25	50

Hardware and Software requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel Core i3/i5/i7 Processor 2. 4 GB RAM 3. 500 GB Hard disk	1. Ubuntu or Linux Desktop OS 2. VMware 3. Cooja contiki or any open source software 4. Cupcarbon	1. Internet Connection

Lab Objectives: Students will try:

1. To learn different types of sensors from Motes families.
2. To design the problem solution as per the requirement analysis done using Motes sensors.
3. To study the basic concepts of programming/sensors/ emulator like cooja etc.
4. To design and implement the mini project intended solution for project based learning.
5. To build and test the mini project successfully.
6. To improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Identify the requirements for the real world problems.
2. Conduct a survey of several available literatures in the preferred field of study.
3. Study and enhance software/ hardware skills.

4. Demonstrate and build the project successfully by hardware/sensor requirements, coding, emulating and testing.
5. To report and present the findings of the study conducted in the preferred domain
6. Demonstrate an ability to work in teams and manage the conduct of the research study.

Prerequisite: Basics of Java and Python Programming

Guidelines

1. The mini project work is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students must understand the
 - a. Concept
 - b. Importance
 - c. Interdisciplinary
 - d. Challenges
 - e. Various applications/smart objects
 - f. Major Players/Industry, Standards.
4. The students must understand the IoT Architecture:
 - a. Node Structure: Sensing, Processing, Communication, Powering
 - b. Networking: Topologies, Layer/Stack architecture
 - c. Communication Technologies: Introduction to ZigBee, BLE, WiFi, LTE, IEEE 802.11ah, Discuss data rate, range, power, computations/bandwidth, QoS
 - d. Smartness - Signal Processing/Analytics: Impact on Power/Energy savings, dynamic networks, simple case studies
 - e. IoT Fabricator: Introduction to Embedded electronics, fabricating electronics, Communication Network requirements, Data processing challenges – recreation, IP/security, Challenges
 - f. Hands-on in IoT: Projects based on some Hardware (Raspberry pi, Arduino, Intel, IITH Mote, Smartphones), Software (Contiki, TinyOS, Android), IoT Fabricator etc. can be used.
5. The students may do will visit different websites to identify their IOT topic for the mini project.
6. The students may do survey for different application using different types of sensors for their mini project.

7. Each group will identify the Hardware (Motes from different Motes families) & sensor configuration and software requirement for their mini project problem statement.
8. Design your own circuit board using multiple sensors etc.
9. Installation, configure and manage your sensors in such away so that they can communicate with each other.
10. Work with operating system, emulator like contiki cooja and do coding to for input devices on sensors.
11. Each group will identify the Hardware and software requirement for their mini project problem statement.
12. Create and interface using Mobile/Web to publish or remotely access the data on Internet.
13. Each group along with the concerned faculty shall identify a potential problem statement, on which the study and implementation is to be conducted.
14. Each group may present their work in various project competitions and paper presentations.
15. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Text Books:

1. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann
2. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally
3. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers
4. Internet of Things (A Hands-on-Approach) , Vijay Madiseti , Arshdeep Bahga

References:

1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
2. Building the internet of things with ipv6 and mipv6, The Evolving World of M2M Communications, Daniel Minoli John Wiley & Sons
3. Contiki Cooja User Guide.
4. Fundamentals of Sensor Network Programming: Applications and Technology, By S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley publication.
5. Recent research/white papers

Term Work:

Term Work shall consist of full Mini Project on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL803	DevOps Lab	--	2	--	--	--	--	01

Course Code	Course Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. of two Tests					
		Test1	Test2							
ITL803	DevOps Lab	--	--	--	--	25	25	--	50	

Lab Objectives: Students will try:

1. To understand the concept of DevOps with associated technologies and methodologies.
2. To be familiarized with Jenkins, which is used to build & test software Applications & Continuous integration in Devops environment.
3. To understand different Version Control tools like GIT, CVS or Mercurial
4. To understand Docker to build, ship and run containerized images
5. To use Docker to deploy and manage Software applications running on Container.
6. To be familiarized with concept of Software Configuration Management & provisioning using tools like Puppet, Chef, Ansible or Saltstack.

Lab Outcomes: Students will be able to:

1. Remember the importance of DevOps tools used in software development life cycle
2. Understand the importance of Jenkins to Build, Deploy and Test Software Applications
3. Examine the different Version Control strategies
4. Analyze & Illustrate the Containerization of OS images and deployment of applications over Docker
5. Summarize the importance of Software Configuration Management in DevOps
6. Synthesize the provisioning using Chef/Puppet/Ansible or Saltstack.

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration	1. Windows or Linux Desktop OS for Client machines	1. Internet Connection for each PC with at least 2 MBPS

1. Intel Core i3/i5/i7 Processor with Intel VT-X support 2. 4 GB RAM 3. 500 GB Harddisk 4. Gigabit Ethernet (GbE) network interface card (NIC)	2. CentOS/Fedora/Ubuntu/Redhat Server OS for One Server 3. JDK 1.8 or higher 4. Netbeans or Eclipse 5. OpenSSH	bandwidth.
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Prerequisite Subjects: Operating System, Virtualization, Cloud Computing, Java and Web Programming, and Software Engineering.

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	To Understand the Concept of DevOps with related technologies which are used to Code, Build, Test, Configure & Monitor the Software Applications.	02	--
I	Build & Test Applications with Continuous Integration	To Install and Configure Jenkins to test, and deploy Java or Web Applications using Netbeans or eclipse.	04	LO 1 LO2
II	Version Control	To Perform Version Control on websites/ Softwares using different Version control tools like RCS/ CVS/GIT/Mercurial (Any two)	04	LO 1 LO 3
III	Virtualization & Containerization	To Install and Configure Docker for creating Containers of different Operating System Images	04	LO 1 LO 4
IV	Virtualization & Containerization	To Build, deploy and manage web or Java application on Docker	04	LO 1 LO 4
V	Software Configuration Management	To install and configure Software Configuration Management using Chef/Puppet/Ansible or Saltstack.	04	LO 1 LO 5

VI	Provisioning	To Perform Software Configuration Management and provisioning using Chef/Puppet/Ansible or Saltstack.	04	LO 1 LO 6
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Text Books:

1. Karl Matthias & Sean P. Kane, Docker: Up and Running, O'Reilly Publication.
2. Len Bass, Ingo Weber, Liming Zhu, "DevOps, A Software Architects Perspective", Addison-Wesley-Pearson Publication.
3. John Ferguson Smart, "Jenkins, The Definitive Guide", O'Reilly Publication.
4. Learn to Master DevOps by Star EduSolutions.

References:

1. Sanjeev Sharma and Bernie Coyne, "DevOps for Dummies", Wiley Publication
2. Httermann, Michael, "DevOps for Developers", Apress Publication.
3. Joakim Verona, "Practical DevOps", Pack publication

Term Work:

Term Work shall consist of experiment on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical & Oral	Tutorial	Total
ITL804	R Programming Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & oral	Oral	Total
		Internal assessment			Avg. of two Tests					
		Test1	Test 2							
ITL804	R Programming Lab	--	--	--	--	25	25	--	50	

Lab Objectives: Students will try:

1. To provide an overview of a new language R used for data science.
2. To introduce students to the R programming environment and related eco-system and thus provide them with an in-demand skill-set, in both the research and business environments
3. To introduce the extended R ecosystem of libraries and packages
4. To demonstrate usage of as standard Programming Language.
5. To familiarize students with how various statistics like mean median etc. can be collected for data exploration in R
6. To enable students to use R to conduct analytics on large real life datasets.

Lab Outcomes: students will be able to:

1. Install and use R for simple programming tasks.
2. Extend the functionality of R by using add-on packages
3. Extract data from files and other sources and perform various data manipulation tasks on them.
4. Code statistical functions in R.
5. Use R Graphics and Tables to visualize results of various statistical operations on data .
6. Apply the knowledge of R gained to data Analytics for real life applications.

SOFTWARE requirements:

1. The R statistical software program. Available from: <https://www.r-project.org/>
2. RStudio an Integrated Development Environment (IDE) for R. Available from: <https://www.rstudio.com/>

Detailed syllabus:

Module	Detailed Content	Hours	LO Mapping
0	Prerequisites - Any programming Language like Java Python. Basic statistics. Data Mining Algorithms	--	--
I	Introduction: Installing R on personal machines. installing R and RStudio. <ul style="list-style-type: none"> The basic functionality of R will be demonstrated, Variable types in R. Numeric variables, strings and factors. Accessing the help system. Retrieving R packages. Basic data types and operations: numbers, characters and composites. Data entry and exporting data 	02	LO 1, LO 2, LO 3
II	Data structures: vectors, matrices, lists and data frames.	04	LO1, LO 3
III	R as a programming language: <ul style="list-style-type: none"> Grouping, loops and conditional execution, Functions Exploratory data analysis <ul style="list-style-type: none"> Range, summary, mean, variance, median, standard deviation, histogram, box plot, scatterplot 	04	LO 1, LO 4
IV	Graphics in R <ul style="list-style-type: none"> Graphics and tables Working with larger datasets Building tables with aggregate Introduction to ggplot2 graphics 	06	LO 3
V	Regression and correlation <ul style="list-style-type: none"> Simple regression and correlation, Multiple regression Tabular data and analysis of Categorical data 	02	LO 4
VI	R for Data Science (Mini Project) Implementing a mini project using any data mining or big data analytics algorithm in R <ul style="list-style-type: none"> Extracting data from a large Dataset Exploratory analysis Using Mining algorithm Visualizations and interpretation of results 	06	LO 5, LO 6

Text Books:

1. URL: <https://cran.r-project.org/doc/manuals/r-release/R-intro.pdf> (Online Resources)
2. R Cookbook Paperback – 2011 by Teetor Paul O Reilly Publications
3. Beginning R: The Statistical Programming Language by Dr. Mark Gardener, Wiley Publications
4. R Programming For Dummies by Joris Meys Andrie de Vries, Wiley Publications

References:

1. Hands-On Programming with R by Golemund, O Reilly Publications
2. R for Everyone: Advanced Analytics and Graphics, 1e by Lander, Pearson Ltd.
3. R for Data Science Learning Dan Toomey December 2014 Packt Publishing Limited

Term Work:

Term Work shall consist of experiment on above guidelines/syllabus. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical / Oral	Tutorial	Total
ITM805	Project-II	--	16	--	--	8	--	8

Course Code	Course Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. of two Tests					
		Test1	Test2							
ITM805	Project-II	--	--	--	--	100	--	50	150	

Lab Objectives: Students will try:

1. To offer students a glimpse into real world problems and challenges that need IT based solutions
2. To enable students to create very precise specifications of the IT solution to be designed.
3. To introduce students to the vast array of literature available of the various research challenges in the field of IT
4. To create awareness among the students of the characteristics of several domain areas where IT can be effectively used.
5. To enable students to use all concepts of IT in creating a solution for a problem
6. To improve the team building, communication and management skills of the students.

Lab Outcomes: Student will be able to:

1. Discover potential research areas in the field of IT
2. Conduct a survey of several available literature in the preferred field of study
3. Compare and contrast the several existing solutions for research challenge
4. Demonstrate an ability to work in teams and manage the conduct of the research study.
5. Formulate and propose a plan for creating a solution for the research plan identified
6. To report and present the findings of the study conducted in the preferred domain

Guidelines

1. The project work is to be conducted by a group of three students
2. Each group will be associated with a project mentor/guide. The group should meet with the project mentor/guide periodically and record of the meetings and work discussed must be documented.
3. Department has to allocate 1 day in VII semester and 2 day in VIII semester every week.
4. Students will do literature survey in Sem VI or Sem VII.
5. Students will do design, implementation and coding in Sem VII.
6. Each group along with its guide/mentor shall identify a potential research area/problem domain, on which the study is to be conducted.
7. Each team will do a rigorous literature survey of the problem domain by reading and understanding at least 3-5 research papers from current good quality national/international journals/conferences. (Papers selected must be indexed by Scopus/IEEE/Springer/ACM etc.). The list of papers surveyed must be clearly documented.
8. The project assessment for term work will be done at least two times at department level by giving presentation to panel members which consist of at least three (3) members as Internal examiners (including the project guide/mentor) appointed by the Head of the department of respective Programme.
9. A report is to be prepared summarizing the findings of the literature survey. A comparative evaluation of the different techniques surveyed is also to be done.
10. Students will do testing and analyze in Sem VIII
11. Teams must analyze all the results obtained by comparing with other standard techniques.
12. Every team must publish their work in national / international conference/journals (if possible publish in Scopus indexed journals).

Evaluation

1. Each team has to give presentation/demo to the Internal Panel and External examiner.
2. Each team will prepare a report that will summarize the results of the literature survey and implementation and coding as project proposal in SEM VII. The list of papers surveyed must be clearly documented.
3. Each group will be jointly evaluated by a team of Internal and External Examiners approved by the University of Mumbai.
4. Oral exam will be conduct on the project done by the students.

Term Work:

Term Work shall consist of full Project-I on above guidelines/syllabus.

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Term Work Marks: 100 Marks (Total marks) = 95 Marks (Project-II) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Project-II and Presentation.

Course code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO8041	User Interaction Design	04	--	--	04	--	--	04

Course code	Course Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical	Oral	Total
		Internal assessment			Avg. of two Tests					
		Test1	Test2							
ITDLO8041	User Interaction Design	20	20	20	80	--	--	--	100	

Course Objectives: Students will try to:

- 1 To stress the importance of good interface design.
- 2 To understand the importance of human psychology as well as social and emotional aspect in designing good interfaces.
- 3 To learn the techniques of data gathering, establishing requirements, analysis and data interpretation.
- 4 To learn the techniques for prototyping and evaluating user experiences.
- 5 To understand interaction design process.
- 6 To bring out the creativity in each student – build innovative applications that are usable, effective and efficient for intended users.

Course Outcomes:

1. Students will be able to identify and criticize bad features of interface designs.
2. Students will be able to predict good features of interface designs.
3. Students will be able to illustrate and analyze user needs and formulate user design specifications.
4. Students will be able to interpret and evaluate the data collected during the process.
5. Students will be able to evaluate designs based on theoretical frameworks and methodological approaches.
6. Students will be able to produce/show better techniques to improve the user interaction design interfaces.

Prerequisite: Web technologies, Software Engineering, Experiences in designing interfaces for applications and web sites. Basic Knowledge of designing tools and languages like HTML , Java etc.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Software Engineering concepts and any programming Language	02	--
I	Introduction to Interaction Design	Good and Poor Design, What is Interaction Design, The User Experience, The Process Of Interaction Design, Interaction Design and the User Experience	09	CO1,CO 2
II	Understanding and Conceptualizing Interaction Cognitive aspects and Social, Emotional Interaction	Understanding the Problem Space and Conceptualizing Design, Conceptual Model, Interface Types Cognitive aspects, Social Interaction and the Emerging Social Phenomena, Emotions and the User Experience, Expressive and Frustrating Interfaces, Persuasive Technologies	09	CO2,CO 3
III	Data Gathering, Establishing Requirements, Analysis, Interpretation and Presentation	Establishing Requirements, Five Key Issues, Techniques for Data Gathering, Data Analysis Interpretation and Presentation, Task Description and Task Analysis	09	CO4
IV	Process of Interaction Design, Prototyping, Construction,	Interaction Design Process, Prototyping and Conceptual Design, Interface Metaphors and Analogies	09	CO4
V	Design rules and Industry standards	Design principles, Principles to support Usability, Standards and Guidelines, Golden rules and Heuristics, ISO/IEC standards	08	CO5
VI	Evaluation Techniques and Framework	The Why, What, Where and When of Evaluation, Types of Evaluation, case studies, DECIDE Framework, Usability Testing, conducting	06	CO5,CO 6

		experiments, Field studies, Heuristic Evaluation and walkthroughs, Predictive models.		
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Text Books:

1. *Interaction Design*, by J. Preece, Y. Rogers and H. Sharp. ISBN 0-471-49278-7.
2. *Human Computer Interaction*, by Alan Dix, Janet Finlay, Gregory D Abowd, Russell Beale
3. Alan Cooper, Robert Reimann, David Cronin, "About Face3: Essentials of Interaction design", Wiley publication.
4. Wilbert O. Galitz, "The Essential Guide to User Interface Design", Wiley publication.

References:

1. The UX Book, by Rex Hartson and Pardha S Pyla.
2. Donald A. Norman, "The design of everyday things", Basic books.
3. Jeff Johnson, "Designing with the mind in mind", Morgan Kaufmann Publication.

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO8042	Information Retrieval System	04	--	--	04	--	--	04

Course Code	CourseName	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam					
		Test1	Test2	Avg. of twoTests						
ITDL O804 2	Information Retrieval System	20	20	20	80	--	--	--	100	

Course Objectives: students will try:

1. To learn the fundamentals of information retrieval system.
2. To classify various Information retrieval models.
3. To demonstrate the query processing techniques and operations
4. To compare the relevance of query languages for text and multimedia data
5. To evaluate the significance of various indexing and searching techniques for information retrieval.
6. To develop a effective user interface for information retrieval.

Course Outcomes:

1. Students will define and describe the objectives the basic concepts of Information retrieval system.
2. Students will evaluate the taxonomy of different information retrieval models.
3. Students will solve and process text and multimedia retrieval queries and their operations
4. Students will evaluate text processing techniques and operations in information retrieval system.
5. Students will demonstrate and evaluate various indexing and searching techniques.
6. Student will design the user interface for an information retrieval system.

Prerequisite: Data structures and algorithms

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Comment (Prerequisite syllabus should not be considered for paper setting) Indexing and searching Algorithms	02	
I	Introduction	Motivation, Basic Concepts, The retrieval Process, Information System: Components, parts and types on information system; Definition and objectives on information retrieval system	05	CO1
II	IR Models	Modeling: Taxonomy of Information Retrieval Models, Retrieval: Adhoc and filtering, Formal Characteristics of IR models, Classic Information Retrieval, Alternative Set Theoretic models, Probabilistic Models, Structured text retrieval Models, models for Browsing; Multimedia IR models: Data Modeling	09	CO2
III	Query Processing and Operations	Query Languages: Keyword based Querying, Pattern Matching, Structural Queries, Query Protocols; Query Operations: User relevance feedback, Automatic local analysis, Automatic global analysis, Multimedia IR Query Languages	10	CO3
IV	Text Processing	Text and Multimedia languages and properties: Metadata, Markup Languages, Multimedia; Text Operations: Document Preprocessing, Document Clustering, Text Compression, Comparing Text Comparison Technique	10	CO4
V	Indexing and Searching	Inverted files, Other indices for text, Boolean Queries, Sequential Searching, Pattern Matching, Structural Queries, Compression; Multimedia IR: Indexing and Searching:- Spatial Access Methods, A Generic Multimedia indexing approach, One-	11	CO5

		dimensional time series, Two dimensional color images, Automatic Feature extraction; Searching Web: Challenges, Characterizing the web, Search Engines. Browsing, Meta searches, Searching needle in haystack, Searching using Hyperlinks		
VI	User interface and visualization	Human Computer interaction, the information access process, starting points, query specifications, context, using relevance judgments, interface support for the search process	05	CO6

Text Books:

- 1.Modern Information Retrieval, Ricardo Baeza-Yates,berthier Ribeiro- Neto, ACM Press- Addison Wesley
2. Information Retrieval Systems: Theory and Implementation, Gerald Kowaski, Kluwer Academic Publisher
3. Storage Network Management and Retrieval by Dr. Vaishali Khairnar, Nilima Dongre, Wiley India

References:

1. Introduction to Information Retrieval By Christopher D. Manning and Prabhakar Raghavan, Cambridge University Press
2. Information Storage & Retieval By Robert Korfhage – John Wiley & Sons
3. Introduction to Modern Information Retrieval. G.G. Chowdhury. NealSchuman

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO8043	Knowledge Management	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. of two Tests					
		Test1	Test2							
ITDLO8043	Knowledge Management	20	20	20	80	--	--	--	100	

Course Objectives:

1 Establish a foundation of key terms and concepts, historical events and contributions, organizational benefits, and guiding principles on which to build greater understanding of knowledge management

2 Appreciate the role and use of knowledge for individuals, as well as organizations and institutions.

3 Increase information and understanding about knowledge transfer using low- and high technology strategies

4 Explore the future of knowledge management and its influence on our jobs, communities, and society

Course Outcomes: After completion of the course the learner will be able to

- 1) Discuss KM, learning organizations, intellectual capital and related terminologies in clear terms and understand the role of knowledge management in organizations.
- 2) Demonstrate an understanding of the history, concepts, and the antecedents of management of knowledge and describe several successful knowledge management systems
- 3) Evaluate the impact of technology including telecommunications, networks, and Internet/intranet role in managing knowledge.
- 4) Discuss new jobs, roles and responsibilities resulting from the New or Knowledge Economy
Ponder KM's current and future impact on individuals, organizations and society at large

Prerequisite: An introductory course in IT/ IS

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Prerequisite	Meaning of data, information, knowledge and expertise Meaning of epistemology, Types of Knowledge - Subjective & Objective views of knowledge, procedural Vs. Declarative, tacit Vs. explicit, general Vs. specific.	3
I	Introduction to Knowledge Management	What is Knowledge? Types of expertise – associational, motor skill, – theoretical Characteristics of knowledge – explicitness, codifiability, teachability, specificity Reservoirs of knowledge, Meaning of Knowledge Management, Forces Driving Organizational issues in KM, KM Systems & their role Relevance of KM in today’s dynamic & complex environment Future of Knowledge Management	5
II	Knowledge management system life cycle	Challenges in Building KM Systems – Conventional versus KM System Life Cycle (KMSLS) – Knowledge Creation and Knowledge Architecture – Nonaka’s Model of Knowledge Creation and Transformation. Knowledge Architecture.	8
III	KM Solutions for capture, sharing & applications	KM Processes, KM Systems, Mechanisms & Technologies Knowledge Capturing Techniques: Brain Storming – Protocol Analysis – Consensus Decision Making – Repertory Grid- Concept Mapping –Blackboarding, Nominal Group Technique, Delphi method,	9
IV	Knowledge codification	Modes of Knowledge Conversion – Codification Tools and Procedures – Knowledge Developer’s Skill Sets – System Testing and Deployment – Knowledge Testing – Approaches to Logical Testing, User Acceptance Testing – KM System Deployment Issues – User Training – Post implementation.	9
V	Knowledge transfer and sharing	Transfer Methods – Role of the Internet – Knowledge Transfer in e-world – KM System Tools – Neural Network – Association Rules – Classification Trees – Data Mining and Business Intelligence – Decision Making Architecture – Data Management – Knowledge Management Protocols – Managing Knowledge Workers.	9

VI	KM Impact	Dimensions of KM Impact – People, Processes, Products & Organizational Performance Factors influencing impact – universalistic & contingency views Assessment of KM Impact – Qualitative & quantitative measures Identification of appropriate KM solutions, Ethical Legal and Managerial Issues	9
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Text Books:

1. Irma Becerra-Fernandez, Avelino Gonzalez, Rajiv Sabherwal (2004). Knowledge Management Challenges, Solutions, and Technologies . Prentice Hall. ISBN: 0-13-109931-0.
2. Elias M. Awad, Hassan M. Ghaziri (2004). Knowledge Management. Prentice Hall. ISBN: 0-13-034820-1
3. Donald Hislop, Knowledge Management in Organizations, Oxford 2nd Edition. Ian Watson (2002).
4. Shelda Debowski, Knowledge Management, Wiley India Edition.

References:

1. Madanmohan Rao (2004). Knowledge Management Tools and Techniques: Practitioners and Experts Evaluate KM Solutions. Butterworth-Heinemann. ISBN: 0750678186.
2. Stuart Barnes (Ed.) (2002). Knowledge Management Systems Theory and Practice. Thomson Learning.
3. Kimiz Dalkir, Knowledge Management in Theory and Practice, Elsevier, Butterworth Hinemann.
4. Applying Knowledge Management: Techniques for Building Corporate Memories. Morgan Kaufmann. ISBN: 1558607609.

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO8044	Robotics	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test1	Test2	Avg. of two Tests						
ITDLO8044	Robotics	20	20	20	80	--	--	--	100	

Course Objectives: Students will try:

1. Learn the basic concepts of Robots.
2. Learn the concepts of Kinematics of Robotics.
3. Learn the concepts of Motions, velocities and dynamic analysis of force.
4. Learn the concepts of Motion planning.
5. Learn the concepts of Trajectory Planning
6. Learn the concepts of Potential Functions, Visibility Graphs and Coverage Planning

Course Outcomes: Student will be able to:

1. Apply the basic concepts of Robots.
2. Apply and evaluate the concepts of Kinematics of Robotics.
3. Apply the Motions, velocities and dynamic analysis of force.
4. Apply and evaluate Motion planning.
5. Apply the concepts of Trajectory Planning
6. Apply the concepts of Potential Functions, Visibility Graphs and Coverage Planning

Prerequisites: Basic of Electrical Engineering.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Basics of Electrical Engineering	02	--
I	Fundamentals	Robot Classification, Robot Components, Degrees of freedom, Joints, Coordinates, Coordinate	04	CO1

		frames, workspace, applications		
II	Kinematics of Robotics	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation, Denavit-Hatenberg representation of forward kinematics, Inverse kinematic solutions, Case studies	11	CO2
III	Motions, velocities and dynamic analysis of force	Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian. Lagrangian mechanics, Moments of Inertia, Dynamic equations of robots, Transformation of forces and moment between coordinate frames	09	CO3
IV	Trajectory Planning	Trajectory planning, Joint-space trajectory planning, Cartesian-space trajectories	08	CO5
V	Motion Planning	Concept of motion planning, Bug Algorithms – Bug1, Bug2, Tangent Bug	04	CO4
VI	Potential Functions, Visibility Graphs and Coverage Planning	Attractive/Repulsive potential, Gradient descent, wave-front planner, navigation potential functions, Visibility map, Generalized Voronoi diagrams and graphs, Silhouette methods. Cell Decomposition, Localization and Mapping	14	CO6

Text Books:

1. Saeed Benjamin Niku, “Introduction to Robotics – Analysis, Control, Applications”, Wiley India Pvt. Ltd., Second Edition, 2011
2. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, “Principles of Robot Motion –Theory, Algorithms and Implementations”, Prentice-Hall of India

References:

1. Mark W. Spong & M. Vidyasagar, “Robot Dynamics & Control”, Wiley India Pvt. Ltd., Second Edition, 2004
2. John J. Craig, “Introduction to Robotics – Mechanics & Control”, Third Edition, Pearson Education, India, 2009
3. Aaron Martinez & Enrique Fernandez, “Learning ROS for Robotics Programming”, Shroff Publishers, First Edition, 2013.

Assessment:

Internal Assessment for 20 marks:

Consisting of Two Compulsory Class Tests

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDLO8045	Enterprise Resource Planning	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test1	Test2	Avg. of two Tests						
ITDLO8045	Enterprise Resource Planning	20	20	20	80	--	--	--	100	

Course Objectives: Students will try:

1. To learn the basic concepts of ERP.
2. To learn different technologies used in ERP.
3. To learn the concepts of ERP Manufacturing Perspective and ERP Modules.
4. To learn what are the benefits of ERP
5. To study and understand the ERP life cycle.
6. To learn the different tools used in ERP.

Course Outcomes: Student will be able to:

1. Understand the basic concepts of ERP.
2. Identify different technologies used in ERP.
3. Understand and apply the concepts of ERP Manufacturing Perspective and ERP Modules.
4. Discuss the benefits of ERP
5. Understand and implement the ERP life cycle.
6. Apply different tools used in ERP.

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisites	Basics of software.	02	--
I	Introduction to ERP	Enterprise – An Overview Integrated Management Information, Business Modeling, Integrated Data Model	04	CO1

II	ERP Technologies	Business Processing Reengineering(BPR), Data Warehousing, Data Mining, On-line Analytical Processing(OLAP), Supply Chain Management (SCM), Customer Relationship Management(CRM), MIS - Management Information System, DSS - Decision Support System, EIS - Executive Information System	06	CO2
III	ERP Manufacturing Perspective and ERP Modules	MRP - Material Requirement Planning, BOM - Bill Of Material, MRP - Manufacturing Resource Planning, DRP - Distributed Requirement Planning, PDM - Product Data Management. Finance, Plant Maintenance, Quality Management, Materials Management.	10	CO3
IV	Benefits of ERP	Reduction of Lead-Time, On-time Shipment, Reduction in Cycle Time, Improved Resource Utilization, Better Customer Satisfaction, Improved Supplier Performance, Increased Flexibility, Reduced Quality, Costs, Improved Information Accuracy and Design-making Capability	08	CO4
V	ERP Life cycle	Pre-evaluation Screening, Package Evaluation, Project Planning Phase, Gap Analysis, Reengineering, Configuration, Implementation Team Training, Testing, Going Live, End-user Training, Post-implementation (Maintenance mode).	06	CO5
VI	E-Commerce to E-business	E-Business structural transformation, Flexible Business Design, Customer Experience, Create the new techno enterprise, New generation e-business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications. Enterprise resource planning the E-business Backbone Enterprise architecture, planning, ERP usage in Real world, ERP Implementation, Future of ERP applications, memo to CEO ,E-Procurement, E- Governance, Developing the E-Business Design.	16	CO6

		JD Edwards-Enterprise One. Microsoft Dynamics-CRM Module.		
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Text Books:

1. Enterprise Resource Planning - Alexis Leon, Tata McGraw Hill.
2. Enterprise Resource Planning – Diversified by Alexis Leon, TMH.
3. Enterprise Resource Planning - Ravi Shankar & S. Jaiswal , Galgotia.

References:

1. Guide to Planning ERP Application, Annetta Clewto and Dane Franklin, McGraw-Hill, 1997
2. The SAP R/3 Handbook, Jose Antonio, McGraw – Hill
3. E-Business Network Resource planning using SAP R/3 Baan and Peoplesoft : A Practical Roadmap For Success By Dr. Ravi Kalakota

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks.**
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus.**
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)
- Total **four questions** need to be solved.

Course Code	Course Name	Credits
ILO8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to...

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	Planning Projects: Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	5.1 Executing Projects: Planning monitoring and controlling cycle. Information needs and reporting,	8

	<p>engaging with all stakeholders of the projects. Team management, communication and project meetings.</p> <p>5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.</p> <p>5.3 Project Contracting Project procurement management, contracting and outsourcing,</p>	
06	<p>6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects. Multicultural and virtual projects.</p> <p>6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.</p>	6

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to...

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	<p>Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.</p> <p>Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p>Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p>Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	06
02	<p>Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.</p> <p>Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.</p>	06
03	<p>Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p>Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.</p>	09
04	<p>Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)</p>	10

	Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	
05	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	Indian Environment for Entrepreneurship: key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to...

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	<p>Introduction to HR</p> <ul style="list-style-type: none"> • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues. 	5
02	<p>Organizational Behavior (OB)</p> <ul style="list-style-type: none"> • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study 	7
03	<p>Organizational Structure & Design</p> <ul style="list-style-type: none"> • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and 	6

	<p>stress.</p> <ul style="list-style-type: none"> • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. 	
04	<p>Human resource Planning</p> <ul style="list-style-type: none"> • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods 	5
05	<p>Emerging Trends in HR</p> <ul style="list-style-type: none"> • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation. 	6
06	<p>HR & MIS Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries)</p> <p>Strategic HRM Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals</p> <p>Labor Laws & Industrial Relations Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</p>	10

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporat Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to...

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. [Corporate Social Responsibility in India \(2015\) by BidyutChakrabarty, Routledge, New Delhi.](#)

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to...

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
03	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data	08

	j. Preparation of Research Report	
05	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	Outcome of Research 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	04

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to...

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement	07

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8028	Digital Business Management	03

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	<p>Introduction to Digital Business-</p> <p>Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts</p> <p>Difference between physical economy and digital economy,</p> <p>Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)</p> <p>Opportunities and Challenges in Digital Business,</p>	09
2	<p>Overview of E-Commerce</p> <p>E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement</p> <p>B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals</p> <p>Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing</p> <p>EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC</p>	06

3	Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure	06
4	Managing E-Business- Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	E-Business Strategy- E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization- Business plan preparation Case Studies and presentations	08

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:[10.1787/9789264221796-en](https://doi.org/10.1787/9789264221796-en) OECD Publishing

Assessment:

Internal:

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End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to...

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, **T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000

6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four question need to be solved.

Computer Engineering

Sr. No.	Subject Code	Subject Name	Count
1	CSL301	Digital System Lab	1
2	CSL302	Basic Electronics Lab	1
3	CSL303	Data structure Lab	1
4	CSL304	OOPM(Java) Lab	1
5	CSL401	Analysis of Algorithms Lab	1
6	CSL402	Computer Graphics Lab	1
7	CSL403	Processor Architecture Lab	1
8	CSL404	Operating System Lab	1
9	CSL405	Open-Source Tech Lab	1
10	CSL501	Microprocessor Lab	1
11	CSL503	Database & Info. System Lab	1
12	CSL502	Computer Network Lab	1
13	CSC504	Theory of Computer Science	1
14	CSL504	Web Design Lab	1
15	CSL601	Software Engineering Lab	1
16	CSL602	System software Lab	1
17	CSL603	Data Warehousing & Mining Lab	1
18	CSL604	System Security Lab	1
19	CSL701	Digital Signal & Image Processing Lab	1
20	CSL702	Mobile App. Development. Tech. Lab	1
21	CSL703	Artificial Intelligence & Soft Computing Lab	1
22	CSL704	Computational Lab-I	1
23	CSP705	Major Project-I	1
24	CSL801	Human Machine Interaction Lab	1
25	CSL802	Distributed Computing Lab	1
26	CSL803	Cloud Computing Lab	1
27	CSL804	Computational Lab-II	1
28	CSP805	Major Project-II	1
		Total	28

AC – 11.05.2017

Item No. 4.193

UNIVERSITY OF MUMBAI



Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Under

FACULTY OF TECHNOLOGY

Computer Engineering

Second Year with Effect from **AY 2017-18**

Third Year with Effect from **AY 2018-19**

Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**

with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Computer Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brainstorming session, which was attended by more than 85 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Computer Engineering. The Program Educational Objectives finalized for the undergraduate program in Computer Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals.
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems.
3. To equip the Learner with broad education necessary to understand the impact of Computer Science and Engineering in a global and social context.
4. To encourage, motivate and prepare the Learner's for Lifelong- learning.
5. To inculcate professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. Subhash K. Shinde
Chairman, Board of Studies in Computer Engineering,
University of Mumbai, Mumbai.

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2017-18

S. E. Computer Engineering (Semester-III)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
CSC301	Applied Mathematics -III	4+1@	-	-	5	-	-	5
CSC302	Digital Logic Design and Analysis	4	-	-	4	-	-	4
CSC303	Discrete Mathematics	3+1@	-	-	4	-	-	4
CSC304	Electronic Circuits and Communication Fundamentals	4	-	-	4	-	-	4
CSC305	Data Structures	4	-	-	4	-	-	4
CSL301	Digital System Lab	-	2	-	-	1	-	1
CSL302	Basic Electronics Lab	-	2	-	-	1	-	1
CSL303	Data structure Lab	-	2	-	-	1	-	1
CSL304	OOPM(Java) Lab	-	2+2*	-	-	2	-	2
Total		21	10	-	21	5	-	26

@ 1 hour to be taken tutorial as class wise.

*2 hours shown as practical's to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC301	Applied Mathematics -III	20	20	20	80	3	-	-	-	100
CSC302	Digital Logic Design and Analysis	20	20	20	80	3	-	-	-	100
CSC303	Discrete Structures	20	20	20	80	3	-	-	-	100
CSC304	Electronic Circuits and Communication Fundamentals	20	20	20	80	3	-	-	-	100
CSC305	Data Structures	20	20	20	80	3	--	-	-	100
CSL301	Digital System Lab	-	-	-	-	-	25	--	25	50
CSL302	Basic Electronics Lab	-	-	-	-	-	25	25	---	50
CSL303	Data structure Lab	-	-	-	-	-	25	-	25	50
CSL304	OOPM(Java) Lab	-	-	-	-	-	50	--	50	100
Total		100	100	100	400	-	125	25	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2017-18

S. E. Computer Engineering (Semester-IV)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
CSC401	Applied Mathematics- IV	4+1@	-	-	5	-	-	5
CSC402	Analysis of Algorithms	4	-	-	4	-	-	4
CSC403	Computer Organization and Architecture	4	-	-	4	-	-	4
CSC404	Computer Graphics	4	-	-	4	-	-	4
CSC405	Operating System	4	-	-	4	-	-	4
CSL401	Analysis of Algorithms Lab	-	2	-	-	1	-	1
CSL402	Computer Graphics Lab	-	2	-	-	1	-	1
CSL403	Processor Architecture Lab	-	2	-	-	1	-	1
CSL404	Operating System Lab	-	2	-	-	1	-	1
CSL405	Open Source Tech Lab	-	2+2*	-	-	2	-	2
Total		21	12	-	21	6	-	27

@ 1 hour to be taken tutorial as class wise .

*2 hours shown as Practical's to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC401	Applied Mathematics- IV	20	20	20	80	3	-	-	-	100
CSC402	Analysis of Algorithms	20	20	20	80	3	-	-	-	100
CSC403	Computer Organization and Architecture	20	20	20	80	3	-	-	-	100
CSC404	Computer Graphics	20	20	20	80	3	-	-	-	100
CSC405	Operating System	20	20	20	80	3	--	-	-	100
CSL401	Analysis of Algorithms Lab	-	-	-	-	-	25	--	25	50
CSL402	Computer Graphics Lab	-	-	-	-	-	25	--	25	50
CSL403	Processor Architecture Lab	-	-	-	-	-	25	25	-	50
CSL404	Operating System Lab	-	-	-	-	-	25	-	25	50
CSL405	Open Source Tech Lab	-	-	-	-	-	25	---	25	50
Total		100	100	100	400	-	125	25	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2018-19

T. E. Computer Engineering (Semester-V)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
CSC501	Microprocessor	4	-	-	4	-	-	4
CSC502	Database Management System	4	-	-	4	-	-	4
CSC503	Computer Network	4	-	-	4	-	-	4
CSC504	Theory of Computer Science	3+1@	-	-	4	-	-	4
CSDLO 501X	Department Level Optional Course -I	4	-	-	4	-	-	4
CSL501	Microprocessor Lab	-	2	-	-	1	-	1
CSL502	Computer Network Lab	-	2	-	-	1	-	1
CSL503	Database & Info. System Lab	-	2	-	-	1	-	1
CSL504	Web Design Lab	-	2+2*	-	-	2	-	2
CSL505	Business Comm. & Ethics	-	2+2*	-	-	2	-	2
	Total	20	14	-	20	7	-	27

@ 1 hour to be taken tutorial as class wise.

*2 hours shown as Practical's to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme							Total
		Theory					TW	Oral & Pract	
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC501	Microprocessor	20	20	20	80	3	-	-	100
CSC502	Database Management System	20	20	20	80	3	-	-	100
CSC503	Computer Network	20	20	20	80	3	-	-	100
CSC504	Theory of Computer Science	20	20	20	80	3	-	-	100
CSDLO 501X	Department Level Optional Course -I	20	20	20	80	3	--	-	100
CSL501	Microprocessor Lab	-	-	-	-	-	25	25	50
CSL502	Computer Network Lab	-	-	-	-	-	25	25	50
CSL503	Database & Info. System Lab	-	-	-	-	-	25	25	50
CSL504	Web Design Lab	-	-	-	-	-	25	25	50
CSL505	Business Comm. & Ethics	-	-	-	-	-	50	-	50
	Total	100	100	100	400	-	150	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2018-19

T. E. Computer Engineering (Semester-VI)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
CSC601	Software Engineering	4	-	-	4	-	-	4
CSC602	System Programming & Compiler Construction	4	-	-	4	-	-	4
CSC603	Data Warehousing & Mining	4	-	-	4	-	-	4
CSC604	Cryptography & System Security	4	-	-	4	-	-	4
CSDLO 601X	Department Level Optional Course -II	4	-	-	4	-	-	4
CSL601	Software Engineering Lab	-	2	-	-	1	-	1
CSL602	System software Lab	-	2	-	-	1	-	1
CSL603	Data Warehousing & Mining Lab	-	2	-	-	1	-	1
CSL604	System Security Lab	-	2	-	-	1	-	1
CSP605	Mini-Project	-	4	-	-	2	-	2
Total		20	12	-	20	6	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC601	Software Engineering	20	20	20	80	3	-	-	-	100
CSC602	System Programming & Compiler Construction	20	20	20	80	3	-	-	-	100
CSC603	Data Warehousing & Mining	20	20	20	80	3	-	-	-	100
CSC604	Cryptography & System Security	20	20	20	80	3	-	-	-	100
CSDLO 601X	Department Level Optional Course -II	20	20	20	80	3	-	-	-	100
CSL601	Software Engineering Lab	-	-	-	-	-	25	25	--	50
CSL602	System Software Lab	-	-	-	-	-	25	--	25	50
CSL603	Data Warehousing & Mining Lab	-	-	-	-	-	25	--	25	50
CSL604	System Security Lab	-	-	-	-	-	25	---	25	50
CSP605	Mini-Project	-	-	-	-	-	25	---	25	50
Total		100	100	100	400	-	150	25	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2019-20
B. E. Computer Engineering (Semester-VII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
CSC701	Digital Signal & Image Processing	4	-	-	4	-	-	4
CSC702	Mobile Communication & Computing	4	-	-	4	-	-	4
CSC703	Artificial Intelligence & Soft Computing	4	-	-	4	-	-	4
CSDLO 701X	Department Level Optional Course -III	4	-	-	4	-	-	4
ILO701X	Institute Level Optional Course-I	3	-	-	3	-	-	3
CSL701	Digital Signal & Image Processing Lab	-	2	-	-	1	-	1
CSL702	Mobile App. Development. Tech. Lab	-	2	-	-	1	-	1
CSL703	Artificial Intelligence & Soft Computing Lab	-	2	-	-	1	-	1
CSL704	Computational Lab-I	-	2	-	-	1	-	1
CSP705	Major Project-I	-	6	-	-	3	-	3
Total		19	14	-	19	7	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC701	Digital Signal & Image Processing	20	20	20	80	3	-	--	-	100
CSC702	Mobile Communication & Computing	20	20	20	80	3	-	--	-	100
CSC703	Artificial Intelligence & Soft Computing	20	20	20	80	3	-	--	-	100
CSDLO 701X	Department Level Optional Course -III	20	20	20	80	3	-	--	-	100
ILO701X	Institute Level Optional Course-I	20	20	20	80	3	--	--	-	100
CSL701	Digital Signal & Image Processing Lab	-	-	-	-	-	25	--	--	25
CSL702	Mobile App. Development. Tech. Lab	-	-	-	-	-	25	--	25	50
CSL703	Artificial Intelligence & Soft Computing Lab	--	-	-	-	--	25	25	--	50
CSL704	Computational Lab-I						25	--	25	50
CSP705	Major Project-I	-	-	-	-	-	50	-	25	75
Total		100	100	100	400		150	25	75	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2019-20

B. E. Computer Engineering (Semester-VIII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
CSC801	Human Machine Interaction	4	-	-	4	-	-	4
CSC802	Distributed Computing	4	-	-	4	-	-	4
CSDLO 801X	Department Level Optional Course -IV	4	-	-	4	-	-	4
ILO801X	Institute Level Optional Course-II	3	-	-	3	-	-	3
CSL801	Human Machine Interaction Lab	-	2	-	-	1	-	1
CSL802	Distributed Computing Lab	-	2	-	-	1	-	1
CSL803	Cloud Computing Lab	-	4	-	-	2	-	2
CSL804	Computational Lab-II	-	2	-	-	1	-	1
CSP805	Major Project-II	-	12	-	-	6	-	6
	Total	15	22	-	15	11	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in				
		Test 1	Test 2	Avg.						
CSC801	Human Machine Interaction	20	20	20	80	3	-	-	-	100
CSC802	Distributed Computing	20	20	20	80	3	-	-	-	100
CSDLO 801X	Department Level Optional Course -IV	20	20	20	80	3	-	-	-	100
ILO801X	Institute Level Optional Course-II	20	20	20	80	3	-	-	-	100
CSC801	Human Machine Interaction Lab						25	25	-	50
CSL802	Distributed Computing Lab	-	-	-	-	-	25	25	-	50
CSL803	Cloud Computing Lab	-	-	-	-	-	50	--	25	75
CSL804	Computational Lab-II	-	-	-	-	-	50	--	25	75
CSP805	Major Project-II						50		50	100
	Total	100	100	100	400	--	150		100	750

Course Code	Course Name	Credits
CSC301	Applied Mathematics-III	5

Course objectives:

1. To understand the concept of complex variables, C-R equations, harmonic functions and its conjugate and mapping in complex plane.
2. To learn the complex mapping, standard mappings, cross ratios and fixed point.
3. To learn the Laplace Transform, Inverse Laplace Transform of various functions, its application and Z-transform.
4. To understand the concept of Fourier Series, its complex form and enhance the problem solving skill.

Course outcomes: On successful completion of course learner will be able to:

1. Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic function.
2. Plot the image of the curve by a complex transformation from z-plane to w-plane.
3. Expand the periodic function by using Fourier series and complex form of Fourier series.
4. Understand the concept of Laplace transform and inverse Laplace transform of various functions and its application to solve ordinary differential equations.
5. Apply the concept of Z- transformation and its inverse of the given sequence.
6. Apply the concept of Correlation and Regression to the engineering problems.

Module No.	Unit No.	Topics	Hrs.
1.0		Laplace Transform	09
	1.1	Laplace Transform of Standard Functions: Introduction, Definition of Laplace transform, Laplace transform of $1, e^{at} \sin(at), \cos(at), \sinh(at), \cosh(at), t^n \operatorname{erf}(t)$, Heavi-side unit step, dirac-delta function, LT of periodic function.	
	1.2	Properties of Laplace Transform: Linearity, first shifting property, second shifting property, multiplication by t^n , division by t , Laplace Transform of derivatives and integrals, change of scale property. (without proof)	
2.0		Inverse Laplace Transform	08
	2.1	Inverse Laplace Transform by Partial fraction method, Convolution theorem	
	2.2	Application to solve initial and boundary value problem involving	

		ordinary differential equations with one dependent variable and constant coefficients.	
3.0		Fourier Series	10
	3.1	Dirichlet's conditions, Fourier series of periodic functions with period 2π and $2L$, Fourier series for even and odd functions.	
	3.2	Half range sine and cosine Fourier series, Parseval's identities (without proof)	
	3.3	Complex form of Fourier series, Orthogonal and Orthonormal set of functions.	
4.0		Complex Variable & mapping	09
	4.1	Functions of a complex variable, Analytic functions, Cauchy-Riemann equations in Cartesian co-ordinates & Polar co-ordinates.	
	4.2	Harmonic functions, Analytic method and Milne Thomson methods to find $f(z)$, Orthogonal trajectories.	
	4.3	Mapping: Conformal mapping, bilinear transformations, cross ratio, fixed points, bilinear transformation of straight lines and circles.	
5.0		Z-transform	06
	5.1	Z-transform of standard functions such as $Z(a^n)$, $Z(n^p)$.	
	5.2	Properties of Z-transform :Linearity, Change of scale, Shifting property, Multiplication of K, Initial and final value, Convolution theorem (without proof)	
	5.3	Inverse Z transform: Binomial Expansion and Method of Partial fraction	
6.0		Correlation & regression, Curve Fitting	10
	6.1	Scattered diagrams, Karl Pearson's coefficient of correlation, covariance, Spearman's Rank correlation(non-repeated and repeated ranks)	
	6.2	Regression coefficient & Lines of Regression.	
	6.3	Fitting of curves: Least square method. Fitting of the straight line $y = a + bx$, parabolic curve $y = a + bx + cx^2$, & exponential curve $y = ab^x$	
		Total	52

Text Books:

1. Higher Engineering Mathematics by Grewal B. S. 38th edition, Khanna Publication 2005.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
3. A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar &
4. J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.

Reference Books:

1. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
2. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
3. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy Knowledgewar.
4. Laplace Transforms by Murry R. Spieget, Schaun's out line series-McGraw Hill Publication.

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- 1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC302	Digital Logic Design and Analysis	4

Course Objectives:

1. To introduce the fundamental concepts and methods for design of digital circuits and a pre-requisite for computer organization and architecture, microprocessor systems.
2. To provide the concept of designing Combinational and sequential circuits.
3. To provide basic knowledge of how digital building blocks are described in VHDL.

Course Outcomes: At the end of the course student should be able-

1. To understand different number systems and their conversions.
2. To analyze and minimize Boolean expressions.
3. To design and analyze combinational circuits.
4. To design and analyze sequential circuits
5. To understand the basic concepts of VHDL.
6. To study basics of TTL and CMOS Logic families.

Module	Detailed Content	Hours
1	<p>Number Systems and Codes Introduction to number system and conversions: Binary, Octal, Decimal and Hexadecimal number Systems, Binary arithmetic: addition, subtraction (1's and 2's complement), multiplication and division. Octal and Hexadecimal arithmetic: Addition and Subtraction (7's and 8's complement method for octal) and (15's and 16's complement method for Hexadecimal). Codes: Gray Code, BCD Code, Excess-3 code, ASCII Code. Error Detection and Correction: Hamming codes.</p>	8
2	<p>Boolean Algebra and Logic Gates: Theorems and Properties of Boolean Algebra, Boolean functions, Boolean function reduction using Boolean laws, Canonical forms, Standard SOP and POS form. Basic Digital gates: NOT , AND , OR , NAND , NOR , EXOR , EX-NOR, positive and negative logic, K-map method 2 variable, 3 variable, 4 variable, Don't care condition, Quine-McClusky Method, NAND-NOR Realization.</p>	8
3	<p>Combinational Logic Design: Introduction, Half and Full Adder, Half subtractor Full Subtractor, Four Bit Ripple adder, look ahead carry adder, 4 bit adder subtractor, one digit BCD Adder, Multiplexer, Multiplexer tree, Demultiplexer, Demultiplexer tree, Encoders Priority encoder, Decoders, One bit, Two bit , 4-bit Magnitude Comparator, ALU IC 74181.</p>	8

4	<p>Sequential Logic Design: Introduction: SR latch, Concepts of Flip Flops: SR, D, J-K, T, Truth Tables and Excitation Tables of all types, Race around condition, Master Slave J-K Flip Flops, Timing Diagram, Flip-flop conversion, State machines, state diagrams, State table, concept of Moore and Mealy machine.</p> <p>Counters : Design of Asynchronous and Synchronous Counters, Modulus of the Counters, UP- DOWN counter, Shift Registers: SISO, SIPO, PIPO, PISO Bidirectional Shift Register, Universal Shift Register, Ring and twisted ring/Johnson Counter, sequence generator.</p>	15
5	<p>Introduction to VHDL: Introduction: Fundamental building blocks Library, Entity, Architecture, Modeling Styles, Concurrent and sequential statements, simple design examples for combinational circuits and sequential circuits.</p>	6
6	<p>Digital Logic Families: Introduction: Terminologies like Propagation Delay, Power Consumption, Fan in and Fan out , current and voltage parameters, noise margin, with respect to TTL and CMOS Logic and their comparison</p>	3

Text Books:

1. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill.
2. M. Morris Mano, “Digital Logic and computer Design”, PHI.
3. Norman Balabanian, “Digital Logic Design Principles”, Wiley.
4. J. Bhasker. “VHDL Primer”, Pearson Education.

Reference Books:

1. Donald p Leach, Albert Paul Malvino, “Digital principles and Applications”, Tata McGraw
2. Yarbrough John M. , “Digital Logic Applications and Design “, Cengage Learning.
3. Douglas L. Perry, “VHDL Programming by Example”, Tata McGraw Hill.

Internal Assessment: Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC303	Discrete Mathematics	4

Course Objectives:

1. Cultivate clear thinking and creative problem solving.
2. Thoroughly train in the construction and understanding of mathematical proofs. Exercise common mathematical arguments and proof strategies.
3. Thoroughly prepare for the mathematical aspects of other Computer Engineering courses

Course Outcomes: At the end of the course student will be able to

1. Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
2. Ability to reason logically.
3. Ability to understand relations, Diagraph and lattice..
4. Ability to understand use of functions, graphs and their use in programming applications.
5. Understand use of groups and codes in Encoding-Decoding
6. Apply discrete structures into other computing problems such as formal specification, verification, artificial intelligence, cryptography, Data Analysis and Data Mining etc.

Prerequisite: Basic Mathematics

Sr. No.	Module	Detailed Content	Hours
1	Set Theory	<ul style="list-style-type: none"> • Sets, Venn diagrams, Operations on Sets • Laws of set theory, Power set and Products • Partitions of sets, The Principle of Inclusion and Exclusion 	4
2	Logic	<ul style="list-style-type: none"> • Propositions and logical operations, Truth tables • Equivalence, Implications • Laws of logic, Normal Forms • Predicates and Quantifiers • Mathematical Induction 	8
3	Relations and Functions	<ul style="list-style-type: none"> • Relations, Paths and Digraphs • Properties and types of binary relations • Operations on relations, Closures, Warshall's algorithm • Equivalence and partial ordered relations, • Poset, Hasse diagram and Lattice • Functions: Types of functions - Injective, Surjective and Bijective 	12

		<ul style="list-style-type: none"> • Composition of functions , Identity and Inverse function • Pigeon-hole principle 	
4	Counting	<ul style="list-style-type: none"> • Permutations , Combinations • Elements of Probability, Discrete Probability and Conditional Probability • Generating Functions and Recurrence Relations • Recursive Functions • Introduction to Functional Programming 	6
5	Graphs	<ul style="list-style-type: none"> • Definitions, Paths and circuits: Eulerian and Hamiltonian • Types of graphs, Sub Graphs • Isomorphism of graphs 	6
6	Algebraic Structures and Coding Theory	<ul style="list-style-type: none"> • Algebraic structures with one binary operation: semigroup, monoid and group, Abelian group • Isomorphism, Homomorphism and Automorphism • Cyclic groups, Normal subgroups, • Codes and group codes 	8

Text Books:

1. BernadKolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, “Discrete Mathematical Structures”, Pearson Education.
2. C.L.Liu, Elements of Discrete Mathematics, second edition 1985, McGraw-Hill BookCompany. Reprinted 2000.
3. K.H.Rosen, Discrete Mathematics and applications, fifth edition 2003, TataMcGraw Hill publishing Company.
4. D.E. Rydeheard University of Manchester , R.M. Burstall, University of Edinburgh “Computational Category Theory”.

Reference Books:

1. Y N Singh, “Discrete Mathematical Structures”, Wiley-India.
2. J .L.Mott, A.Kandel, T.P .Baker, Discrete Mathematics for Computer Scientists and Mathematicians, second edition 1986, Prentice Hall of India.
3. J. P. Trembley, R. Manohar “Discrete Mathematical Structures with Applications to Computer Science”, TataMcgraw-Hill.
4. Seymour Lipschutz , Marc Lars Lipson,“ Discrete Mathematics” Schaum’sOutline, McGraw Hill Education.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

**** Tutorial lecture can be conducted for each unit and min 10 problems on the covered unit can be given to the students for practice.**

Course Code	Course Name	Credits
CSC304	Electronic Circuits and Communication Fundamentals	4

Course Objectives:

1. To develop the knowledge of semiconductor devices and circuits, and explain their use in communication applications.
2. To inculcate circuit analysis capabilities in students.
3. To gain knowledge in electronic devices and circuits that is useful in real life applications.
4. To understand the fundamental concepts of electronic communication and their use in computer applications.

Course Outcomes: At the end of the course student should be able

1. To understand the use of semiconductor devices in circuits and analyze them.
2. To understand importance of oscillators and power amplifiers in communication system.
3. To understand basic concepts of operational amplifier and their applications.
4. To understand the fundamental concepts of electronic communication
5. To apply knowledge of electronic devices and circuits to communication applications.
6. To study basic concepts of information theory.

Prerequisite: Basic electrical engineering

Module	Detailed Content	Hours
1	Electronic Circuits: Bipolar junction transistor. Input and Output characteristics, Types of Biasing - Fixed bias, self-bias, voltage divider bias, DC load line and significance, CE amplifier using re model, (Analysis based Numericals)	08
2	Power Amplifiers: Introduction, Class A and Class C power amplifier. Oscillators: Introduction, Barkhausen criteria, Colpitts oscillator and Crystal oscillator	04
3	Electronic Circuits : Operational Amplifier and its applications Op-amp – block diagram, parameters and characteristics, applications- Inverting and Non inverting amplifier, Summing Amplifier(Numerical), Difference amplifier, Basic Integrator and Differentiator, Comparator, Zero Crossing Detector (only theory)	10

4	<p>Communication Fundamentals: Analog Communication</p> <p>Block diagram and elements of analog communication systems, Theory of amplitude modulation and types of AM (Numerical)</p> <p>Generation of DSB SC using diode based balanced modulator, Generation of SSB using phase shift method, Introduction of FM, and its mathematical representation, Statement of Carson's Rule Comparison of AM, FM, Block diagram of AM transmitter (HLM and LLM)</p> <p>Block diagram of AM Superheterodyne receiver.</p>	10
5	<p>Pulse Modulation and Multiplexing.</p> <p>Statement of Sampling Theorem, Generation and detection of PAM, PWM, PPM, PCM, DM and ADM.</p> <p>Principle of TDM using PCM and FDM</p>	10
6	<p>Communication Fundamentals: Information theory.</p> <p>Amount of information, average information, information rate, Statement of Shannon's theorem, channel capacity (Numericals)</p>	06

Text Books:

1. Robert Boylestad, 'Electronic Devices and circuit Theory', Prentice Hall.
2. D Roy Choudhury, ' Linear integrated Circuits' New Age International Ltd
3. G. Kennedy, B. Davis, S R M Prasanna, 'Electronic Communication Systems', McGraw Hill, 5th Edition.
4. Wayne Tomasi, 'Electronic Communication Systems (fundamentals through advanced)', Pearson Education, 4th Edition.
5. K. Sam Shanmugam, ' Digital and analog communication systems', Wiley.

Reference Books:

1. Donald Neamen, 'Electronic Circuit Analysis and Design', Tata McGraw Hill, 2nd Edition.
2. K. R. Botkar, 'Integrated Circuits', Khanna Publishers, 9th Edition
3. Simon Haykin, 'Digital Communication systems', Wiley.
4. David Bell, 'Electronic Devices and Circuits', Oxford, 5th Edition.
5. Ramakant A. Gayakwad, 'Op-amp and linear integrated circuits', PHI, 3rd edition.

Internal Assessment

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

2. Question paper will comprise of 6 questions, each carrying 20 marks.
5. The students need to solve total 4 questions.
6. Question No.1 will be compulsory and based on entire syllabus.
7. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC305	Data Structures	4

Course Objectives:

1. To teach various storage mechanisms of data.
2. To design and implement various data structures.
3. To introduce various techniques for representation of the data in the real world.
4. To teach different sorting techniques.
5. To teach different searching techniques.

Course Outcomes:

1. Students will be able to implement various linear and nonlinear data structures.
2. Students will be able to handle operations like insertion, deletion, searching and traversing on various data structures.
3. Students will be able to select appropriate sorting technique for given problem.
4. Students will be able to select appropriate searching technique for given problem.
5. Students will be able to apply the learned concepts in various domains like DBMS and Compiler Construction.
6. Students will be able to choose appropriate data structure for specified problem domain.

Prerequisite: C Programming

Module	Detailed Content	Hours
01	Introduction to Data Structures	03
	Introduction, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of ADT, Arrays.	
02	Stack and Queues	10
	Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack – Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation, Recursion. ADT of Queue, Operations on Queue, Array Implementation of Queue, Circular Queue, Priority Queue, Double Ended Queue, Applications of Queue.	
03	Linked List	10
	Introduction, Representation of Linked List, Linked List v/s Array, Implementation of Linked List, Linked Implementation of Stack and Queue, Circular Linked List, Doubly Linked List, Application – Polynomial Representation and Addition.	
04	Trees	12
	Introduction, Tree Terminologies, Binary Tree, Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Implementation of Binary Search Tree, Applications – Expression Tree, Huffman Encoding. Search Trees – AVL, B Tree, B+ Tree, Splay Tree and Trie.	

05	Graphs	06
	Introduction, Graph Terminologies, Representation, Graph Traversals – Depth First Search (DFS) and Breadth First Search (BFS), Application – Topological Sorting	
06	Sorting and Searching	07
	Introduction, Bubble Sort, Insertion Sort, Merge Sort, Quick Sort. Linear Search, Binary Search, Hashing – Concept, Hash Functions, Collision Handling Techniques.	

Text Books:

1. Data Structures using C, Reema Thareja, Oxford
2. Data Structures using C and C++, Rajesh K Shukla, Wiley - India
3. Data Structures Using C, Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, Pearson
4. Data Structures: A Pseudocode Approach with C, Richard F. Gilberg & Behrouz A., Forouzan, Second Edition, CENGAGE Learning
5. Introduction to Data Structure and Its Applications, JeanPaul Tremblay, P. G. Sorenson

Reference Books:

1. C & Data Structures, Prof. P.S. Deshpande, Prof. O.G. Kakde, DreamTech press.
2. Data Structure Using C, Balagurusamy.
3. Data Structures Using C, ISRD Group, Second Edition, Tata McGraw-Hill.
4. Data Structures, Adapted by: GAV PAI, Schaum's Outlines.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- 1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules

Lab Code	Lab Name	Credits
CSL301	Digital System Lab	1

Lab Outcome:

1. Understand the basics of various digital components.
2. Understand the principles of design of combinational logic and sequential logic circuits using basic components.
3. Recognize the importance of digital systems in computer architecture.
4. Design and simulate the basic digital circuit.

Description

Experiments with Logic Building Blocks using SSI/MSI, Experiments on Design and/or use Minimization tools. Use of VHDL and simulation in Logic Design. Experiment on design using MSI and/or PLDs tools.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	To study and verify the truth table of various logic gates using ICs and realize Boolean expressions using gates
2	To realize basic gates using universal gates
4	To realize binary to gray code and gray code to binary converter.
5	To realize parity generator and detector.
6	To realize arithmetic circuits i) Half adder ii) Full adder iii) Half subtractor iv) Full subtractor
7	To realize 2 bit magnitude comparator.
8	To Study multiplexer IC and realization of full adder using multiplexer IC
9	To Study decoder IC and realization of combinational logic using decoder IC
10	Study of flip-flops using IC's
11	To realize asynchronous 3 bit up counter.
12	To realize shift registers using flip flops
13	To realize basic gates using VHDL

14	To realize 4:1 multiplexer using VHDL
15	To realize 4 bit counter using VHDL

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Oral & Practical exam will be based on the above and CSC302: Digital Logic Design and Analysis syllabus.

Lab Code	Lab Name	Credits
CSL302	Basic Electronics Lab	1

Lab Outcome:

1. Understand the basics of various semiconductor devices, electronic components and instruments.
2. Understand the working of electronic circuits using components
3. Recognize the importance of electronic circuits in electronic communications.
4. Study the fundamental concepts of various modulation methods.

Description

Experiments with semiconductor devices, ICs, electronic component and various measuring instruments. Study experiments on various modulation methods.

Suggested List of Experiments:

Sr. No.	List Experiments
1	Study of electronic components and measuring instruments.
2	Implementation of single stage BJT amplifier.
3	Implementation of oscillators.
4	Implementation of inverting, non inverting amplifier using IC741.
5	Implementation of adder and subtractor using IC 741.
6	Implementation of differentiator using IC741.
7	Implementation of integrator using IC741.
8	Modulation and Demodulation of AM.
9	Study of super heterodyne receiver
10	Modulation and Demodulation PAM.
11	Modulation and Demodulation PWM.
12	Modulation and Demodulation PPM.
13	Modulation and Demodulation PCM.
14	Study of TDM.

15	Study of FDM.
16	SPICE based simulation.

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Oral exam will be based on the above mentioned experiment list and CSC304: Electronic circuits and communication fundamentals syllabus.

Lab Code	Lab Name	Credits
CSL303	Data Structures Lab	1

Lab outcomes:

1. Students will be able to implement various linear and nonlinear data structures.
2. Students will be able to handle operations like insertion, deletion, searching and traversing on various data structures.

Description: Experiments based on creating and manipulating various data structures.

Suggested Experiments:

Students are required to complete at least 12 experiments.

Star (*) marked experiments are compulsory.

- *1) Array Implementation of Stack.
- *2) Conversion of Infix to Postfix.
- 3) Evaluation of Postfix Expression.
- 4) Check continuity of different types of parenthesis using stack.
- 5) Array Implementation of Queue.
- *6) Array Implementation of Circular Queue.
- 7) Array Implementation of Priority Queue
- *8) Implementation of Singly Linked List
- 9) Linked Implementation of Stack
- 10) Linked Implementation of Queue.
- 11) Implementation of Circular Linked List.
- 12) Implementation of Doubly Linked List.
- *13) Implement Binary Search Tree.
- 14) Implementation of Bubble Sort.
- 15) Implementation of Insertion Sort.
- 16) Implementation of Merge Sort.
- *17) Implementation of Quick Sort.
- *18) Implementation of Binary Search.
- 19) Implementation of Hashing.
- 20) Implementation of Depth First Search and Breadth First Search.

Term Work:

1. Term work should consist of at least 10 experiments.
2. Journal must include at least 2 assignments.
3. A case study should be conducted using a Mini Project by taking a good problem definition and complete the following phases.
 - a. Decomposing the problem into modules
 - b. Identifying the best suited data structure for solving the sub problems with justification
 - c. Define algorithms for various identified functions
 - d. Implement the modules
4. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5. Term Work:
Total 25 Marks = (Experiments: 10 mark + Mini Project: 05 mark + Assignments: 05 mark)

Practical and oral examination will be based on the above syllabus.

Lab Code	Lab Name	Credits
CSL304	OOPM (JAVA) Lab	2

Course Objective:

1. To learn the object oriented programming concepts.
2. To study various java programming concept like multithreading, exception handling, packages etc.
3. To explain components of GUI based programming.

Course Outcomes: At the end of the course Student should be able:

1. To apply fundamental programming constructs.
2. To illustrate the concept of packages, classes and objects.
3. To elaborate the concept of strings, arrays and vectors.
4. To implement the concept of inheritance and interfaces.
5. To implement the notion of exception handling and multithreading.
6. To develop GUI based application.

Prerequisite: Structured Programming Approach

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Object Oriented Programming	1.1 OOP Concepts: Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism. 1.2 Features of Java, JVM 1.3 Basic Constructs/Notions: Constants, variables and data types, Operators and Expressions, Revision of Branching and looping	02
2	Classes, Object and Packages	2.1 Class, Object, Method. 2.2 Constructor, Static members and methods 2.3 Passing and returning Objects 2.4 Method Overloading 2.5 Packages in java, creating user defined packages, access specifiers.	05
3	Array, String and Vector	3.1 Arrays, Strings, String Buffer 3.2 Wrapper classes, Vector	04
4	Inheritance and Interface	4.1 Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword, 4.2 Implementing interfaces, extending interfaces	03
5	Exception Handling and Multithreading	5.1 Error vs Exception, try, catch, finally, throw, throws, creating own exception 5.2 Thread lifecycle, Thread class methods, creating threads, Synchronization	04
6	GUI programming in JAVA	6.1 Applet: Applet life cycle, Creating applets, Graphics class methods, Font and Color class, parameter passing.	08

		6.2 Event Handling: Event classes and event listener 6.3 Introduction to AWT: Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Check Box, and Radio Buttons. 6.4 Programming using JDBC: Introduction to JDBC, JDBC Drivers & Architecture.	
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Text books:

1. Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
2. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University Press, 2010

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.
2. DietalandDietal, 'Java: How to Program', 8/e, PHI
3. 'JAVA Programming', Black Book, Dreamtech Press.
4. 'Learn to Master Java programming', Staredusolutions

Digital Material:

1. www.nptelvideos.in
2. www.w3schools.com
3. <http://spoken-tutorial.org>
4. www.staredusolutions.org

Suggested List of Programming Assignments/Laboratory Work:

1.	Program on various ways to accept data through keyboard and unsigned right shift operator.
2.	Program on branching, looping, labelled break and labelled continue.
3.	Program to create class with members and methods, accept and display details for single object.
4.	Program on constructor and constructor overloading
5.	Program on method overloading
6.	Program on passing object as argument and returning object
7.	Program on creating user defined package
8.	Program on 1D array
9.	Program on 2D array

10.	Program on String
11.	Program on StringBuffer
12.	Program on Vector
13.	Program on single and multilevel inheritance (Use super keyword)
14.	Program on abstract class
15.	Program on interface demonstrating concept of multiple inheritance
16.	Program on dynamic method dispatch using base class and interface reference.
17.	Program to demonstrate try, catch, throw, throws and finally.
18.	Program to demonstrate user defined exception
19.	Program on multithreading
20.	Program on concept of synchronization
21.	Program on Applet to demonstrate Graphics, Font and Color class.
22.	Program on passing parameters to applets
23.	Program to create GUI application without event handling using AWT controls
24.	Program to create GUI application with event handling using AWT controls
25.	Mini Project based on content of the syllabus. (Group of 2-3 students)

Term Work:

Students will submit term work in the form of journal that will include:

1. At least 16-18 programs and mini project
2. Two assignments covering whole syllabus

Term Work: 50 Marks (Total Marks) = 20 marks (Experiments) +
20 marks (Mini Project) +
05 marks (Assignments) +
05 marks (Attendance)

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Credits
CSC401	Applied Mathematics-IV	5

Course Objectives: The objectives of this course are to teach the students:

1. Matrix theory, and it's application to find the matrix function. Present methods of computing and using Eigen values and Eigen vectors.
2. Set up and directly evaluate contour integrals Cauchy's integral theorem and formula in basic and extended form. Present Taylor and Laurent's series to find singularities zero's and poles also presents residues theory
3. Theory of probability, Baye's Theorem, Expectation and Moments and it's application.
4. Probability distribution such as Binomial, Poisson and Normal distribution with their properties.
5. Sampling theory and it's application for small and large sample and Optimization techniques.

Course Outcomes:

1. Students in this course will be able to apply the method of solving complex integration, computing residues & evaluate various contour integrals.
2. Demonstrate ability to manipulate matrices and compute Eigen values and Eigen vectors.
3. Apply the concept of probability distribution to the engineering problems.
4. Apply the concept of sampling theory to the engineering problems.
5. Use matrix algebra with its specific rules to solve the system of linear equation, using concept of Eigen value and Eigen vector to the engineering problems.
6. Apply the concept of Linear & Non-Linear Programming Problem to the engineering problems.

Module No.	Unit No.	Topics	Hrs.
1.0		Complex Integration	10
	1.1	Complex Integration – Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula(without proof)	
	1.2	Taylor's and Laurent's series (without proof)	
	1.3	Zeros, poles of f(z), Residues, Cauchy's Residue theorem.	
	1.4	Applications of Residue theorem to evaluate Integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta, \int_{-\infty}^{\infty} f(x)dx$	
2.0		Matrices	10
	2.1	Eigen values and Eigen vectors.	
	2.2	Cayley-Hamilton theorem(without proof)	
	2.3	Similar matrices, diagonalisable matrix.	
	2.4	Derogatory and non-derogatory matrices, Functions of square matrix.	

3.0		Probability	10
	3.1	Baye's Theorem	
	3.2	Random Variables: Discrete & continuous random variables, expectation, Variance, Probability Density Function & Cumulative Density Function.	
	3.3	Moments & Moment generating function.	
	3.4	Probability distribution: Binomial distribution, Poisson & Normal distribution. (For detail study)	
4.0		Sampling Theory (Large Sample test)	06
	4.1	Sampling Distribution, Test of Hypothesis, Level of significance, Critical region, One Tailed and Two Tailed test,	
	4.2	Test of significant for Large Samples:-Means of the samples and test of significant of means of two large samples.	
5.0		Sampling Theory (Small Sample test)	06
	5.1	Test of significant for small samples:- Students t- distribution for dependent and independent samples	
	5.2	Chi square test:- Test of goodness of fit and independence of attributes,Contingency table.	
6.0		Mathematical Programming	10
	6.1	Types of solution, Standard and Canonical form of LPP, Basic and feasible solutions, simplex method.	
	6.2	Artificial variables, Big –M method (method of penalty).	
	6.3	Duality and Dual simplex method.	
	6.4	Non Linear Programming Problems with equality constrains and inequality Constrains (two or three variables with one constrains) (No formulation, No Graphical method).	
		Total	52

Text Books:

1. Higher Engineering Mathematics by Grewal B. S. 38th edition, Khanna Publication 2005.
2. Operation Research by Hira & Gupta,S Chand.
3. A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar &
4. J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.
5. Probability and Statistics for Engineering, Dr. J Ravichandran, Wiley-India.

Reference Books:

1. Probability & Statistics with reliability by Kishor s. Trivedi, Wiley India.
2. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
3. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
4. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
5. Operations Research by S.D. Sharma Kedar Nath, Ram Nath & Co. Meerat.
6. Engineering optimization (Theory and Practice) by Singiresu S.Rao, New Age International publication.

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Credits
CSC402	Analysis of Algorithms	4

Course Objectives:

4. To provide mathematical approach for Analysis of Algorithms
5. To solve problems using various strategies
6. To analyse strategies for solving problems not solvable in polynomial time.

Course Outcomes: At the end of the course student will be able to

1. Analyze the running time and space complexity of algorithms.
2. Describe, apply and analyze the complexity of divide and conquer strategy.
3. Describe, apply and analyze the complexity of greedy strategy.
4. Describe, apply and analyze the complexity of dynamic programming strategy.
5. Explain and apply backtracking, branch and bound and string matching techniques to deal with some hard problems.
6. Describe the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP-Complete.

Prerequisites: Students should be familiar with concepts of Data structure and discrete structures.

Module	Detailed Content	Hours
1	<p>Introduction to analysis of algorithm Performance analysis , space and time complexity Growth of function – Big –Oh ,Omega , Theta notation Mathematical background for algorithm analysis, Analysis of selection sort , insertion sort.</p> <p>Recurrences: -The substitution method -Recursion tree method -Master method</p> <p>Divide and Conquer Approach: General method Analysis of Merge sort, Analysis of Quick sort, Analysis of Binary search, Finding minimum and maximum algorithm and analysis, Strassen’s matrix multiplication</p>	12
2	<p>Dynamic Programming Approach: General Method Multistage graphs single source shortest path all pair shortest path Assembly-line scheduling 0/1 knapsack Travelling salesman problem Longest common subsequence</p>	08
3	<p>Greedy Method Approach:</p>	06

	General Method Single source shortest path Knapsack problem Job sequencing with deadlines Minimum cost spanning trees-Kruskal and prim's algorithm Optimal storage on tapes	
4	Backtracking and Branch-and-bound: General Method 8 queen problem(N-queen problem) Sum of subsets Graph coloring 15 puzzle problem, Travelling salesman problem.	08
5	String Matching Algorithms: The naïve string matching Algorithms The Rabin Karp algorithm String matching with finite automata The knuth-Morris-Pratt algorithm	06
6	Non-deterministic polynomial algorithms: Polynomial time, Polynomial time verification NP Completeness and reducibility NP Completeness proofs Vertex Cover Problems Clique Problems	08

Text Books:

1. T.H.coreman , C.E. Leiserson,R.L. Rivest, and C. Stein, "Introduction to algorithms", 2nd edition , PHI publication 2005.
2. Ellis horowitz , Sartaj Sahni , S. Rajsekar. "Fundamentals of computer algorithms" University Press

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw- Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.
3. John Kleinberg, Eva Tardos, "Algorithm Design", Pearson.
4. Michael T. Goodrich, Roberto Tamassia, "Algorithm Design", Wiley Publication.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules..

Course Code	Course Name	Credit
CSC403	Computer Organization and Architecture	4

Course Objectives:

1. To have a thorough understanding of the basic structure and operation of a digital computer.
2. To discuss in detail the operation of the arithmetic unit including the algorithms & implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
3. To study the different ways of communicating with I/O devices and standard I/O interfaces.
4. To study the hierarchical memory system including cache memories and virtual memory.

Course Outcomes: At the end of the course student should be able-

1. To describe basic structure of the computer system.
2. To demonstrate the arithmetic algorithms for solving ALU operations.
3. To describe instruction level parallelism and hazards in typical processor pipelines.
4. To describe superscalar architectures, multi-core architecture and their advantages
5. To demonstrate the memory mapping techniques.
6. To Identify various types of buses, interrupts and I/O operations in a computer system

Prerequisite: Digital Logic Design and Application

Sr. No.	Module	Detailed Content	Hours
1	<u>Introduction</u>	<u>Overview of Computer Architecture & Organization</u> <ul style="list-style-type: none"> • Introduction • Basic organization of computer • Block level description of the functional units. <u>Data Representation and Arithmetic Algorithms:</u> <ul style="list-style-type: none"> • Integer Data computation: Addition, Subtraction. Multiplication: unsigned multiplication, Booth's algorithm. • Division of integers: Restoring and non restoring division • Floating point representation. IEEE 754 floating point number representation. • Floating point arithmetic: Addition, Subtraction, Multiplication, Division 	08
2	<u>Processor Organization and Architecture</u>	<ul style="list-style-type: none"> • Von Neumann model, Harvard Architecture • Register Organization, Instruction formats, addressing modes, instruction cycle. Instruction interpretation and sequencing. • ALU and Shifters • Basic pipelined datapath and control, Data dependences, data hazards, Branch hazards, delayed branches, branch prediction • Performance measures – CPI, speedup, efficiency, throughput and Amdahl's law 	10

3	<u>Control Unit Design</u>	<ul style="list-style-type: none"> • Hardwired control unit design methods: State table, delay element, sequence counter with examples like control unit for multiplication and division • Microprogrammed control Unit: Microinstruction sequencing and execution. Micro operations, Wilkie's microprogrammed Control Unit, Examples on microprograms 	08
4	<u>Memory Organization</u>	<ul style="list-style-type: none"> • Classifications of primary and secondary memories. Types of RAM (SRAM, DRAM, SDRAM, DDR, SSD) and ROM, Characteristics of memory, Memory hierarchy: cost and performance measurement. • Virtual Memory: Concept, Segmentation and Paging, Address translation mechanism. • Interleaved and Associative memory. • Cache memory Concepts, Locality of reference, design problems based on mapping techniques. Cache Coherency, Write Policies 	12
5	<u>I/O Organization and Peripherals</u>	<ul style="list-style-type: none"> • Common I/O device types and characteristics • Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA. • Introduction to buses, Bus arbitration and multiple bus hierarchy • Interrupt types, Interrupts handling 	06
6	<u>Advanced Processor Principles</u>	<ul style="list-style-type: none"> • Introduction to parallel processing, Flynn's Classification • Concepts of superscalar architecture, out-of-order execution, speculative execution, multithreaded processor, VLIW, data flow computing. • Introduction to Multi-core processor architecture 	08

Text Books:

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", Pearson Publication, 10th Edition, 2013
2. John P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1988
3. B. Govindarajulu, "Computer Architecture and Organization: Design Principles and Applications", Second Edition, McGraw-Hill (India),

Reference Books:

1. Andrew S. Tanenbaum "Structured Computer Organization", Pearson, Sixth Edition
2. Morris Mano. "Computer System Architecture" Pearson Publication, 3rd Edition, 2007
3. Kai Hwang, Fayé Alayé Briggs. "Computer architecture and parallel processing", McGraw-Hill
4. P. Pal Chaudhuri. "Computer Organization and Design" Prentice Hall India, 2004
5. Dr. M. Usha, T.S. Shrikant. "Computer System Architecture and Organization" Wiley India, 2014.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC404	Computer Graphics	4

Course Objectives

- 1 To equip students with the fundamental knowledge and basic technical competence in the field of computer graphics.
- 2 To emphasize on implementation aspect of Computer Graphics Algorithms.
- 3 To prepare the student for advance areas like Image Processing or Computer Vision or Virtual Reality and professional avenues in the field of Computer Graphics.

Course Outcomes : At the end of the course , the students should be able to

- 1 Understand the basic concepts of Computer Graphics.
- 2 Demonstrate various algorithms for scan conversion and filling of basic objects and their comparative analysis.
- 3 Apply geometric transformations, viewing and clipping on graphical objects.
- 4 Explore solid model representation techniques and projections.
- 5 Understand visible surface detection techniques and illumination models.

Prerequisite: Knowledge of C Programming, Basic Data Structures and Mathematics.

Module No	Detail Syllabus	Hours
1	<p>Introduction and Overview of Graphics System:</p> <ul style="list-style-type: none"> • Definition and Representative uses of computer graphics, classification of application areas, Overview of coordinate systems ,definition of scan conversion, rasterization and rendering. • Raster scan & random scan displays, Flat Panel displays like LCD and LED , architecture of raster graphics system with display processor, architecture of random scan systems. 	03
2	<p>Output Primitives :</p> <ul style="list-style-type: none"> • Scan conversions of point,line, circle and ellipse : DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle, midpoint algorithm for ellipse drawing (Mathematical derivation for above algorithms is expected) • Aliasing , Antialiasing techniques like Pre and post filtering , super sampling , and pixel phasing). • Filled Area Primitive: Scan line Polygon Fill algorithm, Inside outside tests, Boundary Fill and Flood fill algorithm. 	12
3	<p>Two Dimensional Geometric Transformations</p> <ul style="list-style-type: none"> • Basic transformations : Translation , Scaling , Rotation • Matrix representation and Homogeneous Coordinates • Composite transformation • Other transformations : Reflection and Shear • Raster method for transformation. 	06

4	Two Dimensional Viewing and Clipping <ul style="list-style-type: none"> Viewing transformation pipeline and Window to Viewport coordinate transformation Clipping operations – Point clipping , Line clipping algorithms : Cohen – Sutherland , Midpoint subdivision , Liang – Barsky , Polygon Clipping Algorithms : Sutherland – Hodgeman, Weiler – Atherton. 	08
5	Three Dimensional Object Representations , Geometric Transformations and 3D Viewing <ul style="list-style-type: none"> Boundary Representation and Space partitioning representation: Polygon Surfaces , Bezier Curve , Bezier Surface , B-Spline Curve , Sweep Representation, Constructive Solid Geometry ,Octree, Fractal-Geometry : Fractal Dimension, Koch Curve. 3D Transformations :Translation, Rotation , Scaling and Reflection. Composite transformations :Rotation about an arbitrary axis 3D transformation pipeline Projections – Parallel , Perspective.(Matrix Representation) 3D clipping. 	12
6	Visible Surface Detection <ul style="list-style-type: none"> Classification of Visible Surface Detection algorithm Back Surface detection method Depth Buffer method Depth Sorting method Scan line method Area Subdivision method 	04
7	Illumination Models and Surface Rendering <ul style="list-style-type: none"> Basic Illumination Models : Diffused reflection, Phong Specular reflection Model Halftone and Dithering techniques Polygon Rendering :Constant shading , Gouraud Shading , Phong Shading. 	03

Text Books:

1. “Computer Graphics” C version by Hearn & Baker, 2nd Edition, Pearson
2. “Computer Graphics Principles and Practice in C , 2nd Edition ,James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, Pearson .
3. “Computer Graphics”, by Rajesh K. Maurya, Wiley India Publication.
4. “Computer Graphics “ , by Samit Bhattacharya , Oxford Publication.

Reference Books:

1. “Procedural Elements for Computer Graphics “ by D. Rogers , Tata McGraw-Hill Publications.
2. “Computer Graphics” , by Zhigang Xiang , Roy Plastock , Schaum’s Outlines McGraw-Hill Education
3. “Computer Graphics using OpenGL” , by F.S.Hill , Jr. ,Third edition, Pearson Publications.

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC405	Operating System	4

Course Objectives:

1. To introduce basic concepts and functions of operating systems.
2. To understand the concept of process, thread and resource management.
3. To understand the concepts of process synchronization and deadlock.
4. To understand various Memory, I/O and File management techniques.

Course Outcomes: At the end of the course student should be able to

1. Understand role of Operating System in terms of process, memory, file and I/O management.
2. Apply and analyse the concept of a process, thread, mutual exclusion and deadlock.
3. Evaluate performance of process scheduling algorithms and IPC.
4. Apply and analyse the concepts of memory management techniques.
5. Evaluate the performance of memory allocation and replacement techniques.
6. Apply and analyze different techniques of file and I/O management.

Prerequisite: Computer Organization & Architecture

Sr No	Module	Detailed Content	Hours
1	Operating System Overview	Operating System Objectives and Functions, The Evolution of Operating Systems, OS Design Considerations for Multiprocessor and Multicore architectures, Operating system structures, System Calls, Linux Kernel and Shell.	8 hrs
2	Process Concept and Scheduling	<p>Process: Concept of a Process, Process States, Process Description, Process Control Block, Operations on Processes.</p> <p>Threads: Definition and Types, Concept of Multithreading, Multicore processors and threads.</p> <p>Scheduling: Uniprocessor Scheduling - Types of Scheduling: Preemptive and, Non-preemptive, Scheduling Algorithms: FCFS, SJF, SRTN, Priority based, Round Robin, Multilevel Queue scheduling. Introduction to Thread Scheduling, Multiprocessor Scheduling and Linux Scheduling.</p>	8 hrs

3	Synchronization and Deadlocks	<p>Concurrency: Principles of Concurrency, Inter-Process Communication, Process/Thread Synchronization.</p> <p>Mutual Exclusion: Requirements, Hardware Support, Operating System Support (Semaphores and Mutex), Programming Language Support (Monitors), Classical synchronization problems: Readers/Writers Problem, Producer and Consumer problem.</p> <p>Principles of Deadlock: Conditions and Resource Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker's Algorithm for Single & Multiple Resources, Deadlock Detection and Recovery. Dining Philosophers Problem.</p>	12 hrs
4	Memory Management	<p>Memory Management: Memory Management Requirements, Memory Partitioning: Fixed Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit, Next Fit, Buddy System, Relocation. Paging, Segmentation.</p> <p>Virtual Memory: Hardware and Control Structures, Demand Paging, Structure of Page Tables, Copy on Write, Page Replacement Strategies: FIFO, Optimal, LRU, LFU, Approximation, Counting Based. Allocation of frames, Thrashing.</p>	8 hrs
5	File Management	<p>File Management: Overview, File Organization and Access, File Directories, File Sharing, Secondary Storage Management, Linux Virtual File System.</p>	6 hrs
6	Input /Output Management	<p>I/O Management and Disk Scheduling: I/O Devices, Organization of the I/O Function, Operating System Design Issues, I/O Buffering, Disk Scheduling algorithm: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK. Disk Management, Disk Cache, Linux I/O.</p>	6 hrs

Text Books:

1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8th Edition, 2014, ISBN-10: 0133805913 • ISBN-13: 9780133805918 .
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley & Sons , Inc., 9th Edition, 2016, ISBN 978-81-265-5427-0
3. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rd Edition.
4. D.M Dhamdhere, Operating Systems: A Concept Based Approach, Mc-Graw Hill

Reference Books:

1. Maurice J. Bach, “Design of UNIX Operating System”, PHI
2. Achyut Godbole and Atul Kahate, Operating Systems, Mc Graw Hill Education, 3rd Edition
3. The Linux Kernel Book, Remy Card, Eric Dumas, Frank Mevel, Wiley Publications.

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Lab Code	Lab Name	Credit
CSL401	Analysis of Algorithms Lab	1

Lab outcomes: At the end of the course student will be able to

1. Analyze the complexities of various problems in different domains.
2. Prove the correctness and analyze the running time of the basic algorithms for those classic problems in various domains.
3. Develop the efficient algorithms for the new problem with suitable designing techniques.
4. Implement the algorithms using different strategies.

Prerequisites: Students should be familiar with concepts of Data structure and Discrete structures.

Description:

Minimum 2 experiments should be implemented using any language on each algorithm design strategy (Divide and conquer, dynamic programming, Greedy method, backtracking and branch & bound, string matching).

Suggested Laboratory Experiments:

Sr. No.	Module Name	Suggested Experiment List
1	Introduction to analysis of algorithm Divide and Conquer Approach	Selection sort , insertion sort. Merge sort, Quick sort, Binary search.
2	Dynamic Programming Approach	Multistage graphs, single source shortest path, all pair shortest path, 0/1 knapsack, Travelling salesman problem, Longest common subsequence.
3	Greedy Method Approach	Single source shortest path, Knapsack problem, Job sequencing with deadlines, Minimum cost spanning trees-Kruskal and prim's algorithm, Optimal storage on tapes.
4	Backtracking and Branch-and-bound	8 queen problem (N-queen problem), Sum of subsets, Graph coloring, 15 puzzle problem, Travelling salesman problem.

5	String Matching Algorithms	The naïve string matching Algorithms, The Rabin Karp algorithm, String matching with finite automata, The knuth-Morris-Pratt algorithm.
6	Any two Experiments	This will involve implementation of two algorithms for problems beyond the scope of syllabus. The exact set of algorithms to implement is to be decided by the course instructor.

Text Books:

1. T.H.Coreman , C.E. Leiserson,R.L. Rivest, and C. Stein, “Introduction to algorithms”, 2nd edition , PHI publication 2005.
2. Ellis horowitz , sartaj Sahni , s. Rajsekar. “Fundamentals of computer algorithms” University Press

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, “Algorithms”, Tata McGraw- Hill Edition.
2. S. K. Basu, “Design Methods and Analysis of Algorithm”, PHI.
3. Dana Vrajitoru and William Knight, “Practical Analysis of Algorithms”, Springer 2014th Edition.

Term Work:

Laboratory work must contain implementation of minimum 10 experiments. The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing marks in term work. The 25 marks of the term work should be divided as below:

25 Marks (total marks) = 15 Marks Lab. Experiments + 05 Marks Assignments (based on theory syllabus) + 05 (Attendance: theory + practical)

Oral & Practical Exam will be based on the experiments implemented in the Laboratory.

Lab Code	Lab Title	Credit
CSL402	Computer Graphics Lab	1

Lab Objectives

- 1 To emphasize on implementation aspect of Computer Graphics Algorithm.
- 2 To prepare students for advanced areas like Animation, image processing ,virtual reality etc

Lab Outcomes : At the end of the course , the students should be able to

- 1 Explore the working principle, utility of various input/ output devices and graphical tools.
- 2 Implement various output and filled area primitive algorithms using C/ OpenGL
- 3 Apply transformation and clipping algorithms on graphical objects.
- 4 Implementation of curve and fractal generation.
- 5 Develop a Graphical application based on learned concept.

Content:

Scan conversions: lines, circles, ellipses. Filling algorithms, clipping algorithms. 2D and 3D transformation. Curves. Visible surface determination. Simple animations Application of these through exercises in C/C++/ Open GL

List of Desirable Experiments:

1. Study and apply basic opengl functions to draw basic primitives. (*)
2. Implement sierpinsky gasket using openGL.
3. Implement DDA Line Drawing algorithms and Bresenham algorithm(*)
4. Implement midpoint Circle algorithm(*)
5. Implement midpoint Ellipse algorithm
6. Implement Area Filling Algorithm: Boundary Fill, Flood Fill ,Scan line Polygon Fill (*)
7. Implement Curve : Bezier for n control points , B Spline (Uniform) (atleast one)(*)
8. Implement Fractal (Koch Curve)
9. Character Generation : Bit Map method and Stroke Method
10. Implement 2D Transformations: Translation, Scaling, Rotation, Reflection, Shear.(*)
11. Implement Line Clipping Algorithm: Cohen Sutherland / Liang Barsky.(*)
12. Implement polygon clipping algorithm(atleast one)
13. Program to represent a 3D object using polygon surfaces and then perform 3D transformation.
14. Program to perform projection of a 3D object on Projection Plane : Parallel and Perspective.(*)

Term Work

1. Term work should consist of at least 12 experiments. (*)→ Practical to be covered necessarily
2. Journal must include at least 2 assignments.
3. Mini Project to perform using C / OpenGL.

Possible Ideas:

- a. Animation using multiple object
- b. Graphics editor with following features :

*Draw basic geometrical entities; apply geometrical transformations, Area filling, Clipping against Clip window, displaying the text, displaying bar / line graphs , pie charts etc.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

Term Work: 25 Marks (Total) = 10 Marks (Experiments)

+ 5 Marks (Mini Project)

+ 5 Marks (Assignments)

+ 5 Marks (Theory + Practical Attendance).

Oral & Practical exam will be based on the above content and CSC404: Computer Graphics.

Lab Code	Lab Name	Credit
CSL403	Processor Architecture Lab	1

Lab Objectives:

1. To implement the operation of the arithmetic unit including the algorithms & implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
2. To study the different ways of communicating with I/O devices and standard I/O interfaces.
3. To design memory subsystem including cache memory
4. To have through understanding of various computer buses

Lab Outcomes: At the end of the course student should be

1. Assemble personal computer
2. Design the basic building blocks of a computer: arithmetic-logic unit, registers, central processing unit, and memory.
3. Implement various algorithms like Booth's algorithm for arithmetic operations
4. Describe various I/O buses with merits and demerits.

Prerequisite: Digital Logic Design and Applications

Content:

Sr. No.	Module	Detailed Content
1	Overview of Computer Architecture & Organization	<ul style="list-style-type: none"> • Computer Anatomy- Memory, Ports, Motherboard and add-on cards • Dismantling and assembling PC
2	Programs on Data Representation and Arithmetic	<ul style="list-style-type: none"> • Ripple carry adder, Carry look-ahead adder, registers, Multiplication • Booths Algorithm, Restoring and Non restoring Division
3	Processor Organization and Architecture	<ul style="list-style-type: none"> • ALU Design, CPU Design • Case Study on multi-core Processors
4	Memory Organization	<ul style="list-style-type: none"> • Memory design, Cache Memory design
5	I/O Organization and Interrupts	<ul style="list-style-type: none"> • Case study on buses like ISA, PCI, USB etc • Interrupt handling using C/Java Programming

Digital Material:

- **Manual to use the simulator for computer organization and architecture.** Developed by the Department of CSE, IIT kharagpur (<http://cse10-iitkgp.virtual-labs.ac.in/>)

Books:

1. William Stallings, “Computer Organization and Architecture: Designing for Performance”, Pearson Publication, 10th Edition, 2013
2. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, McGraw-Hill (India),
6. Andrew S. Tanenbaum “Structured Computer Organization”, Pearson, Sixth Edition
7. Morris Mano. “Computer System Architecture” Pearson Publication, 3rd Edition, 2007
8. Kai Hwang, Fayé Alayé Briggs. “Computer architecture and parallel processing”, McGraw-Hill
9. P. Pal Chaudhuri. “Computer Organization and Design” Prentice Hall India, 2004
10. Dr. M. Usha, T.S. Shrikant. “Computer System Architecture and Organization” Wiley India, 2014.

Term Work

Term work should consist of at least 10-12 experiments and 3-4 assignments based on above content and CSC403: Computer Organization and Architecture

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

Term Work: 25 Marks (Total) = 10 Marks (Experiments)
+ 5 Marks (Mini Project)
+ 5 Marks (Assignments)
+ 5 Marks (Theory + Practical Attendance).

Oral exam will be based on the above content and CSC403: Computer Organization and Architecture.

Lab Code	Lab Name	Credit
CSL404	Operating System Lab	1

Lab Outcome:

1. Understand basic operating system commands.
2. Understand and explore various system calls.
3. Write shell scripts and shell commands using kernel APIs.
4. Implement and analyze different process scheduling algorithms
5. Implement and analyze different memory management algorithms.
6. Evaluate process management techniques and deadlock handling using simulator.

Descriptions:

Sr. No	Contents
1	Explore the internal commands of linux like ls, chdir, mkdir, chown, chmod, chgrp, ps etc
2	Write shell scripts to do the following: <ul style="list-style-type: none"> ➤ Display top 10 processes in descending order ➤ Display processes with highest memory usage. ➤ Display current logged in user and logname. ➤ Display current shell, home directory, operating system type, current path setting, current working directory. ➤ Display OS version, release number, kernel version. ➤ Illustrate the use of sort, grep, awk, etc.
3	a) Create a child process in Linux using the fork system call. From the child process obtain the process ID of both child and parent by using getpid and getppid system call. Explore wait and waitpid before termination of process. b) Explore the following system calls: open, read, write, close, getpid, setpid, getuid, getgid, getegid, geteuid.
4	Implement basic commands of linux like ls, cp, mv and others using kernel APIs.
5	Write a program to implement any two CPU scheduling algorithms like FCFS, SJF, Round Robin etc.
6	Write a program to implement dynamic partitioning placement algorithms i.e Best Fit, First-Fit, Worst-Fit etc
7	Write a program to implement various page replacement policies.
8	Using the CPU-OS simulator analyze and synthesize the following: <ol style="list-style-type: none"> a. Process Scheduling algorithms. b. Thread creation and synchronization. c. Deadlock prevention and avoidance.

Digital Materials:

1. Download the CPU-OS simulator along with related tutorials from <http://www.teach-sim.com>
2. <http://www.teach-sim.com>

Books:

1. Linux Kernel Book, by Remy Card, Eric Dumas, Frank Mevel, Wiley India
2. Unix Concepts and Applications, Sumitabha Das, McGraw Hill.

Term Work:

- Term work should consist of at least 12 experiments and 2-3 assignments on above content.
- The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
- Term Work: 25 Marks (Total) = 10 Marks (Experiments)
+ 5 Marks (Mini Project)
+ 5 Marks (Assignments)
+ 5 Marks (Theory + Practical Attendance).

Oral & Practical exam will be based on the above content and CSC405: Operating system syllabus.

Lab Code	Lab Name	Credit
CSL405	Open Source Technology Lab	2

Course Outcomes:

1. To understand basic concepts in python and perl.
2. To explore contents of files, directories and text processing with python
3. To develop program for data structure using built in functions in python.
4. To explore django web framework for developing python based web application.
5. To understand file handling and database handling using perl.
6. To explore basics of two way communication between client and server using python and perl

Prerequisites: Knowledge of some programming language like C, Java

Content:

Sr. No	Module Name	Detailed Content
1	Python basics	Data types in python ,Operators in python, Input and Output, Control statement, Arrays in python, String and Character in python, Functions, List and Tuples, Dictionaries Exception, Introduction to OOP, Classes , Objects , Interfaces, Inheritance
2	Advanced Python	Files in Python, Directories, Building Modules, Packages, Text Processing, Regular expression in python.
3	Data Structure in Python	Link List, Stack, Queues, Dequeues
4	Python Integration Primer	Graphical User interface ,Networking in Python , Python database connectivity, Introduction to Django
5	Basics of Perl	Perl Overview, Variables, Control Statements, Subroutines, Objects, Packages and Modules
6	Perl advanced	Working with Files, Data manipulation, Database Systems, Networking

Text Books

1. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
2. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
3. Perl: The Complete Reference. Second Edition. Martin C. Brown, McGraw-Hill
4. Introduction to computing and problem solving using python , E Balagurusamy, McGraw Hill Education

Reference Book

1. Perl Black Book, 2nd Edition: Steven Holzner, Dreamtech Press
2. Learn Python the Hard Way: (3rd Edition) (Zed Shaw's Hard Way Series)
3. Python Projects , Laura Cassell, Alan Gauld, wrox publication

Digital Material:

1. "The Python Tutorial", <http://docs.python.org/release/3.0.1/tutorial/>
2. Beginning Perl, <https://www.perl.org/books/beginning-perl/>
3. <http://spoken-tutorial.org>
4. www.staredusolutions.org

Suggested experiments using Python:

1. Exploring basics of python like data types (strings, list, array, dictionaries, set, tuples) and control statements.
2. Creating functions, classes and objects using python. Demonstrate exception handling and inheritance.
3. Exploring Files and directories
 - a. Python program to append data to existing file and then display the entire file
 - b. Python program to count number of lines, words and characters in a file.
 - c. Python program to display file available in current directory
4. Creating GUI with python containing widgets such as labels, textbox, radio, checkboxes and custom dialog boxes.
5. Menu driven program for data structure using built in function for link list, stack and queues.
6. Program to demonstrate CRUD(**create, read, update and delete**) operations on database (SQLite/MySQL) using python.
7. Creation of simple socket for basic information exchange between server and client.
8. Creating web application using Django web framework to demonstrate functionality of user login and registration (also validating user detail using regular expression).

Suggested experiments using Perl:

10. Exploring various data type , loops and conditional statement in perl. And Creating functions, packages and modules in perl.
11. Program to demonstrate use of objects and classes in perl.
12. Program to demonstrate file handling, data manipulation and use of regular expression for text processing in perl
13. Program to send email and read content of URL.

Term Work:

Students will submit term work in the form of journal that will include:

1. At least 12-14 programs.
2. One mini-project in a group 2-3 student.
3. Two assignments covering whole syllabus.

Term Work (25) = 15 marks (Experiments & Assignments)

+ 10 marks (Mini Project)

+ 05 marks (Attendance)

Practical and oral examination will be based on suggested practical list and entire syllabus.

AC – 5th May, 2018

Item No. – 4.51

UNIVERSITY OF MUMBAI



Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Under

FACULTY OF TECHNOLOGY

Computer Engineering

Second Year with Effect from **AY 2017-18**

Third Year with Effect from **AY 2018-19**

Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**

with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Dean (I/ c), Faculty of Science and Technology,
Member - Academic Council,
University of Mumbai, Mumbai

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Computer Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brainstorming session, which was attended by more than 85 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Computer Engineering. The Program Educational Objectives finalized for the undergraduate program in Computer Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals.
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems.
3. To equip the Learner with broad education necessary to understand the impact of Computer Science and Engineering in a global and social context.
4. To encourage, motivate and prepare the Learner's for Lifelong- learning.
5. To inculcate professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Dr. Subhash K. Shinde

**Chairman, Board of Studies in Computer Engineering,
University of Mumbai, Mumbai.**

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2018-19

T. E. Computer Engineering (Semester-V)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
CSC501	Microprocessor	4	-	-	4	-	-	4
CSC502	Database Management System	4	-	-	4	-	-	4
CSC503	Computer Network	4	-	-	4	-	-	4
CSC504	Theory of Computer Science	3+1@	-	-	4	-	-	4
CSDLO 501X	Department Level Optional Course -I	4	-	-	4	-	-	4
CSL501	Microprocessor Lab	-	2	-	-	1	-	1
CSL502	Computer Network Lab	-	2	-	-	1	-	1
CSL503	Database & Info. System Lab	-	2	-	-	1	-	1
CSL504	Web Design Lab	-	2+2*	-	-	2	-	2
CSL505	Business Comm. & Ethics	-	2+2*	-	-	2	-	2
	Total	20	14	-	20	7	-	27

@ 1 hour to be taken tutorial as class wise.

*2 hours shown as Practical's to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme							Total
		Theory					TW	Oral & Pract	
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC501	Microprocessor	20	20	20	80	3	-	-	100
CSC502	Database Management System	20	20	20	80	3	-	-	100
CSC503	Computer Network	20	20	20	80	3	-	-	100
CSC504	Theory of Computer Science	20	20	20	80	3	-	-	100
CSDLO 501X	Department Level Optional Course -I	20	20	20	80	3	--	-	100
CSL501	Microprocessor Lab	-	-	-	-	-	25	25	50
CSL502	Computer Network Lab	-	-	-	-	-	25	25	50
CSL503	Database & Info. System Lab	-	-	-	-	-	25	25	50
CSL504	Web Design Lab	-	-	-	-	-	25	25	50
CSL505	Business Comm. & Ethics	-	-	-	-	-	50	-	50
	Total	100	100	100	400	-	150	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2018-19

T. E. Computer Engineering (Semester-VI)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
CSC601	Software Engineering	4	-	-	4	-	-	4
CSC602	System Programming & Compiler Construction	4	-	-	4	-	-	4
CSC603	Data Warehousing & Mining	4	-	-	4	-	-	4
CSC604	Cryptography & System Security	4	-	-	4	-	-	4
CSDLO 601X	Department Level Optional Course -II	4	-	-	4	-	-	4
CSL601	Software Engineering Lab	-	2	-	-	1	-	1
CSL602	System software Lab	-	2	-	-	1	-	1
CSL603	Data Warehousing & Mining Lab	-	2	-	-	1	-	1
CSL604	System Security Lab	-	2	-	-	1	-	1
CSP605	Mini-Project	-	4	-	-	2	-	2
	Total	20	12	-	20	6	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC601	Software Engineering	20	20	20	80	3	-	-	-	100
CSC602	System Programming & Compiler Construction	20	20	20	80	3	-	-	-	100
CSC603	Data Warehousing & Mining	20	20	20	80	3	-	-	-	100
CSC604	Cryptography & System Security	20	20	20	80	3	-	-	-	100
CSDLO 601X	Department Level Optional Course -II	20	20	20	80	3	-	-	-	100
CSL601	Software Engineering Lab	-	-	-	-	-	25	25	--	50
CSL602	System Software Lab	-	-	-	-	-	25	--	25	50
CSL603	Data Warehousing & Mining Lab	-	-	-	-	-	25	--	25	50
CSL604	System Security Lab	-	-	-	-	-	25	---	25	50
CSP605	Mini-Project	-	-	-	-	-	25	---	25	50
	Total	100	100	100	400	-	125	25	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2019-20
B. E. Computer Engineering (Semester-VII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
CSC701	Digital Signal & Image Processing	4	-	-	4	-	-	4
CSC702	Mobile Communication & Computing	4	-	-	4	-	-	4
CSC703	Artificial Intelligence & Soft Computing	4	-	-	4	-	-	4
CSDLO 701X	Department Level Optional Course -III	4	-	-	4	-	-	4
ILO701X	Institute Level Optional Course-I	3	-	-	3	-	-	3
CSL701	Digital Signal & Image Processing Lab	-	2	-	-	1	-	1
CSL702	Mobile App. Development. Tech. Lab	-	2	-	-	1	-	1
CSL703	Artificial Intelligence & Soft Computing Lab	-	2	-	-	1	-	1
CSL704	Computational Lab-I	-	2	-	-	1	-	1
CSP705	Major Project-I	-	6	-	-	3	-	3
	Total	19	14	-	19	7	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC701	Digital Signal & Image Processing	20	20	20	80	3	-	--	-	100
CSC702	Mobile Communication & Computing	20	20	20	80	3	-	--	-	100
CSC703	Artificial Intelligence & Soft Computing	20	20	20	80	3	-	--	-	100
CSDLO 701X	Department Level Optional Course -III	20	20	20	80	3	-	--	-	100
ILO701X	Institute Level Optional Course-I	20	20	20	80	3	--	--	-	100
CSL701	Digital Signal & Image Processing Lab	-	-	-	-	-	25	--	--	25
CSL702	Mobile App. Development. Tech. Lab	-	-	-	-	-	25	--	25	50
CSL703	Artificial Intelligence & Soft Computing Lab	--	-	-	-	--	25	25	--	50
CSL704	Computational Lab-I						25	--	25	50
CSP705	Major Project-I	-	-	-	-	-	50	-	25	75
	Total	100	100	100	400		150	25	75	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2019-20

B. E. Computer Engineering (Semester-VIII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/Pract	Tut	Total
CSC801	Human Machine Interaction	4	-	-	4	-	-	4
CSC802	Distributed Computing	4	-	-	4	-	-	4
CSDLO 801X	Department Level Optional Course -IV	4	-	-	4	-	-	4
ILO801X	Institute Level Optional Course-II	3	-	-	3	-	-	3
CSL801	Human Machine Interaction Lab	-	2	-	-	1	-	1
CSL802	Distributed Computing Lab	-	2	-	-	1	-	1
CSL803	Cloud Computing Lab	-	4	-	-	2	-	2
CSL804	Computational Lab-II	-	2	-	-	1	-	1
CSP805	Major Project-II	-	12	-	-	6	-	6
	Total	15	22	-	15	11	-	26

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in				
		Test 1	Test 2	Avg.						
CSC801	Human Machine Interaction	20	20	20	80	3	-	-	-	100
CSC802	Distributed Computing	20	20	20	80	3	-	-	-	100
CSDLO 801X	Department Level Optional Course -IV	20	20	20	80	3	-	-	-	100
ILO801X	Institute Level Optional Course-II	20	20	20	80	3	-	-	-	100
CSC801	Human Machine Interaction Lab						25	25	-	50
CSL802	Distributed Computing Lab	-	-	-	-	-	25	25	-	50
CSL803	Cloud Computing Lab	-	-	-	-	-	50	--	25	75
CSL804	Computational Lab-II	-	-	-	-	-	50	--	25	75
CSP805	Major Project-II						50	--	50	100
	Total	80	80	80	320	--	200	50	100	750

Course Code	Course Name	Credits
CSC501	Microprocessor	4

Course objectives:

1. To equip students with the fundamental knowledge and basic technical competence in the field of Microprocessors.
2. To emphasize on instruction set and logic to build assembly language programs.
3. To prepare students for higher processor architectures and Embedded systems

Course outcomes: On successful completion of course learner will be able to:

1. Describe architecture of x86 processors.
2. Interpret the instructions of 8086 and write assembly and Mixed language programs.
3. Explain the concept of interrupts
4. Identify the specifications of peripheral chip
5. Design 8086 based system using memory and peripheral chips
6. Appraise the architecture of advanced processors

Prerequisite: Digital Electronics and Logic Design

Module No.	Unit No.	Topics	Hrs.
1.0		The Intel Microprocessors 8086/8088 Architecture	10
	1.1	<ul style="list-style-type: none"> • 8086/8088 CPU Architecture, Programmer's Model • Functional Pin Diagram • Memory Segmentation • Banking in 8086 • Demultiplexing of Address/Data bus • Study of 8284 Clock Generator • Study of 8288 Bus Controller • Functioning of 8086 in Minimum mode and Maximum mode • Timing diagrams for Read and Write operations in minimum and maximum mode 	
2.0		Instruction Set and Programming	12
	2.1	<ul style="list-style-type: none"> • Addressing Modes • Instruction set – Data Transfer Instructions, String Instructions, Logical Instructions, Arithmetic Instructions, Transfer of Control Instructions, Processor Control Instructions • Assembler Directives and Assembly Language Programming, Macros, Procedures • Mixed Language Programming with C Language and Assembly Language. • Programming based on DOS and BIOS Interrupts (INT 21H, INT 10H) 	
3.0		8086 Interrupts	6
	3.1	<ul style="list-style-type: none"> • Types of interrupts • Interrupt Service Routine • Interrupt Vector Table • Servicing of Interrupts by 8086 microprocessor • Programmable Interrupt Controller 8259 – Block Diagram, Interfacing the 8259 in single and cascaded mode, Operating modes, programs for 8259 using ICWs and OCWs 	

4.0		Peripherals and their interfacing with 8086	12
	4.1	Memory Interfacing - RAM and ROM Decoding Techniques – Partial and Absolute	
	4.2	8255-PPI – Block diagram, Functional PIN Diagram, CWR, operating modes, interfacing with 8086.	
	4.3	8253 PIT - Block diagram, Functional PIN Diagram, CWR, operating modes, interfacing with 8086.	
	4.4	8257-DMAC – Block diagram, Functional PIN Diagram, Register organization, DMA operations and transfer modes	
5.0		Intel 80386DX Processor	6
	5.1	<ul style="list-style-type: none"> • Architecture of 80386 microprocessor • 80386 registers – General purpose Registers, EFLAGS and Control registers • Real mode, Protected mode, virtual 8086 mode • 80386 memory management in Protected Mode – Descriptors and selectors, descriptor tables, the memory paging mechanism 	
6.0		Pentium Processor	6
	6.1	Pentium Architecture Superscalar Operation, Integer & Floating Point Pipeline Stages, Branch Prediction Logic, Cache Organisation and MESI Model	
		Total	52

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
1. The students need to solve total 4 questions.
2. Question No.1 will be compulsory and based on entire syllabus.
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. 8086/8088 family: Design Programming and Interfacing: John Uffenbeck , PHI.
2. Advanced Microprocessors and Peripherals: K M Bhurchandani, A k Ray McGraw Hill
3. The 80386DX Microprocessor: hardware, Software and Interfacing, Walter A Triebel, Prentice Hall
4. Pentium Processor System Architecture: Tom Shanley & Don Anderson, Addison-Wesley.

Reference Books:

1. Intel Microprocessors: Barry B. Brey, 8th Edition, Pearson Education India
2. Microprocessor and Interfacing: Douglas Hall, Tata McGraw Hill.
3. Advanced MS DOS Programming – Ray Duncan BPB
4. Intel 80386 Datasheets
5. IBM PC Assembly language and Programming: Peter Abel, 5th edition, PHI
6. The Pentium Microprocessor, James Antonakons, Pearson Education

Course Code	Course Name	Credits
CSC502	Database Management System	4

Course objectives:

1. Learn and practice data modelling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Apply normalization techniques to normalize the database
4. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

Course outcomes: On successful completion of course learner will be able to:

1. Understand the fundamentals of a database systems
2. Design and draw ER and EER diagram for the real life problem.
3. Convert conceptual model to relational model and formulate relational algebra queries.
4. Design and querying database using SQL.
5. Analyze and apply concepts of normalization to relational database design.
6. Understand the concept of transaction, concurrency and recovery.

Prerequisite:

Basic knowledge of Data structure.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction Database Concepts:	4
	1.1	<ul style="list-style-type: none"> ● Introduction, Characteristics of databases ● File system v/s Database system ● Users of Database system 	
	1.2	<ul style="list-style-type: none"> ● Data Independence ● DBMS system architecture ● Database Administrator 	
2.0		Entity–Relationship Data Model	8
	2.1	<ul style="list-style-type: none"> ● The Entity-Relationship (ER) Model: Entity types : Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints : Cardinality and Participation, Extended Entity-Relationship (EER) Model : Generalization, Specialization and Aggregation 	
3.0		Relational Model and relational Algebra	8
	3.1	<ul style="list-style-type: none"> ● Introduction to the Relational Model, relational schema and concept of keys. ● Mapping the ER and EER Model to the Relational Model 	
	3.2	<ul style="list-style-type: none"> ● Relational Algebra – unary and set operations, Relational Algebra Queries. 	
4.0		Structured Query Language (SQL)	12
	4.1	<ul style="list-style-type: none"> ● Overview of SQL 	

		<ul style="list-style-type: none"> Data Definition Commands, Data Manipulation commands, Data Control commands, Transaction Control Commands. 	
	4.2	<ul style="list-style-type: none"> Set and string operations, aggregate function - group by, having. Views in SQL, joins , Nested and complex queries, Integrity constraints :- key constraints, Domain Constraints, Referential integrity , check constraints 	
	4.3	<ul style="list-style-type: none"> Triggers 	
5.0		Relational–Database Design	8
	5.1	<ul style="list-style-type: none"> Pitfalls in Relational-Database designs , Concept of normalization Function Dependencies , First Normal Form, 2nd , 3rd , BCNF, multi valued dependencies , 4NF. 	
6.0		Transactions Management and Concurrency	12
	6.1	<ul style="list-style-type: none"> Transaction concept, Transaction states, ACID properties Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols. 	
	6.2	<ul style="list-style-type: none"> Recovery System: Failure Classification, Log based recovery, ARIES, Checkpoint, Shadow paging. Deadlock handling 	
		Total	52

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. G. K. Gupta “Database Management Systems”, McGraw – Hill.
2. Korth, Silberchatz, Sudarshan, “Database System Concepts”, 6th Edition, McGraw – Hill
3. Elmasri and Navathe, “Fundamentals of Database Systems”, 5th Edition, Pearson education.
4. Peter Rob and Carlos Coronel, “Database Systems Design, Implementation and Management”, Thomson Learning, 5th Edition.

Reference Books:

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
2. Gillenson, Paulraj Ponniah, “Introduction to Database Management”, Wiley Publication.
3. Sharaman Shah, “Oracle for Professional”, SPD.
4. Raghu Ramkrishnan and Johannes Gehrke, “ Database Management Systems ”, TMH.

Course Code	Course Name	Credits
CSC 503	Computer Network	4

Course objective:

1. To introduce concepts and fundamentals of data communication and computer networks.
2. To explore the inter-working of various layers of OSI.
3. To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4. To assess the strengths and weaknesses of various routing algorithms.
5. To understand the transport layer and various application layer protocols.

Course Outcomes:

On successful completion of course learner will be able to:

1. Demonstrate the concepts of data communication at physical layer and compare ISO - OSI model with TCP/IP model.
2. Demonstrate the knowledge of networking protocols at data link layer.
3. Design the network using IP addressing and subnetting / supernetting schemes.
4. Analyze various routing algorithms and protocols at network layer.
5. Analyze transport layer protocols and congestion control algorithms.
6. Explore protocols at application layer .

Prerequisite: Digital Communication Fundamentals

Module No.	Unit No.	Topics	Hrs.
1	Introduction to Networking		06
	1.1	Introduction to computer network, network application, network software and hardware components (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services	
	1.2	Reference models: Layer details of OSI, TCP/IP models. Communication between layer.	
2	Physical Layer		06
	2.1	Introduction to Communication System, digital Communication, Electromagnetic Spectrum	
	2.2	Guided Transmission Media: Twisted pair, Coaxial, Fiber optics. Unguided media (Wireless Transmission): Radio Waves, Microwave, Bluetooth, Infrared, Circuit and Packet Switching	

3	Data Link Layer		10
	3.1	DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code, CRC, Checksum) , Elementary Data Link protocols , Stop and Wait, Sliding Window(Go Back N, Selective Repeat), HDLC	
	3.2	Medium Access Control sublayer Channel Allocation problem, Multiple access Protocol(Aloha, Carrier Sense Multiple Access (CSMA/CD), Local Area Networks - Ethernet (802.3)	
4	Network layer		14
	4.1	4.1 Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. IPv4 Addressing (classfull and classless), Subnetting, Supernetting design problems ,IPv4 Protocol, Network Address Translation (NAT)	
	4.2	Routing algorithms : Shortest Path (Dijkstra's), Link state routing, Distance Vector Routing	
	4.3	Protocols - ARP,RARP, ICMP, IGMP	
	4.4	Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms	
5	Transport Layer		10
	5.1	The Transport Service: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers	
	5.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start	
6	Application Layer		06
	6.1	DNS: Name Space, Resource Record and Types of Name Server. HTTP, SMTP, Telnet, FTP, DHCP	

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Textbooks:

1. A.S. Tanenbaum, “Computer Networks”, Pearson Education, (4e)
2. B.A. Forouzan, “Data Communications and Networking”, TMH (5e)
3. James F. Kurose, Keith W. Ross, “Computer Networking, A Top-Down Approach Featuring the Internet”, Addison Wesley, (6e)

References:

1. S.Keshav: An Engineering Approach To Computer Networking, Pearson
2. Natalia Olifer& Victor Olifer,“Computer Networks:Principles, Technologies & Protocols for Network Design”, Wiley India, 2011.
3. Larry L.Peterson, Bruce S.Davie, Computer Networks: A Systems Approach, Second Edition (The Morgan Kaufmann Series in Networking).

Course Code	Course Name	Credits
CSC504	Theory of Computer Science	4

Course Objectives:

1. Acquire conceptual understanding of fundamentals of grammars and languages.
2. Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
3. Develop understanding of different types of Turing machines and applications.
4. Understand the concept of Undecidability.

Course Outcomes: On successful completion of course learner will be able to:

1. Identify the central concepts in theory of computation and differentiate between deterministic and nondeterministic automata, also obtain equivalence of NFA and DFA.
2. Infer the equivalence of languages described by finite automata and regular expressions.
3. Devise regular, context free grammars while recognizing the strings and tokens.
4. Design pushdown automata to recognize the language.
5. Develop an understanding of computation through Turing Machine.
6. Acquire fundamental understanding of decidability and undecidability.

Prerequisite: Discrete Mathematics

Module No.	Unit No.	Topics	Theory Hrs.	Tutorial Hrs.
1.0		Basic Concepts and Finite Automata	09	03
	1.1	<ul style="list-style-type: none"> Alphabets, Strings, Languages, Closure properties. Finite Automata (FA) and Finite State machine (FSM). 		
	1.2	<ul style="list-style-type: none"> Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers NFA to DFA Conversion Equivalence between NFA with and without ϵ- transitions Minimization of DFA FSM with output: Moore and Mealy machines, Equivalence Applications and limitations of FA 		
2.0		Regular Expressions and Languages	06	02
	2.1	<ul style="list-style-type: none"> Regular Expression (RE) Equivalence of RE and FA, Arden's Theorem RE Applications 		
	2.2	<ul style="list-style-type: none"> Regular Language (RL) Closure properties of RLs Decision properties of RLs Pumping lemma for RLs 		
3.0		Grammars	08	03
	3.1	<ul style="list-style-type: none"> Grammars and Chomsky hierarchy 		
	3.2	<ul style="list-style-type: none"> Regular Grammar (RG) 		

		<ul style="list-style-type: none"> • Equivalence of Left and Right linear grammar • Equivalence of RG and FA 		
	3.3	Context Free Grammars (CFG) <ul style="list-style-type: none"> • Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity. • Simplification and Applications. • Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF). • CFLs - Pumping lemma, Closure properties 		
4.0		Pushdown Automata(PDA)	04	01
	4.1	<ul style="list-style-type: none"> • Definition, Transitions ,Language of PDA • Language acceptance by final state and empty stack • PDA as generator, decider and acceptor of CFG. • Deterministic PDA , Non-Deterministic PDA • Application of PDA. 		
5.0		Turing Machine (TM)	09	03
	5.1	<ul style="list-style-type: none"> • Definition, Transitions • Design of TM as generator, decider and acceptor. • Variants of TM: Multitrack, Multitape • Universal TM. • Equivalence of Single and Multi Tape TMs. • Applications, Power and Limitations of TMs. • Context Sensitivity and Linear Bound Automata. 		
6.0		Undecidability	03	01
	6.1	<ul style="list-style-type: none"> • Decidability and Undecidability, • Recursive and Recursively Enumerable Languages. • Halting Problem, • Rice's Theorem, • Post Correspondence Problem, 		
		Total	39	13

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, “Introduction to Automata Theory, Languages and Computation”, Pearson Education.
2. Michael Sipser, “Theory of Computation”, Cengage learning.
3. Vivek Kulkarni, “Theory of Computation”, Oxford University Press, India.

Reference Books:

1. J. C. Martin, “Introduction to Languages and the Theory of Computation”, Tata McGraw Hill.
2. Kavi Mahesh, “Theory of Computation: A Problem Solving Approach”, Wiley-India.

Course Code	Course Name	Credits
CSDLO5011	Multimedia System	4

Course objectives:

1. To introduce students about basic fundamentals and key aspects of Multimedia system.
2. To provide knowledge of compression techniques of different multimedia components
3. To help students to understand multimedia communication standards along with technology environment
4. To provide an opportunity to gain hands-on experience in building multimedia applications.

Course outcomes: Learner will be able to

1. To identify basics of multimedia and multimedia system architecture.
2. To understand different multimedia components.
3. To explain file formats for different multimedia components.
4. To analyze the different compression algorithms.
5. To describe various multimedia communication techniques.
6. To apply different security techniques in multimedia environment.

Prerequisite: Computer Fundamentals and Graphics.

Module No.	Unit No.	Topics	Hrs.
1	Introduction to Multimedia		8
	1.1	Overview	
	1.2	Objects and Elements of Multimedia	
	1.3	Applications of Multimedia	
	1.4	Multimedia Systems Architecture – IMA, Workstation, Network	
	1.5	Types of Medium (Perception, Representation-..)	
	1.6	Interaction Techniques	
	1.7	I/O devices - Salient features (Electronic Pen , Scanner, Digital Camera, Printers, plotters), Storage Media (Jukebox, DVD), Multimedia Databases	
2	Text & Digital Image		10
	Text		
	2.1	Visual Representation, Digital Representation.	
	2.2	File Formats: RTF, TIFF.	
	2.3	Compression Techniques : Huffman Coding, RLE, CCITT group 3 1D	

	Digital Image		
	2.4	Digital Image Representation (2D format, resolution) Types of Images (monochrome, gray, color), examples of images (X-Ray, fractal, synthetic, acoustic).	
	2.5	File formats: BMP, JPG	
	2.6	Compression Techniques: fundamentals (coding, interpixel and psychovisual redundancies),Types – lossless and lossy, Lossless Compression Algorithms– Shannon-Fano, CCITT group 4 2D, Lossy Compression Algorithm – JPEG	
3	Digital Audio		8
	3.1	Basic Sound Concepts: computer representation of sound,	
	3.2	File Formats – WAV, MPEG Audio	
	3.3	Compression: PCM, DM, DPCM	
4	Digital Video		8
	4.1	Digitization of Video, types of video signals (component, composite and S-video),	
	4.2	File Formats: MPEG Video, H.261	
	4.3	Compression: MPEG	
5	Multimedia Network Communication and Representation		10
	5.1	Quality of Service	
	5.2	Multimedia over IP (RTP, RTSP, RTCP,RSVP)	
	5.3	Representation- Authoring systems and user interface	
6	Multimedia Security		8
	6.1	Requirements and properties	
	6.2	Mechanisms – Digital Signatures, Steganographic methods	
	6.3	Sample applications – unidirectional distributed systems, information systems and conference systems	
		Total	52

Text Books:

1. Multimedia System Design, Prabhat K. Andleigh& Kiran Thakrar, PHI.
2. Multimedia Communication Systems: Techniques, Standards & Networks, K. R. Rao, Zoran S. Bojkovic&Dragorad A. Milovanovic, TMH.
3. Multimedia Systems, K. Buford, PHI.
4. Fundamentals of Multimedia, Ze-Nian Li & Mark S. Drew, PHI.

Reference Books:

1. Multimedia Computing Communications & Applications, Ralf Steinmetz & Klara Nahrstedt, Pearson.
2. Digital Image processing, Rafael C. Gonzalez, Richard E. Woods, Pearson.
3. Multimedia Applications, Ralf Steinmetz & Klara Nahrstedt, Springer International Edition

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Suggested List of Experiments:

1. Create a new file format to store a multimedia data.
2. Implement a compression technique and check the efficiency on different inputs.
3. To develop a theme based multimedia presentation
4. To add a digital signature onto a document
5. To perform steganography of text onto an image and check the efficiency with different inputs.

** Perform laboratory work of this course in 'CSL504: Web Design Lab' as experiments or mini project.

Course Code	Course Name	Credits
CSDL05012	Advanced Operating Systems	4

Course Objectives:

1. To understand design issues of Advanced Operating systems.
2. To understand the architecture, kernel and file management of Unix operating system.
3. To understand basic concepts and need of Distributed operating systems.
4. To understand concepts and working of different advanced Operating systems like Multiprocessor OS, Real time OS, Mobile OS.

Course Outcomes: On successful completion of the course student should be able to

1. Demonstrate understanding of design issues of Advanced operating systems and compare different types of operating systems.
2. Analyse design aspects and data structures used for file subsystem, memory subsystem and process subsystem of Unix OS.
3. Demonstrate understanding of different architectures used in Multiprocessor OS and analyse the design and data structures used in Multiprocessor operating systems.
4. Differentiate between threads and processes and compare different processor scheduling algorithms used in Multiprocessor OS
5. Classify Real Time OS and analyse various real time scheduling algorithms.
6. Explore architectures and design issues of Mobile OS, Virtual OS, Cloud OS.

Prerequisite: Operating Systems

Module	Unit	Detailed Content	Hrs
1		Introduction	04
		Functions of operating systems, Design approaches: layered, kernel based and virtual machine approach, types of advanced operating systems (NOS, DOS, Multiprocessor OS, Mobile OS, RTOS, Cloud OS)	
2		Unix Kernel and File Management	14
	2.1	System Structure, User Perspective, Architecture of Unix Operating System	
	2.2	Buffer cache: Header, Buffer Pool, Retrieving, Reading and Writing Buffer	
	2.3	File Representation: inodes: Structure of file Directories, Path conversion to inode, superblock, inode assignment, allocation of disk blocks	
3		Unix Process and Memory management	12
	3.1	Detailed design of Process Structure: Kernel Data structures for process, Structure of Uarea and Process table, Process states and Transitions	
	3.2	Context of a Process: Static and Dynamic area of context, Saving the Context Layout of System Memory, Regions, Mapping regions	

		with Process, page table and mapping virtual address to physical address.	
4		Distributed Operating system concepts	06
		Goals, Distributed Computing Models, Hardware Concepts, Software Concepts, Architecture of DOS. Design Issues: Transparency, Flexibility, Scalability, Reliability, Performance, fault tolerance	
5		Multiprocessor Operating System	08
	5.1	Introduction, Basic multiprocessor system architectures, design issues, Threads, Process synchronization: the test and set instruction, the swap instruction, implementation of the process wait	
	5.2	Processor scheduling: Issues, Co-scheduling, Smart scheduling, Affinity Based scheduling	
6		Real Time Operating Systems and Mobile OS	08
	6.1	Characteristics of Real Time operating Systems, Classification of Real Time Operating Systems, Scheduling in RTOS: Clock driven: cyclic, Event driven: EDF and rate monotonic scheduling.	
	6.2	Mobile OS: Architecture, Android OS, iOS, Virtual OS, Cloud OS and their design issues	

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- The students need to solve total 4 questions.
- Question No.1 will be compulsory and based on entire syllabus.
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. The Design of the UNIX Operating System, PHI, by Maurice J. Bach.
2. Distributed Computing 2nd Edition, Mahajan and Seema Shah, Oxford.
3. Advanced Concepts in Operating Systems, Mukesh Singhal, Niranjana G Shivaratri.
4. Mobile Computing by Rajkamal, 1st edition, Oxford.
5. Real Time Operating System, Jane W.S. Liu, Pearson.

Reference Books:

1. Andrew S. Tanenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2. "Real-Time Systems: Theory and Practice", Rajib Mall, Pearson Education India, 2006.

Course Code	Course Name	Credit
CSDLO5013	Advanced Algorithm	4

Course Objectives:

1. To provide mathematical approach for Analysis of Algorithms.
2. To teach advanced data structures.
3. To solve complex problems in real life applications.

Course Outcomes: At the end of the course student will be able to

1. Describe analysis techniques for algorithms.
2. Identify appropriate data structure and design techniques for different problems
3. Identify appropriate algorithm to be applied for the various application like geometric modeling, robotics, networking, etc.
4. Appreciate the role of probability and randomization in the analysis of algorithm
5. Analyze various algorithms.
6. Differentiate polynomial and non deterministic polynomial algorithms.

Prerequisites: Data structures, Discrete mathematics and Analysis of Algorithm

Sr. No.	Module	Detailed Content	Hours
1	Fundamental of Algorithms	Introduction- Complexity- complexity of recursive algorithms, finding complexity by tree method, master method, proving technique (contradiction, mathematical induction). Amortized analysis- aggregate analysis, accounting analysis, potential analysis dynamic tables	08
2	Probabilistic Analysis and Randomized Algorithm	The hiring problem Indicator random variables Randomized algorithms Probabilistic analysis and further uses of indicator random variable	08
3	Advanced Data Structure	Introduction to trees and heap Red-Black Trees: properties of red-black trees , Operations on Red-black trees Binomial Heaps: Binomial trees and binomial heaps, Operation on Binomial heaps Analysis of all above operations	12
4	Maximum Flow	Flow networks , the ford Fulkerson method ,max bipartite matching , push Relabel Algorithm , The relabel to front algorithm	08

5	Computational Geometry	Line Segment properties, Determining whether any pair of segment intersects, finding the convex hull, Finding the closest pair of points.	08
6	NP-Completeness And Approximation Algorithms	NP-Completeness: NP-Completeness and reducibility, NP-Completeness proofs, NP-Complete problems-The vertex-cover problem, The travelling salesman problem	08

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, PHI, India Second Edition.
2. Horowitz, Sahani and Rajsekar, “Fundamentals of Computer Algorithms”, Galgotia.
3. Harsh Bhasin, “Algorithms – Design and Analysis”, Oxford, 2015.

Reference Books:

1. Rajeev Motwani, Prabhakar Raghavan, “ Randomized Algorithm”, Cambridge University
2. S. K. Basu, “Design Methods and Analysis of Algorithm”, PHI
3. Vijay V. Vajirani, “Approximation Algorithms”, Springer.

Internal Assessment:

Assessment consists of two tests out of which; one (T1) should be compulsory class test (on at least 02 Modules) and the other (T2) is either a class test or assignments on live problems or course project

Theory Examination:

1. Question paper will comprise of total six questions.
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Lab Code	Lab Name	Credits
CSL501	Microprocessor Lab	1

Lab Objective:

1. To emphasize on use of Assembly language program.
2. To prepare students for advanced subjects like embedded system and IOT.

Lab Outcome:

1. Use appropriate instructions to program microprocessor to perform various task
2. Develop the program in assembly/ mixed language for Intel 8086 processor
3. Demonstrate the execution and debugging of assembly/ mixed language program

Description:

A microprocessor is the most important unit within a computer system. It is responsible for processing the unique set of instructions and processes. It is a controlling unit of a computer, capable of performing Arithmetic Logical Unit (ALU) operations and communicating with the other devices connected to it. Typical microprocessor operations include adding, subtracting, comparing two numbers, and fetching numbers from one area to another. These operations are the result of a set of instructions that are part of the microprocessor design. When computer is turned on, the microprocessor gets the first instruction from the basic input/output system that comes with the computer as part of its memory. After that, either the BIOS, or the operating system that BIOS loads into computer memory, or an application program provides instructions to perform.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Use of programming tools (Debug/TASM/MASM/8086kit) to perform basic arithmetic operations on 8bit/16 bit data
2	Code conversion (Hex to BCD, BCD to Hex, ASCII to BCD, BCD to ASCII)
3	Assembly programming for 16-bit addition, subtraction, multiplication and division (menu based)
4	Assembly program based on string instructions (overlapping/ non-overlapping block transfer/ string search/ string length)
5	Assembly program to display the contents of the flag register.
6	Mixed Language program to shift a number for given number of times
7	Assembly program to find the GCD/ LCM of two numbers
8	Assembly program to sort numbers in ascending/ descending order

9	Mixed Language program to increment, decrement the size of the cursor and also to disable it.
10	Assembly program to find minimum/ maximum no. from a given array.
11	Program for device driver (printer/mouse/keyboard)
12	Program based on 32 bit architecture (e.g. Switching from real mode to protected mode using DPMI driver, 32bit multiplication)
13	Assembly program to find factorial of number using procedure
14	Program and interfacing using 8255/ 8253
15	Program and interfacing of ADC/ DAC/ Stepper motor

Term Work:

Term should consist of at least 10 experiments.

Journal must include –

- At least one experiment with use of macros/ procedures
- At least five experiments with use of DOS, BIOS interrupts
- At least two assignments

At least one experiment on hardware interfacing is desirable

The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum marks in term work.

Term Work: 25 marks (Total) = 15 Marks (Experiments) + 5 Marks (Assignments) + 5 Marks (Theory + Practical Attendance)

Oral & Practical exam will be based on the CSL501 and CSC501 syllabus.

Lab Code	Lab Name	Credits
CSL 502	Computer Network Lab	1

Lab Objective:

To practically explore OSI layers and understand the usage of simulation tools.

Lab Outcomes:

On successful completion of course learner will be able to

1. Design and setup networking environment in Linux.
2. Use Network tools and simulators such as NS2, Wireshark etc. to explore networking algorithms and protocols.
3. Implement programs using core programming APIs for understanding networking concepts.

Description

The experiments are expected to be performed in Linux environment.

Suggested List of Experiments

Sr. No	Title of Experiments
1.	Setup a network and configure IP addressing, subnetting, masking. (Eg. CISCO Packet Tracer, Student Ed.)
2.	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route)
3.	Build a simple network topology and configure it for static routing protocol using packet tracer.
4.	Perform network discovery using discovery tools (eg. mrtg)
5.	Use Wireshark to understand the operation of TCP/IP layers : <ul style="list-style-type: none"> ● Ethernet Layer : Frame header, Frame size etc. ● Data Link Layer : MAC address, ARP (IP and MAC address binding) ● Network Layer : IP Packet (header, fragmentation), ICMP (Query and Echo) ● Transport Layer: TCP Ports, TCP handshake segments etc. ● Application Layer: DHCP, FTP, HTTP header formats
6.	CRC/ Hamming code implementation.
7.	Stop and wait protocol/ sliding window (selective repeat / Go back N)
8.	Use simulator (Eg. NS2) to understand functioning of ALOHA, CSMA/CD.
9.	<ol style="list-style-type: none"> a. Set up multiple IP addresses on a single LAN. b. Using nestat and route commands of Linux, do the following:

	<ul style="list-style-type: none"> ● View current routing table ● Add and delete routes ● Change default gateway <p>c. Perform packet filtering by enabling IP forwarding using IPtables in Linux.</p>
10.	Implementation of DVR/ LSR in NS2/(any other simulator)
11.	Socket programming using TCP or UDP
12.	Simulate congestion control (leaky bucket / token bucket).
13.	Perform File Transfer and Access using FTP
14.	Perform Remote login using Telnet server

Term Work:

Laboratory work should be based on above syllabus of suggested list having minimum 10 experiments, covering all layers.

Experiments ----- (15) Marks
Assignments ----- (05) Marks
Attendance (Theory + Practical) ----- (05) Marks
Total ----- (25) Marks

Oral & Practical exam will be based on the **above and CSC 503 : Computer Network.**

Lab Code	Lab Name	Credits
CSL503	Database & Information System Lab	1

Lab Outcome: On successful completion of course learner will be able to:

1. Design and draw ER and EER diagram for the real life problem with software tool.
2. Create and update database and tables with different DDL and DML statements.
3. Apply /Add integrity constraints and able to provide security to data.
4. Implement and execute Complex queries.
5. Apply triggers and procedures for specific module/task
6. Handle concurrent transactions and able to access data through front end (using JDBC ODBC connectivity.)

Description:

- The below suggested experiments needs to be performed by a group of **3/4 students**.
- Select any database management system and conduct all experiments based on the same topic.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create and populate database using Data Definition Language (DDL) and DML Commands for you're the specified System.
4	Apply Integrity Constraints for the specified system.
5	Perform Simple queries, string manipulation operations.
6	Nested queries and Complex queries
7	Perform Join operations
8	Views and Triggers
9	Functions , cursor and procedure.
10	Transaction and Concurrency control
11	Mini project- Creating a Two-tier client-server database applications using JDBC

Assignment: Perform Normalization -1NF, 2NF, 3NF

Term Work:

Laboratory work will be based on DBMS syllabus with minimum 10 experiments to be incorporated.

Experiments should be completed by students on the given time duration

Experiments -----	(10) Marks
Mini Project-----	(10) Marks
Attendance (Theory + Practical) -----	(05) Marks
Total -----	(25) Marks

Practical and Oral :

Practical and oral Exam should be conducted for the Lab, on Database Management System subject for given list of experiments .

Implementation -----(15) Marks
Oral -----(10) Marks
Total -----(25) Marks

****Oral & Practical exam** will be based on the above and CSC502: ‘DBMS’ syllabus

Text Books:

1. G. K. Gupta :”Database Management Systems”, McGraw – Hill.
2. Korth, Slberchatz,Sudarshan, :”Database System Concepts”, 6th Edition, McGraw – Hill
3. Elmasri and Navathe, “ Fundamentals of Database Systems”, 5thEdition, PEARSON
4. Peter Rob and Carlos Coronel, “ Database Systems Design, Implementation and Management”, Thomson Learning, 5th Edition.

Reference Books :

1. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g,Black Book, Dreamtech Press
2. PaulrajPonniah, “ Introduction to Database Management”,Wiley publication
3. Raghu Ramkrishnan and Johannes Gehrke, “ Database Management Systems”,TMH
4. Debabrata Sahoo “Database Management Systems” Tata McGraw Hill, Schaum’s Outline

Course Code	Course Name	Credits
CSL504	Web Design Lab	2

Course objectives:

1. To design and create web pages using HTML5 and CSS3.
2. To Create web pages and provide client side validation.
3. To create dynamic web pages using server side scripting.
4. To use MVC framework for web application development.

Course outcomes: On completion of course learner will be able to:

1. Understand the core concepts and features of Web Technology
2. Design static web pages using HTML5 and CSS3
3. Apply the concept of client side validation and design dynamic web pages using JavaScript and JQuery.
4. Evaluate client and server side technologies and create Interactive web pages using PHP , AJAX with database connectivity using MySQL.
5. Understand the basics of XML, DTD and XSL and develop web pages using XML / XSLT.
6. Analyze end user requirements and Create web application using appropriate web technologies and web development framework

Prerequisite: Data Structures, Basics of Programming Languages

Module No.	Unit No.	Topics	Hrs.
1.0		INTRODUCTION TO WWW	2
	1.1	Internet Standards – Introduction to WWW – WWW Architecture – SMTP – POP3 – File Transfer Protocol	
	1.2	Overview of HTTP, HTTP request – response — Generation of dynamic web pages- W3C Validator, How web works - Setting up the environment (LAMP/XAMP/WAMP server)	
2.0		CLIENT SIDE PROGRAMMING	6
	2.1	Markup Language (HTML): Introduction to HTML and HTML5 - Formatting and Fonts –Commenting Code – Anchors – Backgrounds – Images – Hyperlinks	
	2.2	Lists – Tables – Frames - HTML Forms and controls.	
	2.3	Cascading Style Sheet (CSS): The need for CSS, Introduction to CSS 3 – Basic syntax and structure ,CSS Properties-Inline Styles – Embedding Style Sheets	
	2.4	Linking External Style Sheets – Backgrounds –Box Model(Introduction , Border Properties, Padding Properties, Margin Properties), Manipulating text - Margins and Padding - Positioning using CSS., Creating page Layout and Site Designs	
3.0		INTRODUCTION TO JAVASCRIPT	6
	3.1	Introduction - Core features - Data types and Variables - Operators, Expressions, and Statements, Functions - Objects - Array, Date and Math related Objects	
	3.2	Document Object Model - Event Handling Controlling Windows &	

		Frames and Documents Form handling and validations.	
	3.3	Advanced JavaScript - Browser Management and Media Management – Classes – Constructors – Object-Oriented Techniques in JavaScript	
	3.4	Object constructor and Prototyping - Sub classes and Super classes – JSON - jQuery and AJAX., Rich Internet Application with AJAX, JQuery Framework	
		SERVER SIDE PROGRAMMING	
4.0	4.1	Introduction - Programming basics - Print/echo - Variables and constants – Strings and Arrays	8
	4.2	Operators, Control structures and looping structures – Functions – Reading Data in Web Pages	
	4.3	Embedding PHP within HTML - Establishing connectivity with MySQL database, cookies, sessions and Authentication	
	4.4	AJAX with PHP - AJAX with Databases	
5.0		XML	4
	5.1	Dynamic page generation (adding interactivity, styles, using HTML, DHTML, XHTML, CSS, Java Script), XML –DTD(Document Type Definition) - XML Schema	
	5.2	XML –DTD(Document Type Definition) - XML Schema - Document Object Model - Presenting XML - Using XML Parsers: DOM and SAX,XSL-eXtensible Style sheet Language	
6.0		WEB DEVELOPMENT FRAMEWORK	2
	6.1	Introduction to Composer - MVC Architecture	
	6.2	Web Application Development using web development framework :-Introduction to Laravel, Development of Web pages using Laravel., Example web applications – Interactive websites, web based information systems , blogs, social networking sites etc.	
		Total	28

Text Books:

1. Ralph Moseley , M.T. Savliya ,” Developing Web Applications”, Willy India, Second Edition, ISBN: 978-81-265-3867-6
2. “Web Technology Black Book”, Dremtech Press, First Ediction, 978-7722-997
3. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY,2014.
(http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascrpt_CSS_HTML5_Robin_Nixon_3e.pdf)
4. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward Benson, Wiley publications.
<https://ebooks-it.org/0470082801-ebook.htm>

Reference Books:

1. Harvey & Paul Deitel& Associates, Harvey Deitel and Abbey Deitel, “Internet and World Wide Web - How To Program”, Fifth Edition, Pearson Education, 2011.
2. Achyut S Godbole and AtulKahate, “Web Technologies”, Second Edition, Tata McGraw Hill, 2012.
3. Thomas A Powell, Fritz Schneider, “JavaScript: The Complete Reference”, Third Edition, Tata McGraw Hill, 2013.

4. David Flanagan, “JavaScript: The Definitive Guide, Sixth Edition”, O'Reilly Media, 2011
5. Steven Holzner, “The Complete Reference - PHP”, Tata McGraw Hill, 2008
6. Mike Mcgrath, “PHP & MySQL in easy Steps”, Tata McGraw Hill, 2012.

Digital Material:

1. www.nptelvideos.in
2. www.w3schools.com
3. <http://spoken-tutorial.org>

Term work Assessment:

Term work will consist of lab experiments testing all the technologies included in syllabus and a **Mini project** solving an appropriate problem using the above technology.

Module	Detailed Contents	Lab Sessions
1	Installation and Setting of LAMP / WAMP / XAMP	1
2	Create Simple web page using HTML5	1
3	Design and Implement web page using CSS3 and HTML5	1
4	Form Design and Client Side Validation using : a. Javascript and HTML5 b. Javascript and JQuery	2
5	Develop simple web page using PHP	1
6	Develop interactive web pages using PHP with database connectivity MYSQL	2
7	Develop XML web page using DTD, XSL	1
8	Implement a webpage using Ajax and PHP	1
9	Hosting the website with Domain Registration Process.	1
10	Design a Web application using Laravel Framework	3

****Setting up /buying the web host management system for hosting of mini project is recommended.**

Term Work: The distribution of marks for term work shall be as follows:

- Lab Assignments : 10 Marks
- Mini Project : 10 Marks
- Attendance : 05 Marks

Practical & Oral Examination:

Practical & Oral examination is to be conducted by pair of internal and external examiners based on the above syllabus.

Course Code	Course Name	Credits
CSL505	Business Communication & Ethics	02

Course Objectives:

1. To inculcate professional and ethical attitude at the work place
2. To enhance effective communication and interpersonal skills
3. To build multidisciplinary approach towards all life tasks
4. To hone analytical and logical skills for problem-solving.

Course Outcomes: Learner will be able to...

1. Design a technical document using precise language, suitable vocabulary and apt style.
2. Develop the life skills/interpersonal skills to progress professionally by building stronger relationships.
3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
4. Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
5. Deliver formal presentations effectively implementing the verbal and non-verbal skills

Module	Detailed Contents	Hrs.
01	Report Writing	05
1.1	Objectives of Report Writing	
1.2	Language and Style in a report	
1.3	Types: Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports(Memo, Letter, Short and Long Report)	
02	Technical Writing	03
2.1	Technical Paper Writing(IEEE Format)	
2.2	Proposal Writing	
03	Introduction to Interpersonal Skills	09
3.1	Emotional Intelligence	
3.2	Leadership and Motivation	
3.3	Team Building	
3.4	Assertiveness	
3.5	Conflict Resolution and Negotiation Skills	
3.6	Time Management	
3.7	Decision Making	
04	Meetings and Documentation	02
4.1	Strategies for conducting effective meetings	
4.2	Notice, Agenda and Minutes of a meeting	
4.3	Business meeting etiquettes	
05	Introduction to Corporate Ethics	02
5.1	Professional and work ethics (responsible use of social media Facebook, WA, Twitter etc.)	
5.2	Introduction to Intellectual Property Rights	
5.4	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	

06	Employment Skills	07
6.1	Group Discussion	
6.2	Resume Writing	
6.3	Interview Skills	
6.4	Presentation Skills	
6.5	Statement of Purpose	
		28

Assessment:

List of Assignments

1. Report Writing(Theory)
2. Technical Proposal
3. Technical Paper Writing(Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills(Group activities and Role plays)
5. Interpersonal Skills(Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation(Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics(Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work

Term work shall consist of all assignments from the list. The distribution of marks for term work shall be as follows:

Book Report	10 marks
Assignments:	10 marks
Project Report Presentation:	15 marks
Group Discussion:	10 marks
Attendance:	05 marks

References:

1. Fred Luthans, "Organizational Behavior", Mc GrawHill,
2. Lesiker and Petit, "Report Writing for Business ", McGrawHill
3. R. Subramaniam, "Professional Ethics" Oxford University Press
4. Huckin and Olsen, "Technical Writing and Professional Communication ", McGraw
5. Raman and Sharma, Fundamentals of Technical Communication, Oxford University Press
6. Hill Wallace and Masters, "Personal Development for Life and Work", Thomson Learning.
7. Heta Murphy, "Effective Business Communication ", McGraw Hill, edition
8. R.C Sharma and Krishna Mohan, "Business Correspondence and Report Writing",
9. Raman Sharma, "Communication Skills", Oxford University Press
10. B N Ghosh, "Managing Soft Skills for Personality Development", Tata McGraw Hill
11. Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
12. Bell. Smith, "Management Communication" Wiley India Edition, 3rd edition.
13. Dr. K. Alex, "Soft Skills", S Chand and Company
14. Robbins Stephens P., "Organizational Behavior", Pearson Education
15. <https://grad.ucla.edu/asis/agep/advsoystem.pdf>

Course Code	Course Name	Credits
CSC601	Software Engineering	4

Course objectives:

The main objective of the course is to introduce to the students about the product that is to be engineered and the processes that provides a framework for the engineering methodologies and practices.

1. To provide the knowledge of software engineering discipline.
2. To apply analysis, design and testing principles to software project development.
3. To demonstrate and evaluate real time projects with respect to software engineering principles.

Course outcomes:

On successful completion of course, learners will be able to:

1. Understand and demonstrate basic knowledge in software engineering.
2. Identify requirements, analyze and prepare models.
3. Plan, schedule and track the progress of the projects.
4. Design & develop the software projects.
5. Identify risks, manage the change to assure quality in software projects.
6. Apply testing principles on software project and understand the maintenance concepts.

Prerequisite:

1. Concepts of Object Oriented Programming & Methodology
2. Knowledge of developing applications with front end & back end connectivity.

Course syllabus:

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction To Software Engineering and Process Models	08
	1.1	Nature of Software, Software Engineering, Software Process, Capability Maturity Model (CMM)	
	1.2	Generic Process Model, Prescriptive Process Models: The Waterfall Model, V-model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, Agile process, Agility Principles, Extreme Programming (XP), Scrum, Kanban model	
2.0		Requirements Analysis and Modelling	08
	2.1	Requirement Elicitation, Software requirement specification (SRS), Developing Use Cases (UML)	
	2.2	Requirement Model – Scenario-based model, Class-based model, Behavioural model.	
3.0		Project Scheduling and Tracking	08
	3.1	Management Spectrum, 3Ps (people, product and process)	
	3.2	Process and Project metrics	

	3.3	Software Project Estimation: LOC, FP, Empirical Estimation Models - COCOMO II Model, Specialized Estimation Techniques	
	3.4	Project scheduling: Defining a Task Set for the Software Project, Timeline charts, Tracking the Schedule, Earned Value Analysis	
4.0		Software Design	10
	4.1	Design Principles, Design Concepts, Effective Modular Design – Cohesion and Coupling	
	4.2	Architectural Design	
	4.3	Component-level design	
	4.4	User Interface Design	
5.0		Software Risk, Configuration Management & Quality Assurance	08
	5.1	Risk Identification, Risk Assessment, Risk Projection, RMMM	
	5.2	Software Configuration management, SCM repositories, SCM process	
	5.3	Software Quality Assurance Task and Plan, Metrics, Software Reliability, Formal Technical Review (FTR), Walkthrough	
6.0		Software Testing and Maintenance	10
	6.1	Strategic Approach to Software Testing, Unit testing, Integration testing Verification, Validation Testing, System Testing	
	6.2	Software Testing Fundamentals, White-Box Testing , Basis Path Testing, Control Structure Testing, Black-Box Testing,	
	6.3	Software maintenance and its types, Software Re-engineering, Reverse Engineering	
		Total	52

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 06 questions, each carrying 20 marks.
2. The students need to solve total 04 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. Roger Pressman, "Software Engineering: A Practitioner's Approach", McGraw-Hill Publications
2. Ian Sommerville, "Software Engineering", Pearson Education (9th edition)
3. Ali Behfroz and Fredeick J.Hudson, "Software Engineering Fundamentals", Oxford University Press

Reference Books:

1. Ugrasen Suman, "Software Engineering – Concepts and Practices", Cengage Learning
2. Pankaj Jalote, "An integrated approach to Software Engineering", Springer/Narosa
3. Jibitesh Mishra and Ashok Mohanty, "Software Engineering", Pearson
4. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India

Course Code	Course Name	Credits
CSC602	System Programming And Compiler Construction	4

Course objectives:

1. To understand the role and functioning of various system programs over application program.
2. To understand basic concepts and designing of assembler, Macro processor and role of static and dynamic loaders and linkers.
3. To understand the need to follow the syntax in writing an application program and to learn the how the analysis phase of compiler is designed to understand the programmer's requirements without ambiguity.
4. To synthesize the analysis phase outcomes to produce the object code that is efficient in terms of space and execution time.

Course outcomes: On successful completion of course learner will be able to:

1. Identify the relevance of different system programs.
2. Describe the various data structures and passes of assembler design.
3. Identify the need for different features and designing of macros.
4. Distinguish different loaders and linkers and their contribution in developing efficient user applications.
5. Construct different parsers for given context free grammars.
6. Justify the need synthesis phase to produce object code optimized in terms of high execution speed and less memory usage

Prerequisite: Data Structures, Theoretical computer science, Operating system. Computer Organization and Architecture, Microprocessor

Module No.	Unit No.	Topics	Hrs.
1	Introduction to System Software	Concept of System Software, Goals of system softwares, system program and system programming, Introduction to various system programs such as Assembler, Macro processor, Loader, Linker, Compiler, Interpreter, Device Drivers, Operating system, Editors, Debuggers.	2
2	Assemblers	Elements of Assembly Language programming, Assembly scheme, pass structure of assembler, Assembler Design: Two pass assembler Design and single pass Assembler Design for Hypothetical / X86 family processor, data structures used.	10
3	Macros and Macro Processor	Introduction, Macro definition and call, Features of Macro facility: Simple, parameterized, conditional and nested. Design of single pass macro processor, data structures used.	8
4	Loaders and Linkers	Introduction, functions of loaders, Relocation and Linking concept, Different loading schemes: Relocating loader, Direct Linking Loader, Dynamic linking and loading.	8

5	Compilers: Analysis Phase	<p>Introduction to compilers, Phases of compilers:</p> <p>Lexical Analysis- Role of Finite State Automata in Lexical Analysis, Design of Lexical analyser, data structures used .</p> <p>Syntax Analysis- Role of Context Free Grammar in Syntax analysis, Types of Parsers: Top down parser- LL(1), Bottom up parser- Operator precedence parser, SLR</p> <p>Semantic Analysis, Syntax directed definitions.</p>	12
6	Compilers: Synthesis phase	<p>Intermediate Code Generation: Types of Intermediate codes: Syntax tree, Postfix notation, Three address codes: Triples and Quadruples.</p> <p>Code Optimization: Need and sources of optimization, Code optimization techniques: Machine Dependent and Machine Independent.</p> <p>Code Generation: Issues in the design of code generator, code generation algorithm. Basic block and flow graph.</p>	12

Text Books:

1. D. M Dhamdhare: Systems programming, Tata McGraw Hill
2. A. V. Aho, R. Shethi, Monica Lam , J.D. Ulman : Compilers Principles, Techniques and Tools , Pearson Education , Second Edition.
3. J. J. Donovan: Systems Programming Tata McGraw Hill Publishing Company

Reference Books:

1. Lex &yacc, 2nd Edition by John R. Levine, Tony Mason & Doug Brown O'Reilly
2. Compiler construction D,M.Dhamdhare second edition MACMILLAM.
3. Compiler construction : principles and practices , Kenneth C.Louden ,CENGAGE Learning
4. System software : An introduction to system programming , Leland L. Beck, Pearson

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC603	Data Warehousing and Mining	4

Course objectives:

1. To identify the scope and essentiality of Data Warehousing and Mining.
2. To analyze data, choose relevant models and algorithms for respective applications.
3. To study spatial and web data mining.
4. To develop research interest towards advances in data mining.

Course outcomes: On successful completion of course learner will be able to:

1. Understand Data Warehouse fundamentals, Data Mining Principles
2. Design data warehouse with dimensional modelling and apply OLAP operations.
3. Identify appropriate data mining algorithms to solve real world problems
4. Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining
5. Describe complex data types with respect to spatial and web mining.
6. Benefit the user experiences towards research and innovation.

Prerequisite: Basic database concepts, Concepts of algorithm design and analysis.

Module No.	Topics	Hrs.
1.0	Introduction to Data Warehouse and Dimensional modelling: Introduction to Strategic Information, Need for Strategic Information, Features of Data Warehouse, Data warehouses versus Data Marts, Top-down versus Bottom-up approach. Data warehouse architecture, metadata, E-R modelling versus Dimensional Modelling, Information Package Diagram, STAR schema, STAR schema keys, Snowflake Schema, Fact Constellation Schema, Factless Fact tables, Update to the dimension tables, Aggregate fact tables.	8
2.0	ETL Process and OLAP: Major steps in ETL process, Data extraction: Techniques, Data transformation: Basic tasks, Major transformation types, Data Loading: Applying Data, OLTP Vs OLAP, OLAP definition, Dimensional Analysis, Hypercubes, OLAP operations: Drill down, Roll up, Slice, Dice and Rotation, OLAP models : MOLAP, ROLAP.	8
3.0	Introduction to Data Mining, Data Exploration and Preprocessing: Data Mining Task Primitives, Architecture, Techniques, KDD process, Issues in Data Mining, Applications of Data Mining, Data Exploration :Types of Attributes, Statistical Description of Data, Data Visualization, Data Preprocessing: Cleaning, Integration, Reduction: Attribute subset selection, Histograms, Clustering and Sampling, Data Transformation & Data Discretization: Normalization, Binning, Concept hierarchy generation, Concept Description: Attribute oriented Induction for Data Characterization.	10

4.0	Classification, Prediction and Clustering: Basic Concepts, Decision Tree using Information Gain, Induction: Attribute Selection Measures, Tree pruning, Bayesian Classification: Naive Bayes, Classifier Rule - Based Classification: Using IF-THEN Rules for classification, Prediction: Simple linear regression, Multiple linear regression Model Evaluation & Selection: Accuracy and Error measures, Holdout, Random Sampling, Cross Validation, Bootstrap, Clustering: Distance Measures, Partitioning Methods (<i>k</i> -Means, <i>k</i> -Medoids), Hierarchical Methods(Agglomerative, Divisive)	12
5.0	Mining Frequent Patterns and Association Rules: Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Efficient and Scalable Frequent Item set Mining Methods: Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori, FP growth, Mining frequent Itemsets using Vertical Data Format, Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules	8
6.0	Spatial and Web Mining: Spatial Data, Spatial Vs. Classical Data Mining, Spatial Data Structures, Mining Spatial Association and Co-location Patterns, Spatial Clustering Techniques: CLARANS Extension, Web Mining: Web Content Mining, Web Structure Mining, Web Usage mining, Applications of Web Mining	6
Total		52

Text Books:

1. PaulrajPonniah, “Data Warehousing: Fundamentals for IT Professionals”, Wiley India.
2. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd edition.
3. ReemaTheraja “Data warehousing”, Oxford University Press.
4. M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education.

Reference Books:

1. Ian H. Witten, Eibe Frank and Mark A. Hall " Data Mining ", 3rd Edition Morgan kaufmann publisher.
2. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to Data Mining", Person Publisher.
3. R. Chattamvelli, "Data Mining Methods" 2nd Edition NarosaPublishing House.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC604	Cryptography and System Security	4

Course Objectives:

1. To introduce classical encryption techniques and concepts of modular arithmetic and number theory.
2. To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
3. To explore the design issues and working principles of various authentication protocols, PKI standards and various secure communication standards including Kerberos, IPsec, and SSL/TLS and email.
4. To develop the ability to use existing cryptographic utilities to build programs for secure communication.

Course Outcomes: At the end of the course learner will able to

1. Understand system security goals and concepts, classical encryption techniques and acquire fundamental knowledge on the concepts of modular arithmetic and number theory.
2. Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
3. Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes.
4. Apply different digital signature algorithms to achieve authentication and design secure applications
5. Understand network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPsec, and PGP.
6. Analyze and apply system security concept to recognize malicious code.

Detailed Syllabus:

Module No	Unit No	Detailed Content	Hrs
1	Introduction & Number Theory		10
	1.1	Security Goals, Services, Mechanisms and attacks, The OSI security architecture, Network security model, Classical Encryption techniques, Symmetric cipher model, mono-alphabetic and poly-alphabetic substitution techniques: Vigenere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers, steganography.	
	1.2	Modular Arithmetic and Number Theory:- Euclid's algorithm—Prime numbers-Fermat's and Euler's theorem- Testing for primality -The Chinese remainder theorem, Discrete logarithms.	
2	Symmetric and Asymmetric key Cryptography and key Management		12

	2.1	Block cipher principles, block cipher modes of operation, DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Stream Ciphers: RC5 algorithm.	
	2.2	Public key cryptography: Principles of public key cryptosystems-The RSA algorithm, The knapsack algorithm, ElGamal Algorithm.	
	2.3	Key management techniques: using symmetric and asymmetric algorithms and trusted third party. Diffie Hellman Key exchange algorithm.	
	Hashes, Message Digests and Digital Certificates		06
3	3.1	Cryptographic hash functions, Properties of secure hash function, MD5, SHA-1, MAC, HMAC, CMAC.	
	3.2	Digital Certificate: X.509, PKI	
	Authentication Protocols & Digital signature schemes		08
4	4.1	User Authentication and Entity Authentication, One-way and mutual authentication schemes, Needham Schroeder Authentication protocol, Kerberos Authentication protocol.	
	4.2	Digital Signature Schemes – RSA, ElGamal and Schnorr signature schemes.	
	Network Security and Applications		10
	5.1	Network security basics: TCP/IP vulnerabilities (Layer wise), Packet Sniffing, ARP spoofing, port scanning, IP spoofing, TCP syn flood, DNS Spoofing.	
5	5.2	Denial of Service: Classic DOS attacks, Source Address spoofing, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service, Defenses against Denial of Service Attacks.	
	5.3	Internet Security Protocols: SSL, IPSEC, Secure Email: PGP, Firewalls, IDS and types, Honey pots	
	System Security		06
6	6.1	Software Vulnerabilities: Buffer Overflow, Format string, cross-site scripting, SQL injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits.	

Text Books:

1. William Stallings, Cryptography and Network Security, Principles and Practice, 6th Edition, Pearson Education, March 2013
2. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata Mc Graw Hill
3. Bernard Menezes, "Cryptography & Network Security", Cengage Learning.
4. Network Security Bible, Eric Cole, Second Edition, Wiley.

Reference Books:

1. Applied Cryptography, Protocols Algorithms and Source Code in C, Bruce Schneier, Wiley.
2. Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill.

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

1. Question paper will comprise of total six questions.
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code	Course Name	Credits
CSDLO6021	Machine Learning	04

Course Objectives:

- 1 To introduce students to the basic concepts and techniques of Machine Learning.
- 2 To become familiar with regression methods, classification methods, clustering methods.
- 3 To become familiar with Dimensionality reduction Techniques.

Course Outcomes: Students will be able to-

1. Gain knowledge about basic concepts of Machine Learning
2. Identify machine learning techniques suitable for a given problem
3. Solve the problems using various machine learning techniques
4. Apply Dimensionality reduction techniques.
5. Design application using machine learning techniques

Pre-requisites: Data Structures, Basic Probability and Statistics, Algorithms

Module No.	Unit No.	Topics	Hrs.
1		Introduction to Machine Learning Machine Learning, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application.	6
2		Introduction to Neural Network Introduction – Fundamental concept – Evolution of Neural Networks – Biological Neuron, Artificial Neural Networks, NN architecture, Activation functions, McCulloch-Pitts Model.	8
3		Introduction to Optimization Techniques: Derivative based optimization- Steepest Descent, Newton method. Derivative free optimization- Random Search, Down Hill Simplex	6
4		Learning with Regression and trees: Learning with Regression : Linear Regression, Logistic Regression. Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index, Classification and Regression Trees (CART).	10
5		Learning with Classification and clustering:	14
	5.1	Classification: Rule based classification, classification by Bayesian Belief networks, Hidden Markov Models. Support Vector Machine: Maximum Margin Linear Separators, Quadratic Programming solution to finding maximum margin separators, Kernels for learning non-linear functions.	
	5.2	Clustering: Expectation Maximization Algorithm, Supervised learning	

		after clustering, Radial Basis functions.	
6		Dimensionality Reduction: Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis, Single value decomposition	8
		Total	52

Text Books:

1. Peter Harrington “Machine Learning In Action”, DreamTech Press
2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press
3. Tom M.Mitchell “Machine Learning” McGraw Hill
4. Stephen Marsland, “Machine Learning An Algorithmic Perspective” CRC Press
5. J.-S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
6. Samir Roy and Chakraborty, “Introduction to soft computing”, Pearson Edition.
7. Kevin P. Murphy , Machine Learning “ A Probabilistic Perspective”

Reference Books:

1. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers
2. Margaret.H.Dunham, “Data Mining Introductory and Advanced Topics”, Pearson Education

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- The students need to solve total 4 questions.
- Question No.1 will be compulsory and based on entire syllabus.
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

Suggested Experiment work :

1. To implement Linear Regression.
2. To implement Logistic Regression.
3. To implement SVM.
4. To implement PCA.
5. To implement Steepest Descent
6. To implement Random search
7. To implement Naïve Baysian algorithm.
8. To implement Single layer Perceptron Learning algorithm
9. To implement Radialbasis functions.
10. Case study based on any ML technique

**** Laboratory work based on above syllabus is incorporate as mini project in CSM605: Mini-Project.**

Course Code	Course Name	Credits
CSDLO6022	Advanced Database Management System	4

Course objectives:

1. To provide overview of indexing and hashing techniques
2. To impart knowledge of query processing and optimization
3. To provide an overview of distributed database systems.
4. To introduce the concept of document oriented database.
5. To create awareness about potential security threats to a database and mechanisms to handle it.
6. Understand the usage of advanced data models for real life application.

Course outcomes: On successful completion of course learner will be able to:

1. Build indexing mechanisms for efficient retrieval of information from databases.
2. Measure query cost and optimize query execution
3. Design distributed database for better resource management
4. Demonstrate the understanding of the concepts of document oriented databases.
5. Apply appropriate security techniques database systems.
6. Implement advanced data models for real life applications.

Prerequisite: Basic knowledge of Database management System.

Module No.	Unit No.	Topics	Hrs.
1.0		Indexing and Hashing Techniques	8
	1.1	Indexing and Hashing: <ul style="list-style-type: none"> • Operation on Files • Hashing Techniques; Static and dynamic • Types of Single-Level Ordered Indexes; Multilevel Indexes; Dynamic Multilevel Indexes Using B-Trees and B+-Trees; Indexes on Multiple Keys, 	
2.0		Query processing and Optimization	12
		Query Processing : <ul style="list-style-type: none"> • Overview • Measures of Query cost • Selection operation • Sorting • Join Operations, and other Operations Evaluation of Expression Query Optimization : <ul style="list-style-type: none"> • Translations of SQL Queries into relational algebra • Heuristic approach & cost based optimization 	

3.0		Distributed Databases	12
	3.1	<ul style="list-style-type: none"> Types of Distributed Database Systems; Distributed Database Architectures; Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design 	
	3.2	<ul style="list-style-type: none"> Distributed Query Processing (Semi join) distributed Transaction Management in Distributed Databases distributed Concurrency Control (locking) , Recovery in Distributed Databases {2PC/3PC} and deadlock management. 	
4		Document oriented database	
		<ul style="list-style-type: none"> Need of object oriented database. Impedance matching problem between OO languages and Relational database, Case study db4O Need of Document Oriented database, difference between Document Oriented Database and Traditional database. Types of encoding XML, JSON, BSON, Representation XML, Json Objects. Case study on doc oriented based such a Mariadb 	8
5		Advanced data models	6
	5.1	<ul style="list-style-type: none"> Temporal data models :- Aspects of valid time , Bi-temporal time and bi-temporal time with examples of each. Spatial model :- Types of spatial data models - Raster, Vector and Image Mobile databases 	
	5.2	<ul style="list-style-type: none"> Multimedia databases 	
6		Data Security	6
	6.1	<ul style="list-style-type: none"> Introduction to Database Security Issues; authorization , Discretionary Access Control Based on Granting and Revoking Privileges Mandatory Access Control and Role-Based 	

	6.2	Access Control for Multilevel Security <ul style="list-style-type: none"> • SQL Injection • Introduction to Statistical Database Security Introduction to Flow Control 	
		Total	52

Text Books:

1. Elmasri&Navathe“ fundamentals of Database Systems” IV edition. PEARSON Education.
2. Korth, Silberschatzsudarshan “Database systems, concepts” 5th edition McGraw Hill
3. Raghu Ramkrishnan& Johannes Gehrke “Database Management System” Tata McGraw Hill. III edition.
4. Ruosell J.T. Dyer, Learning MySQL and Mariadb.

Reference Books:

1. Chhanda Ray , “Distributed Database System”, Pearson Education India.
2. Hector Garcia-Molina, Jeffery D. Ullman, Jennifer Widom , “ Database system Implementation”
3. Thomas M.Connolly Carolyn Begg, Database Systems : A practical Approach to Design , Implementation and Management, 4/e.

Suggested mini. Project / Experiment work:

1. Given problem statement 2/3 student to perform-
 - a. Design EER model and perform sorting, join operations for the specified problem statement.
 - b. Perform the various fragmentation (Horizontal, Vertical, Derived) and check its correctness criteria.
 - c. Perform two phase commit protocol (2PC)
2. Mini Project / Case study on document oriented database such a Mariadb
3. Mini Project Case study Development of an application based on any one advance data model (temporal, Spatial Multimedia)

**** Perform Laboratory (Experiments) work in the in CSM605:Mini-Project**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- 1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSDLO6023	Enterprise Resource Planning(ERP)	4

Course Objectives:

1. To understand the technical aspects and life cycle of ERP systems.
2. To understand the steps and activities in ERP.
3. To identify and describe different types of ERP system.
4. To understand tools and methodology used for designing ERP for an Enterprise.

Course Outcomes: After completion of this course, students will be able ..

1. To understand the basic structure of ERP.
2. To identify implementation strategy used for ERP.
3. To apply design principles for various business modules in ERP.
4. To apply different emerging technologies for implementation of ERP.
5. To analyze security issues in ERP.
6. To acquire ERP concepts for real world applications.

Pre-requisites: Web Engineering, Computer Network, Database Systems

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Enterprise Resource Planning (ERP) Information System and Its Components, Value Chain Framework, Organizational Functional Units, Evolution of ERP Systems, Role of ERP in Organization, Three-Tier Architecture of ERP system.	8
2.0		ERP and Implementation ERP implementation and strategy, Implementation Life cycle, Pre-implementation task, requirement definition, implementation Methodology.	8
3.0		ERP Business Modules	8
	3.1	Finance, manufacturing, human resources, quality management, material management, marketing, Sales distribution and service.	
	3.2	Case study on Supply Chain management (SCM), Customer relationship Management (CRM)	
4.0		Introduction to ERP related Technologies	10
	4.1	Business Process Re-engineering (BPR) ,Data warehousing ,Data Mining, On- line Analytical Processing(OLAP), Product Life Cycle Management (PLM)	
	4.2	Geographical Information Management ,RFID, QR Code ,Bar	

		Coding, E-commerce and their application in Enterprise planning	
5.0		Extended ERP and security issues	8
	5.1	Enterprise application Integration (EAI), open source ERP, cloud ERP	
	5.2	Managing ERP Securities: Types of ERP security Issues, System Access security, Data Security and related technology for managing data security	
6.0		Cases of ERP for Enterprises.	10
	6.1	Cases of ERP like MySAP for Business suite implementation at ITC, ERP for Nestle GLOBE Project, Oracle ERP Implementation at Maruti Suzuki.	
	6.2	Need of ERP for Small and Medium size enterprises.(Zaveri)	
		Total	52

Text Books:

1. Alexis Leon, ERP Demystified: II Edition, Tata McGraw Hill.
2. Rajesh Ray, Enterprise Resource Planning, Text and cases, Tata McGraw Hill.
3. Sandeep Desai, Abhishek Srivastava, ERP to E² ERP: A Case study approach, PHI.
4. Jyotindra Zaveri, Enterprise Resource Planning, Himalaya Publishing House, 2012.

Reference Books:

1. V.K. Garg & N.K. Venkatakrishnan, Enterprise Resource Planning: concepts & practices, by ; PHI.
2. Supply Chain Management Theories & Practices: R. P. Mohanty, S. G. Deshmukh, - Dreamtech Press.
3. Enterprise wide resource planning: Theory & practice: by Rahul Altekar, PHI
4. Customer Relationship Management, Concepts and cases, Second Edition.

Mini Project / Laboratory Work:

1. Give case study 2/3 student of any organization. Make a report before-after situation at organization (Domain).
2. Make a list of Resource of the Selected Domain.
3. Categorized the Resource as per the function level process and Identify module of the domain.
4. Explain process of each module of the domain.
5. Perform Business process re-engineering (BPR) on selected Module.
6. Implement new system based on BPR.
7. Perform Impact analysis of the new system as the BPR.
 - a. Prepare study on JD Edward Tool.

- b. Prepare study on Microsoft Dynamics.
8. Download any open source ERP Tool and prepare Installation Guideline and information about the Tool.
9. Make Data Entry in the Software in all modules & generate report.

**** Perform Laboratory (Experiments) work in the in CSM605:Mini-Project.**

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- 1 Question paper will comprise of 6 questions, each carrying 20 marks.
 - The students need to solve total 4 questions.
 - Question No.1 will be compulsory and based on entire syllabus.
 - Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSDLO6024	Advanced Computer Network	4

Course Objective:

1. To make learners aware about advances in computer networking technologies.
2. To give overview of advance internet, QoS based and management protocols.
3. To introduce issues related to traffic engineering and capacity planning.

Course Outcomes: On successful completion of course learner will be able to

1. Demonstrate the understanding of advance data communication technologies.
2. Demonstrate the understanding of WAN Technology typically ATM .
3. Demonstrate the understanding of packet switching protocols such as X.25, X.75.
4. Explore the issues of advance internet routing protocols and also QoS based protocols.
5. Analyze issues of traffic requirements and perform capacity planning.
6. Demonstrate the understanding of protocol used for management of network.

Prerequisite: Computer Networks, ISO OSI Layered Protocols, TCP/IP protocol suite.

Module No.	Unit No.	Topics	Hrs.
1	Data Communications:		06
	1.1	Defining Data Communication needs, Transmission Hierarchy	
	1.2	Optical Networks: SONET/SDH standard, Architecture, Format, Hardware, Configuration, advantages	
2	WAN Technology:		10
	2.1	Introducing ATM Technology, Need and Benefit, Concept, Faces of ATM	
	2.2	Why ATM, BISDN Reference Model, ATM Layer, ATM Adaptation Layer, ATM Signaling	
3	Protocols and Interfaces:		10
	3.1	Introduction to TCP/IP: Issues in IPV4, IPV6 protocol	
	3.2	Mature Packet Switching Protocols: ITU Recommendation X.25, User Connectivity, Theory of Operations, Network Layer Functions, X.75 Internetworking Protocol, Advantages and Drawbacks	

	Advance Routing Protocols:	14
4	4.1	Internet Routing Protocols : OSPF, RIP, BGP Multicast Routing: Reverse Path Broadcasting, Internet Group Management Protocol, Reverse Path Multicasting, Discrete Vector Multicasting protocol
	4.2	IP forwarding Architectures Overlay Model: Classical IP over ATM and LANE
	4.3	Multiprotocol Label Switching MPLS : Fundamentals of Labels, Label Stack, VC Merging, Label Distribution Protocol, Explicit routing for Traffic Engineering
	4.4	Integrated services, RSVP, Differentiated Services
	4.5	MultiMedia Over Internet: RTP, Session Control Protocol H.323
	Traffic Engineering :	08
5	5.1	Requirement Definition: User requirement Traffic Sizing , Traffic Characteristics, Protocols, Time and Delay Considerations
	5.2	Traffic Engineering and Capacity planning: Throughput calculation, Traffic Engineering basics, Traditional traffic Engineering and Queued data and Packet Switched packet modeling, Queuing Disciplines (M/M/1), Design parameters for Peak: delay or latency, availability and reliability.
6	Network management	
	6.1	Network Management : SNMP Concept and format, Management Components: SMI, MIB

Text Books:

1. M. A. Gallo and W. M. Hancock, Computer Communications and Networking Technologies, Cengage Learning, (1e).
2. Leon-Garcia, Communication Networks, Tata McGraw-Hill.
3. Darren L. Spohn, Data Network Design, Tata McGraw-Hill.
4. BehrouzForouzan, TCP/IP Protocol Suite ,McGraw-Hill, (5e).
5. William Stallings, High-Speed Networks and Internets, Pearson Education, (2e).

Reference Books:

1. Andrew Tanenbaum“ Computer Networks”, Prentice Hall, (5e).
2. Cisco Certified Network Analyst study guide, Wiley Publishing House.(7e).
3. Douglas E. Comer, Internetworking with TCP/IP Volume One, (6e).
4. James F. Kurose, Keith W. Ross, “Computer Networking, A Top-Down Approach Featuring the Internet”,Addison Wesley, (5e).

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Lab Code	Lab Name	Credits
CSL601	Software Engineering Lab	1

Lab Outcome:

On successful completion of laboratory sessions, learners will be able to

1. Identify requirements and apply process model to selected case study.
2. Analyze and design models for the selected case study using UML modeling.
3. Use various software engineering tools.

Description:

The Software Engineering Lab has been developed by keeping in mind the following objectives:

- Select case studies to solve real life problems by applying software engineering principles.
- To impart state-of-the-art knowledge on Software Engineering and UML.

List of Experiments:

Laboratory work will be based on course syllabus with minimum 10 experiments to be incorporated.

Assign case study to a group of two/three students and each group to perform the following experiments on their case study.

Sr. No.	Title of Experiments
1	Prepare detailed statement of problem for the selected / allotted mini project and identify suitable process model for the same with justification.
2	Develop Software Requirement Specification (SRS) document in IEEE format for the project.
3	Use project management tool to prepare schedule for the project.
4	Prepare RMMM plan for the project.
5	Identify scenarios & develop UML Use case and Class Diagram for the project.
6	Draw DFD (upto 2 levels) and prepare Data Dictionary for the project.
7	Develop Activity / State Transition diagram for the project.
8	Develop Sequence and Collaboration diagram for the project.
9	Change specification and make different versions using any SCM Tool.
10	Develop test cases for the project using white box testing.

Digital Material:

Practical can be conducted using any open source software tools like Dia, Star UML, etc.

Term Work:

Term work (25 Marks) shall consist of

- Laboratory work 15 marks
- Two assignments ... 05 marks
- Attendance (theory and practical) 05 marks

Oral exam will be based on CSC601 and CSL601 syllabus.

Lab Code	Lab Name	Credits
CSL602	System Software Lab	1

Outcome: At the end of the course learner will be able to

1. Generate machine code by using various databases generated in pass one of two pass assembler.
2. Construct different databases of single pass macro processor.
3. Identify and validate different tokens for given high level language code.
4. Parse the given input string by constructing Top down /Bottom up parser.
5. Implement synthesis phase of compiler with code optimization techniques.
6. Explore various tools like LEX and YACC.

Description: The current System Software is highly complex with huge built in functionality offered to the programmer to develop complex applications with ease. This laboratory course aims to make a student understand-

- The need for modular design
- The need for well-defined data structures and their storage management
- The increase in the complexity of translators as we move from assembly level to high level programming
- The need to produce an efficient machine code that is optimized for both execution speed and memory requirement
- The efficient programming constructs that make them a good coder

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Implementations of two pass Assembler.
2	Implementation of single pass Macro Processor.
4	Implementation of Lexical Analyzer.
5	Implementation of Parser (Any one).
6	Implementation of Intermediate code generation phase of compiler.
7	Implementation of code generation phase of compiler.
8	Study and implement experiments on LEX, YACC, Grey Box Probing.

Reference Books:

1. Modern Compiler. Implementation in Java, Second. Edition. Andrew W. Appel Princeton University. Jens Palsberg Purdue University. CAMBRIDGE.
2. Crafting a compiler with C, Charles N. Fischer, Ron K. Cytron, Richard J. LeBlanc .

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/case studies):(15) Marks.
- Assignment: (05) Marks.
- Attendance (05) Marks
- TOTAL: (25) Marks.**

Oral & Practical exam will be based on the above and **CSC602** syllabus.

Lab Code	Lab Name	Credits
CSL603	Data Warehousing and Mining Lab	1

Lab Outcome:

1. Design data warehouse and perform various OLAP operations.
2. Implement classification, prediction, clustering and association rule mining algorithms.
3. Demonstrate classifications, prediction, clustering and association rule mining algorithms on a given set of data sample using data mining tools.
4. Implement spatial and web mining algorithms.

Description:

An operational database undergoes frequent changes on a daily basis on account of the transactions that take place. A data warehouses provides us generalized and consolidated data in multidimensional view. Data mining functions such as classification, prediction, clustering, and association rule mining can be integrated with OLAP operations to enhance the interactive mining of knowledge at multiple level of abstraction. Data mining supports knowledge discovery by finding hidden patterns and associations, constructing analytical models, performing classification and prediction, these mining results can be demonstrated using the data mining tools.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Build Data Warehouse/Data Mart for a given problem statement i) Identifying the source tables and populating sample data ii) Design dimensional data model i.e. Star schema, Snowflake schema and Fact Constellation schema (if applicable)
2	To perform various OLAP operations such as slice, dice, drilldown, rollup, pivot
3	Implementation of Classification algorithm(Decision Tree/ Bayesian)
4	Implementation of Linear Regression.
5	Implementation of Clustering algorithm(K-means/ Agglomerative).
6	Implementation of Association Rule Mining algorithm(Apriori).

7	Perform data Pre-processing task and Demonstrate performing Classification, Clustering, Association algorithm on data sets using data mining tool (WEKA,R tool, XL Miner, etc.)
8	Implementation of page rank algorithm.
9	Implementation of HITS algorithm.
10	Implementation of Spatial Clustering Algorithm- CLARANS Extensions

Term Work:

Laboratory work will be based on above syllabus with minimum 08 experiments to be incorporated.

Experiments ----- (15) Marks
 Assignment----- (05) Marks
 Attendance (Theory + Practical) ----- (05) Marks
Total ----- (25) Marks

Oral & Practical exam will be based on the above and CSC603:“Data Warehousing and Mining” syllabus.

Lab Code	Lab Name	Credit
CSL604	System Security Lab	01

Lab Outcome:

Learner will able to

1. To be able to apply the knowledge of symmetric cryptography to implement simple ciphers.
2. To be able to analyze and implement public key algorithms like RSA and El Gamal.
3. To analyze and evaluate performance of hashing algorithms.
4. To explore the different network reconnaissance tools to gather information about networks.
5. To explore and use tools like sniffers, port scanners and other related tools for analysing packets in a network.
6. To be able to set up firewalls and intrusion detection systems using open source technologies and to explore email security.
7. To be able to explore various attacks like buffer-overflow, and web-application attacks.

Suggested Experiment List: (Any 10)

Sr. No	Description
1	Design and Implementation of a product cipher using Substitution and Transposition ciphers
2	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal.
3	Implementation of Diffie Hellman Key exchange algorithm
4	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs
5	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.
6	Study of packet sniffer tools : wireshark, : 1. Download and install wireshark and capture icmp, tcp, and http packets in promiscuous mode. 2. Explore how the packets can be traced based on different filters.
7	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, xmas scan etc.
8	Detect ARP spoofing using nmap and/or open source tool ARPWATCH and wireshark. Use arping tool to generate gratuitous arps and monitor using wireshark
9	Simulate DOS attack using Hping, hping3 and other tools.
10	Simulate buffer overflow attack using Ollydbg, Splint, Cppcheck etc

11	a. Set up IPSEC under LINUX. b. Set up Snort and study the logs.
12	Setting up personal Firewall using iptables
13	Explore the GPG tool of linux to implement email security
14	SQL injection attack, Cross-Cite Scripting attack simulation

Reference Books:

1. Build your own Security Lab, Michael Gregg, Wiley India
2. CCNA Security, Study Guide, TIm Boyles, Sybex.
3. Network Security Bible, Eric Cole, Wiley India.
4. Web Application Hacker’s Handbook, Dafydd Stuttard, Marcus Pinto, Wiley India.

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Experiments -----	(15) Marks
Assignment-----	(05) Marks
Attendance (Theory + Practical) -----	(05) Marks
Total -----	(25) Marks

Oral & practical examination will be based on the above and Cryptography and System Security (CSC604) syllabus.

Lab Code	Lab Name	Credit
CSM605	Mini-Project	2

Lab Outcome: After successful completion of this Lab student will be able to

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
3. Contribute as an individual or in a team in development of technical projects
4. Develop effective communication skills for presentation of project related activities

Description:

Mini project may be carried out in one or more form of following:

Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software and hardware, statistical data analysis, creating awareness in society, etc.

Guidelines:

- A project to be developed based on one or more of the following fields- Advance Database Management System, Enterprise Resource Planning, Advance Operating System, Advance Computer Network, etc.
- Mini project may be carried out a group of 2 /3 students. The student is required to submit a report based on the work. The evaluation of the project shall be on continuous basis.

Term Work (TW):

Distribution of marks for term work shall be as follows:

- | | |
|----------------------------------|----------|
| 1. Attendance | 05 Marks |
| 2. Mini project work | 10 Marks |
| 3. Project Report (Spiral Bound) | 10 Marks |

The final certification and acceptance of TW ensures the satisfactory performance on the above three aspects.

Oral & Practical Examination should be conducted by internal and external examiners appointed by University of Mumbai. Students have to give presentation and demonstration on the Mini-Project.

Course Code	Course Name	Credits
CSC701	Digital Signal & Image Processing	4

Course objectives:

1. To understand the fundamental concepts of digital signal processing and Image processing.
2. To explore DFT for 1-D and 2-D signal and FFT for 1-D signal
3. To apply processing techniques on 1-D and Image signals.
4. To apply digital image processing techniques for edge detection.

Course outcomes: On successful completion of the course learner will be able to:

1. Apply the concept of DT Signal and DT Systems.
2. Classify and analyze discrete time signals and systems
3. Implement Digital Signal Transform techniques DFT and FFT.
4. Use the enhancement techniques for digital Image Processing
5. Differentiate between the advantages and disadvantages of different edge detection techniques
6. Develop small projects of 1-D and 2-D Digital Signal Processing.

Prerequisite: Applied Mathematics

Module No.	Unit No.	Topic details	Hrs.
1.0		Discrete-Time Signal and Discrete-Time System	14
	1.1	Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations(shifting, reversal, scaling, addition, multiplication).	
	1.2	Classification of Discrete-Time Signals, Classification of Discrete-Systems	
	1.3	Linear Convolution formulation for 1-D and 2-D signal (without mathematical proof), Circular Convolution (without mathematical proof), Linear convolution using Circular Convolution. Auto and Cross Correlation formula evaluation, LTI system, Concept of Impulse Response and Step Response, Output of DT system using Time Domain Linear Convolution.	
2.0		Discrete Fourier Transform	08
	2.1	Introduction to DTFT, DFT, Relation between DFT and DTFT, IDFT	
	2.2	Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parsevals' Energy Theorem). DFT computation using DFT properties.	
	2.3	Transfer function of DT System in frequency domain using DFT. Linear and Circular Convolution using DFT, Convolution of long sequences, Introduction to 2-D DFT	
3.0		Fast Fourier Transform	06
	3.1	Need of FFT, Radix-2 DIT-FFT algorithm,	

Module No.	Unit No.	Topic details	Hrs.
	3.2	DIT-FFT Flow graph for N=4 and 8, Inverse FFT algorithm.	
	3.3	Spectral Analysis using FFT	
4.0		Digital Image Fundamentals	08
	4.1	Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization	
	4.2	Representation of Digital Image, Connectivity	
	4.3	Image File Formats: BMP, TIFF and JPEG.	
5.0		Image Enhancement in Spatial domain	10
	5.1	Gray Level Transformations, Zero Memory Point Operations,	
	5.2	Histogram Processing, Histogram equalization.	
	5.3	Neighborhood Processing, Spatial Filtering, Smoothing and Sharpening Filters, Median Filter.	
6.0		Image Segmentation	06
	6.1	Segmentation based on Discontinuities (point, Line, Edge),	
	6.2	Image Edge detection using Robert, Sobel, Prewitt masks, Image Edge detection using Laplacian Mask.	
		Total	52

Text Books:

1. John G. Proakis, Dimitris and G.Manolakis, 'Digital Signal Processing: Principles, Algorithms, and Applications' 4th Edition 2007, Pearson Education.
2. A. Anand Kumar, 'Digital Signal Processing', PHI Learning Pvt. Ltd. 2013.
3. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, 3rd Edition, 2009,
4. S. Sridhar, 'Digital Image Processing', Oxford University Press, Second Edition, 2012.

Reference Books:

1. Sanjit Mitra, 'Digital Signal Processing: A Computer Based Approach', TataMcGraw Hill, 3rd Edition.
2. S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, 'Digital Signal Processing' Tata McGraw Hill Publication 1st Edition (2010).
3. S. Jayaraman, E. Esakkirajan and T. Veerkumar, 'Digital Image Processing' TataMcGraw Hill Education Private Ltd, 2009.
4. Anil K. Jain, 'Fundamentals and Digital Image Processing', Prentice Hall of India Private Ltd, 3rd Edition.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 50% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC702	Mobile Communication & Computing	4

Course objectives:

1. To introduce the basic concepts and principles in mobile computing. This includes major techniques involved, and networks & systems issues for the design and implementation of mobile computing systems and applications.
2. To explore both theoretical and practical issues of mobile computing.
3. To provide an opportunity for students to understand the key components and technologies involved and to gain hands-on experiences in building mobile applications.

Course outcomes: On successful completion of course learner will be able:

1. To identify basic concepts and principles in mobile communication & computing, cellular architecture.
2. To describe the components and functioning of mobile networking.
3. To classify variety of security techniques in mobile network.
4. To apply the concepts of WLAN for local as well as remote applications.
5. To describe and apply the concepts of mobility management
6. To describe Long Term Evolution (LTE) architecture and its interfaces.

Prerequisite: Computer Networks

Module No.	Unit No.	Topics	Hrs
1.0	1.1	Introduction to Mobile Computing, Telecommunication Generations, Cellular systems,	06
	1.2	Electromagnetic Spectrum, Antenna ,Signal Propagation, Signal Characteristics, , Multiplexing, Spread Spectrum: DSSS & FHSS	
2.0	2.1	GSM Mobile services, System Architecture, Radio interface, Protocols , Localization and Calling, Handover, security (A3,A5 & A8)	10
	2.2	GPRS system and protocol architecture	
	2.2	UTRAN , UMTS core network ; Improvements on Core Network,	
3.0	3.1	Mobile Networking : Medium Access Protocol, Internet Protocol and Transport layer	12
	3.2	Medium Access Control: Motivation for specialized MAC, , Introduction to multiple Access techniques (MACA)	

	3.3	Mobile IP: IP Packet Delivery, Agent Advertisement and Discovery, Registration, Tunneling and Encapsulation, Reverse Tunneling, Routing (DSDV,DSR)	
	3.4	Mobile TCP : Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Fast Retransmit/ Fast Recovery, Transmission/Timeout Freezing, Selective Retransmission	
4.0	4.1	Wireless Local Area Networks : Introduction, Infrastructure and ad-hoc network	08
	4.2	IEEE 802.11 :System architecture , Protocol architecture , Physical layer, Medium access control layer, MAC management, 802.11a, 802.11b	
	4.3	Wi-Fi security : WEP ,WPA, Wireless LAN Threats , Securing Wireless Networks	
	4.4	HiperLAN 1 & HiperLAN 2	
	4.5	Bluetooth: Introduction, User Scenario, Architecture, protocol stack	
5.0	5.1	Mobility Management : Introduction, IP Mobility, Optimization, IPv6	06
	5.2	Macro Mobility : MIPv6, FMIPv6,	
	5.3	Micro Mobility: CellularIP, HAWAII, HMIPv6,	
6.0	6.1	Long-Term Evolution (LTE) of 3GPP : LTE System Overview, Evolution from UMTS to LTE	10
	6.2	LTE/SAE Requirements, SAE Architecture	
	6.3	EPS: Evolved Packet System, E-UTRAN, Voice over LTE (VoLTE), Introduction to LTE-Advanced,	
	6.4	System Aspects, LTE Higher Protocol Layers, LTE MAC layer, LTE PHY Layer,	
	6.5	Self Organizing Network (SON-LTE),SON for Heterogeneous Networks (HetNet), Introduction to 5G	
		Total	52

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

- 1 Jochen Schiller, "Mobile Communication", Addison Wesley, Pearson Education
- 2 "Wireless Communications & Networks," By William Stallings, Second Edition, Pearson Education
- 3 Raj Kamal, Mobile Computing, 2/e, Oxford University Press-New Delhi

Reference Books:

- 1 LTE Self-Organizing Networks (SON): Network Management Automation for Operational Efficiency, [Seppo Hamalainen](#), [Henning Sanneck](#), [Cinzia Sartori](#), Wiley publications
- 2 Christopher Cox, "An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications," Wiley publications
- 3 Mobility Protocols and Handover Optimization: Design, Evaluation and Application By Ashutosh Dutta, Henning Schulzrinne, IEEE Press, Wiley Publication
- 4 Michael Gregg, "Build your own security lab," Wiley India edition
- 5 Emerging Wireless Technologies and the Future Mobile Internet, Dipankar Raychaudhuri, Mario Gerla, Cambridge.
- 6 Andreas F.Molisch, "Wireless Communications," Second Edition, Wiley Publications.

Course Code	Course Name	Credits
CSC703	Artificial Intelligence & Soft Computing	4

Course Objectives (CO):

- 1 To conceptualize the basic ideas and techniques of AI and SC.
- 2 To distinguish various search techniques and to make student understand knowledge representation and planning.
- 3 To become familiar with basics of Neural Networks and Fuzzy Logic.
- 4 To familiarize with Hybrid systems and to build expert system.

Course Outcomes: Students should be able to -

- 1 Identify the various characteristics of Artificial Intelligence and Soft Computing techniques.
- 2 Choose an appropriate problem solving method for an agent to find a sequence of actions to reach the goal state.
- 3 Analyse the strength and weakness of AI approaches to knowledge representation, reasoning and planning.
- 4 Construct supervised and unsupervised ANN for real world applications.
- 5 Design fuzzy controller system.
- 6 Apply Hybrid approach for expert system design.

Pre-requisites: Basic Mathematics, Algorithms

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Artificial Intelligence(AI) and Soft Computing	4
	1.1	Introduction and Definition of Artificial Intelligence.	
	1.2	Intelligent Agents : Agents and Environments ,Rationality, Nature of Environment, Structure of Agent, types of Agent	
	1.3	Soft Computing: Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques.	
2.0		Problem Solving	10
	2.1	Problem Solving Agent, Formulating Problems, Example Problems	
	2.2	Uninformed Search Methods: Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Method: A* Search	
	2.3	Optimization Problems: Hill climbing Search, Simulated annealing, Genetic algorithm	
3.0		Knowledge, Reasoning and Planning	10
	3.1	Knowledge based agents	
	3.2	First order logic: syntax and Semantic, Knowledge Engineering in FOL Inference in FOL : Unification, Forward Chaining, Backward Chaining and Resolution	
	3.3	Planning Agent, Types of Planning: Partial Order, Hierarchical Order, Conditional Order	
4.0		Fuzzy Logic	12

	4.1	Introduction to Fuzzy Set: Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, membership functions,	
	4.2	Fuzzy Logic: Fuzzy Logic basics, Fuzzy Rules and Fuzzy Reasoning	
	4.3	Fuzzy inference systems: Fuzzification of input variables, defuzzification and fuzzy controllers.	
5.0		Artificial Neural Network	12
	5.1	Introduction – Fundamental concept– Basic Models of Artificial Neural Networks – Important Terminologies of ANNs – McCulloch-Pitts Neuron	
	5.2	Neural Network Architecture: Perceptron, Single layer Feed Forward ANN, Multilayer Feed Forward ANN, Activation functions, Supervised Learning: Delta learning rule, Back Propagation algorithm.	
	5.3	Un-Supervised Learning algorithm: Self Organizing Maps	
6.		Expert System	4
	6.1	Hybrid Approach - Fuzzy Neural Systems	
	6.2	Expert system : Introduction, Characteristics, Architecture, Stages in the development of expert system,	
		Total	52

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach "Second Edition" Pearson Education.
2. Samir Roy and Chakraborty, "Introduction to soft computing", Pearson Edition.
3. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
4. S.Rajasekaran and G.A.VijayalakshmiPai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning.
5. N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press.

Reference Books:

1. Elaine Rich and Kevin Knight "Artificial Intelligence" Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
2. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
3. Zimmermann H.S "Fuzzy Set Theory and its Applications"Kluwer Academic Publishers.
4. Hagan, Demuth, Beale,"Neural Network Design" CENGAGE Learning, India Edition.
5. J.-S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
6. JacekM.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSDLO7031	Advanced System Security and Digital Forensics	4

Course Objectives:

1. To understand cyber attacks and defence strategies.
2. To understand underlying principles of access control mechanisms.
3. To explore software vulnerabilities, attacks and protection mechanisms of wireless networks and protocols, mobile devices and web applications.
4. To develop and mitigate security management and policies.
5. To understand and explore techniques used in digital forensics.

Course Outcomes: At the end of the course learner will able to

1. Understand cyber attacks and apply access control policies and control mechanisms.
2. Identify malicious code and targeted malicious code.
3. Detect and counter threats to web applications.
4. Understand the vulnerabilities of Wi-Fi networks and explore different measures to secure wireless protocols, WLAN and VPN networks.
5. Understand the ethical and legal issues associated with cyber crimes and be able to mitigate impact of crimes with suitable policies.
6. Use different forensic tools to acquire and duplicate data from compromised systems and analyse the same.

Prerequisite: Cryptography and System Security

Module No.	Unit No.	Detailed Content	Hrs
1	Introduction & Access Control		08
	1.1	Cyber-attacks, Vulnerabilities, Defence Strategies and Techniques, Authentication Methods and Protocols, Defence in Depth Strategies.	
	1.2	Access Control Policies: DAC, MAC, Multi-level Security Models: Biba Model, Bell La Padula Model, Single Sign on, Federated Identity Management.	
2	Program & OS Security		08
	2.1	Malicious and Non-Malicious programming errors, Targeted Malicious codes: Salami Attack, Linearization Attack, Covert Channel, Control against Program threats.	
	2.2	Operating System Security: Memory and Address protection, File Protection Mechanism, User Authentication.	
	2.3	Linux and Windows: Vulnerabilities, File System Security.	
3	Web Application Security		12
		OWASP, Web Security Considerations, User Authentication and Session	

		Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, Cross-Site Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, Web Service Security, OAuth 2.0	
4	Wireless Security		08
		Wi-Fi Security, WEP, WPA, WPA-2, Mobile Device Security- Security Threats, Device Security, GSM and UMTS Security, IEEE 802.11/802.11i Wireless LAN Security, VPN Security.	
5	Legal and Ethical issues		06
	5.1	Cybercrime and its types, Intellectual property, Privacy, Ethical issues.	
	5.2	Protecting Programs and Data, Information and the Law, Rights of Employees and Employers, Redress for Software Failures, Computer Crime, Ethical Issues in Computer Security, case studies of ethics.	
6	Digital Forensics		10
		Introduction to Digital Forensics, Acquiring Volatile Data from Windows and Unix systems, Forensic Duplication Techniques, Analysis of forensic images using open source tools like Autopsy and SIFT, Investigating logs from Unix and windows systems, Investigating Windows Registry.	

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
3. Network Security and Cryptography, Bernard Menezes, Cengage Learning
4. Network Security Bible, Eric Cole, Second Edition, Wiley

Reference Books:

1. Computer Security, Dieter Gollman, Third Edition, Wiley
2. Digital Forensics by Nilakshi Jain & Kalbande, Wiley.
3. Incident Response & Computer Forensics by Kevin Mandia, Chris Prosis, Wiley.
4. Cyber Security. Nina Godbole, Sunit Belapure, Wiley.

Digital references:

1. https://www.owasp.org/index.php/Category:OWASP_Top_Ten_Project

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

Theory Examination:

1. Question paper will comprise of total six question.
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Laboratory/ Experimental Work

The Experiments for this course are required to be performed and to be evaluated in CSL704: Computational Lab-1.

Lab Outcome:

Learner will able to

1. Analyze static code and program vulnerabilities using open source tools.
2. Explore and analyze network vulnerabilities using open source tools.
3. Explore and analyze different security tools to detect web application and browser vulnerabilities.
4. Explore and analyze different tools to secure wireless networks and routers, and mobile devices and perform penetration testing, and analyze its impact.
5. Understand and implement AAA using RADIUS and TACACS.
6. Explore various forensics tools in Kali Linux and use them to acquire, duplicate and analyze data and recover deleted data.

Sr. No	Description
1	Static code analysis using open source tools like RATS, Flawfinder etc.
3	Vulnerability scanning using Nessus, Nikto (Kali Linux)
4	Explore web-application vulnerabilities using open source tools like Wapiti, browser exploitation framework (BeEf), etc.
5	Detect SQL injection vulnerabilities in a website database using SQLMap
6	Performing a penetration testing using Metasploit (Kali Linux)
7	Exploring Router and VLAN security, setting up access lists using Cisco Packet tracer(student edition)
8	Exploring VPN security using Cisco Packet tracer(student edition)
9	Exploring Authentication and access control using RADIUS, TACACS and TACACS+
10	Install and use a security app on an Android mobile (e.g. Droidcrypt)
11	Explore forensics tools in Kali Linux for acquiring, analyzing and duplicating data: dd, dcfldd, foremost, scalpel, debugfs, wireshark, tcptrace, tcpflow
12	Analysis of forensic images using open source tools like Autopsy, SIFT, FKT Imager
13	Use of steganographic tools like OpenStego, to detect data hiding or unauthorized file copying

14.	Use Password cracking using tools like John the Ripper/Cain and Abel/ Ophcrack to detect weak passwords.
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Reference Books:

1. Build your own Security Lab, Michael Gregg, Wiley India
2. CCNA Security, Study Guide, Tim Boyles, Sybex.
3. Web Application Hacker's Handbook, Dafydd Stuttard, Marcus Pinto, Wiley India
4. Network Infrastructure Security, Randy Waver, Dawn Weaver, Cengage Learning.
5. Incident Response & Computer Forensics by Kevin Mandia, Chris Prorise, Wiley.

Digital References:

<http://www.opentechinfo.com/learn-use-kali-linux/>

Course Code	Course/Subject Name	Credits
CSDLO7032	Big Data Analytics	4

Course Objectives:

1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce programming skills to build simple solutions using big data technologies such as MapReduce and scripting for NoSQL, and the ability to write parallel algorithms for multiprocessor execution.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support.
5. To provide an indication of the current research approaches that is likely to provide a basis for tomorrow's solutions.

Course Outcomes: Learner will be able to...

1. Understand the key issues in big data management and its associated applications for business decisions and strategy.
1. Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop, Mapreduce and NoSQL in big data analytics.
2. Collect, manage, store, query and analyze various forms of Big Data.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
5. Solve Complex real world problems in various applications like recommender systems, social media applications, health and medical systems, etc.

Prerequisite:

Some prior knowledge about Java programming, Basics of SQL, Data mining and machine learning methods would be beneficial.

Module	Detailed Contents	Hrs.
01	<p>Introduction to Big Data and Hadoop</p> <p>1.1 Introduction to Big Data, 1.2 Big Data characteristics, types of Big Data, 1.3 Traditional vs. Big Data business approach, 1.4 Case Study of Big Data Solutions. 1.5 Concept of Hadoop 1.6 Core Hadoop Components; Hadoop Ecosystem</p>	06

02	<p>Hadoop HDFS and MapReduce</p> <p>2.1 Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File-System Organization.</p> <p>2.2 MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.</p> <p>2.3 Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce</p> <p>2.4 Hadoop Limitations</p>	10
03	<p>NoSQL</p> <p>3.1 Introduction to NoSQL, NoSQL Business Drivers,</p> <p>3.2 NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study</p> <p>3.3 NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems.</p>	06
04	<p>Mining Data Streams:</p> <p>4.1 The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing.</p> <p>4.2 Sampling Data techniques in a Stream</p> <p>4.3 Filtering Streams: Bloom Filter with Analysis.</p> <p>4.4 Counting Distinct Elements in a Stream, Count-Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements</p> <p>4.5 Counting Frequent Items in a Stream, Sampling Methods for Streams, Frequent Itemsets in Decaying Windows.</p> <p>4.6 Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.</p>	12
05	<p>Finding Similar Items and Clustering</p> <p>5.1 Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.</p> <p>5.2 CURE Algorithm, Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries</p>	08
	<p>Real-Time Big Data Models</p> <p>6.1 PageRank Overview, Efficient computation of</p>	

06	PageRank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. 6.2 A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering. 6.3 Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph.	10
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Text Books:

1. CreAnand Rajaraman and Jeff Ullman “Mining of Massive Datasets”, Cambridge University Press,
2. Alex Holmes “Hadoop in Practice”, Manning Press, Dreamtech Press.
3. Dan Mcary and Ann Kelly “Making Sense of NoSQL” – A guide for managers and the rest of us, Manning Press.

References books:

1. Bill Franks , “Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics”, Wiley
2. Chuck Lam, “Hadoop in Action”, Dreamtech Press
3. Jared Dean, “Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners”, Wiley India Private Limited, 2014.
4. Jiawei Han and Micheline Kamber, “Data Mining: Concepts and Techniques”, Morgan Kaufmann Publishers, 3rd ed, 2010.
5. Lior Rokach and Oded Maimon, “Data Mining and Knowledge Discovery Handbook”, Springer, 2nd edition, 2010.
6. Ronen Feldman and James Sanger, “The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data”, Cambridge University Press, 2006.
7. Vojislav Kecman, “Learning and Soft Computing”, MIT Press, 2010.

Term Work:

Assign a case study for group of 3/4 students and each group to perform the following experiments on their case-study; Each group should perform the exercises on a large dataset created by them.

The distribution of marks for term work shall be as follows:

- Programming Exercises: (10) Marks.
- Mini project: (10) Marks.
- Attendance (Theory & Practical) (05) Marks.
- TOTAL:** **(25) Marks.**

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q.2 to Q.6) will be selected from all the modules.

Oral examination:

An oral exam will be held based on the above syllabus.

Suggested Practical List:

1. Hadoop HDFS Practical:
 - HDFS Basics, Hadoop Ecosystem Tools Overview.
 - Installing Hadoop.
 - Copying File to Hadoop.
 - Copy from Hadoop File system and deleting file.
 - Moving and displaying files in HDFS.
 - Programming exercises on Hadoop.
2. Use of Sqoop tool to transfer data between Hadoop and relational database servers.
 - a. Sqoop - Installation.
 - b. To execute basic commands of Hadoop eco system component Sqoop.
3. To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands.
4. Experiment on Hadoop Map-Reduce / PySpark:
2. -Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc.
5. Create HIVE Database and Descriptive analytics-basic statistics, visualization using Hive/PIG/R.
6. Write a program to implement word count program using MapReduce.
7. Implementing DGIM algorithm using any Programming Language/ Implement Bloom Filter using any programming language.
8. Implementing any one Clustering algorithm (*K*-Means/CURE) using Map-Reduce.
9. Streaming data analysis – use flume for data capture, HIVE/PYSpark for analysis of twitter data, chat data, weblog analysis etc.
10. Implement PageRank using Map-Reduce.
11. Implement predictive Analytics techniques (regression / time series, etc.) using R/ Scilab/ Tableau/ Rapid miner.
12. **Mini Project:** One real life large data application to be implemented (Use standard Datasets available on the web).

**# The Experiments for this course are required to be performed and to be evaluated
in CSL704: Computational Lab-1.**

Course Code	Course Name	Credits
CSDLO7033	Robotics	4

Course objectives:

- 1 To know basics of a typical robot and its characteristics.
- 2 To analyse mathematically kinematic modelling of a typical robot manipulator.
- 3 To identify actuators, sensors and control of a robot for different applications.
- 4 To apply task planning and vision algorithms.

Course outcomes: On successful completion of course learner will be able to:

1. Describe typical robot and its characteristics.
2. Analyse kinematics parameters of robotic manipulator.
3. Identify actuators, sensors and control of a robot for different applications.
4. Design task plan and motion for a robot.
5. Apply Robotics to solve day to day problems using vision algorithms.
6. Use robot programming languages and acquire skills to program robots.

Prerequisite: Mathematical concepts of Geometry, Matrices Algebra, knowledge of Basic Electronics.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction and Fundamentals of Robotics	08
	1.1	Types of automation, Introduction, definition of a Robot, Classification of Robots, Robotics, History of Robotics, Advantages and Disadvantages of Robots, Robot Applications	
	1.2	Tasks involved in Robotics, Robot Components, Robot characteristics and classification, Degrees of Freedom, Robot joints, Robot Coordinates, Robot Reference frames, Programming Modes, Robot Workspace, Work Envelop.	
2.0		Direct and Inverse Kinematics	08
	2.1	Direct (Forward) Kinematics: Homogeneous coordinates, Link coordinates, Coordinate frame, coordinate transform, Arm equations, An example – Four Axis SCARA.	
	2.2	Inverse Kinematics: Inverse kinematics problem, Tool Configuration, An example – Four Axis SCARA.	
		Sensors, Actuators and Drive Systems	08

3.0	3.1	Sensors: Characteristics, Utilization, Types - Position, Velocity, Acceleration, Force and Pressure, Torque, Visible Light and Infrared, Touch and Tactile, Proximity, Range Finders sensors.	
	3.2	Actuators and Drive System: Characteristics, Hydraulic Actuators, Pneumatic Devices, Electric Motors	
4.0		Robot Task and Motion Planning	10
	4.1	Reactive Paradigms: Overview, Attributes of reactive paradigm	
	4.2	Task level programming, Uncertainty, Configuration Space, Gross motion planning, Fine-motion planning, Simulation of Planner motion, Source and goal scene, Task planner Simulation.	
	4.3	Robot Motion Planning: Concept of motion planning, BUG 1, BUG 2 and Tangent Bug Algorithms	
5.0		Robot Vision	10
	5.1	Image Representation, Template Matching, Polyhedral Objects	
	5.2	Shape Analysis, Iterative Processing	
	5.3	Perspective Transformations, Structured Illumination , Camera Calibration	
6.0		Expert Systems, Robot Language and Fuzzy Logic	12
	6.1	Introduction to Expert Systems, Expert system Characteristics, Robot as a Expert System, Robot Languages: Classification of Robot Languages, Computer Control and Robot Software, VAL System, and Language.	
	6.2	Introduction, Fuzzy set, Fuzzification, Fuzzy Inference Rule Base, Defuzzification, Applications of Fuzzy Logic in Robotics.	
		Total	52

Text Books:

1. Introduction Robotics - Analysis, Control, Applications by Saeed B. Niku, Second Edition, Wiley India.
2. Fundamentals of Robotics – Analysis and Control by Robert J. Schilling, Pearson
3. Introduction to AI robotics by Robin Murphy, PHI.
University of Mumbai, B. E. (Computer Engineering), Rev. 2016

4. Robotics Technology and Flexible Automation by S. R. Deb, TMH.
5. Artificial Intelligence by Rich, Knight and Nair, TMH.
6. Introduction to Fuzzy Sets by M Ganesh PHI

Reference Books:

1. Robotics – Control, Sensing, Vision, and Intelligence by K. S. Fu, R. C. Gonzalez, C. S. G. Lee, Tata McGraw Hill
2. Principles of Robot Motion – Theory, Algorithms and Implementation by Howie Choset, Lynch, PHI
3. Introduction to Fuzzy Logic using Matlab, By: S.N.Sivanandam, S.N.Deepa, P Sumathi , Springer Publications

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Term Work :

The distribution of marks for term work shall be as follows:

• Programming Exercises:	(10) Marks.
• Mini project:	(10) Marks.
• Attendance (Theory & Practical)	(05) Marks.
TOTAL:	(25) Marks.

Suggested List of Experiments:

1. Representation of Various Robots and their all Specifications (Study Experiment)
2. Co-ordinate Transform of a Robot
3. Fundamental Rotation
4. Composite Rotation
5. BFS and DFS
6. Homogeneous Rotation
7. Run Length Encoding
8. Shrink and swell Operator
9. BUG1 Algorithm

- 10 Bug2 Algorithm
- 11 Tangent Bug Algorithm
- 12 Edge detection algorithm
- 13 Case Study of CNC Machine
- 14 Designing a Robot Manipulator for Pre defined Task

Students can perform experiments based on Theory Syllabus or any 12 experiments from above list of experiments or experiments framed by teachers.

The Experiments for this course are required to be performed and to be evaluated in CSL704: Computational Lab-1.

Course Code	Course Name	Credits
ILO 7011	Product Life Cycle Management	03

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to...

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Sr. No.	Detailed Contents	Hrs
01	Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	Integration of Environmental Aspects in Product Design: Sustainable Development,	05

	Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO 7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to...

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Sr. No	Detailed Contents	Hrs
01	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Connor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO 7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to...

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Sr. No.	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to...

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Sr. No	Detailed Contents	Hrs
01	Introduction 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	Fitting Regression Models 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	Two-Level Factorial Designs 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	Two-Level Fractional Factorial Designs 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	Response Surface Methods and Designs 5.1 Introduction to Response Surface Methodology	07

	5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	
06	Taguchi Approach 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO 7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to...

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Sr. No.	Detailed Contents	Hrs
01	<p>Introduction to Operations Research: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research</p> <p>Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p>Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.</p> <p>Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem</p> <p>Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.</p>	14
02	<p>Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population</p>	05
03	<p>Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation</p>	05

04	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Course Code	Course Name	Credits
ILO 7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to...

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Sr. No.	Detailed Contents	Hrs
01	Introduction to Cybercrime: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	Cyber offenses & Cybercrime: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	Tools and Methods Used in Cyberline Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	The Concept of Cyberspace E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	Indian IT Act. Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	Information Security Standard compliances SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Course Code	Course Name	Credits
ILO 7017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to...

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Sr. No.	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures:	09

	5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to...

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Sr. No	Detailed Contents	Hrs
01	Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	Energy Audit Principles: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	Energy Management and Energy Conservation in Electrical System: Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	Energy Management and Energy Conservation in Thermal Systems: Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity,	10

	factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	
05	Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Development Engineering	03

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a ‘good’ human being, a ‘good’ professional, a ‘good’ society and a ‘good life’ in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to...

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Sr. No.	Module Contents	Hrs
01	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
02	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people’s participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	04
03	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	06
04	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
05	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education.	10

	Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	
06	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

References:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Lab Code	Lab Name	Credits
CSL701	Digital Signal and Image Processing Lab	1

Lab Outcome: The learner will be able to

1. Sample and reconstruct the signal.
2. Implement and apply operations like Convolution, Correlation, DFT and FFT on DT signals
3. Implement spatial domain Image enhancement techniques.
4. Implement Edge detection techniques using first order derivative filters.

Description:

Implementation of programs can be in C or C++ or any computational software. A List of ten experiments is given below, are needed to be performed covering all syllabus modules. Additional experiments within the scope of the syllabus can be added.

Suggested List of Experiments:

1. Sampling and Reconstruction
2. To perform Discrete Correlation
3. To perform Discrete Convolution
4. To perform Discrete Fourier Transform
5. To perform Fast Fourier Transform
6. Implementation of Image negative, Gray level Slicing and Thresholding
7. Implementation of Contrast Stretching ,Dynamic range compression & Bit plane Slicing
8. Implementation of Histogram Processing
9. Implementation of Image smoothing/ Image sharpening
10. Implementation of Edge detection using Sobel and Previtt masks

Term Work:

- Laboratory work will be based on above syllabus of CSC701 - ‘Digital Signal and Image Processing’ with minimum 10 experiments to be incorporated.
- The distribution of marks for term work shall be as follows:

Lab Performance	15 Marks
Assignments	05 Marks
Attendance (Theory & practical)	05 Marks

Lab Code	Lab Name	Credits
CSL702	Mobile Application Development Lab	1

Lab Outcome:

1. To develop and demonstrate mobile applications using various tools
2. Students will articulate the knowledge of GSM, CDMA & Bluetooth technologies and demonstrate it.
3. Students will be able to carry out simulation of frequency reuse, hidden terminal problem
4. To develop security algorithms for mobile communication network
5. To demonstrate simulation and compare the performance of Wireless LAN
6. To implement and demonstrate mobile node discovery and route maintains.

Description: The softwares like Android Studio, J2ME, NS2, NS3 and any other software which is suitable are recommended for performing the practicals.

Suggested List of Experiments:

Sr. No.	Title of Experiments
01	To understand the cellular frequency reuse concept to find the co-channel cells for a particular cell. Design a game based application on the above concept.
02	To understand the cellular frequency reuse concept to find the cell clusters within certain geographic area. Design a game based application on the above concept.
03	Implementation a Bluetooth network with application as transfer of a file from one device to another.
04	To implement a basic function of Code Division Multiple Access (CDMA) to test the orthogonality and autocorrelation of a code to be used for CDMA operation. Write an application based on the above concept.
05	To implement Mobile node discovery
06	Implementation of GSM security algorithms (A3/A5/A8)
07	<p><u>Illustration of Hidden Terminal Problem (NS-2)</u> Consider two Wifi base stations (STA) and an access point (AP) located along the x-axis. All the nodes are fixed. The AP is situated at the middle of the two STA, the distance of separation being 150 m. [variable]. Node #0 and node #1 are the hidden terminals. Both are transmitting some data to the AP (almost at same rate) at the same time. The loss across the wireless link between each STA and the AP is fixed at 50 dB <u>irrespective of the distance of separation.</u></p> <p>To study how RTS/CTS helps in wireless networks,</p> <ol style="list-style-type: none"> 1. No RTS/CTS is being sent. 2. Nodes do exchange RTS/CTS packets. <p>Compare the no. of packet retransmissions required in both the cases (as obtained in the output) and compare the results.</p>

08	To setup & configuration of Wireless Access Point (AP) using NS3. Analyze the Wi-Fi communication range in the presence of the access point (AP) and the base station (BS). Consider BS and AP are static. Find out the maximum distance to which two way communications is possible. Try multiple iterations by adjusting its distance in the code and test it.
09	Develop an application that writes data to the SD card.
10	Develop an application that uses GUI components.
11	Write an application that draws basic graphical primitives on the screen.
12	Develop an application that makes use of database.
13	Develop a native application that uses GPS location information.
14	Implement an application that creates an alert upon receiving a message.
15	Implementation of income tax/loan EMI calculator and deploy the same on real devices.

Digital Material (if Any):

1. <http://www.isi.edu/nsnam/ns/> : NS-2 software download
2. https://nsnam.isi.edu/nsnam/index.php/NS_manual
3. <https://www.nsnam.org/> : Ns-3 Software Download
4. <http://vlssit.iitkgp.ernet.in/ant/ant/>

Text Books:

1. Jochen Schiller, "Mobile Communication", Addison Wesley, Pearson Education
2. "Wireless Communications & Networks," By William Stallings, Second Edition, Pearson Education
3. Ekram Hossain and Teerawat Issariyakul, "Introduction to Network Simulator NS-2," Springer, Second Edition.
4. Michael Burton, "Android Application Development for Dummies," A Wiley brand
5. Marko Gargenta & Masumi Nakamura, "Learning Android," O'Reilly publications
6. James Keogh, "The complete reference J2ME," McGraw-Hill.

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Laboratory work (experiments): (15) Marks.

Assignments: (05) Marks.

Attendance (Theory + Practical)..... (05) Marks

TOTAL: (25) Marks.

Oral & Practical exam will be based on the above and CSC702: Mobile Communication & Computing syllabus.

Lab Code	Lab Name	Credits
CSL703	Artificial Intelligence & Soft Computing Lab	1

Lab Outcomes: Learner will be able to

- 1 To realize the basic techniques to build intelligent systems
- 2 To create knowledge base and apply appropriate search techniques used in problem solving.
- 3 Apply the supervised/unsupervised learning algorithm.
- 4 Designfuzzy controller system.

Description: The current applications from almost all domains, like games, robots, expert system, optimization or even the search engines are becoming smarter. We have moved to the era of knowledge processing from data and information processing. Therefore learning these technologies practically is very essential for a student to gain the proficiency. They will also learn and be able to appreciate the use of fusion of basic techniques.

LAB	Topic / Activity	Explanation of Activity
Lab 1	<ul style="list-style-type: none"> • Identify the problem • PEAS Description • Problem formulation 	Select a problem statement relevant to AI
Lab 2	Introduce AI programming Language	Introduce PROLOG programming.
Lab 3	<ul style="list-style-type: none"> • Start Implementation • Knowledge Representation and Create Knowledge Base 	Use AI programming languages Or C/JAVA
Lab 4	Implement search algorithms to reach goal state	Identify and analyse Algorithm to solve the problem
Lab 5	To implement Mc-Culloch Pitts Model for a problem	Apply to solve AND / OR/ XOR, etc.
Lab 6	To implement Fuzzy Controller system	Design an automobile or washing machine controller, etc. and implement
Lab 7	To implement Basic Supervised / Unsupervised Neural Network learning rules for a problem.	Design a NN using a learning method to generate knowledge for classification.
Lab 8	Case study on Hybrid Systems	Study the designing of Neuro Fuzzy systems
Lab 9	Case study of an Application	Printed Character Recognition, Face Recognition, etc.

Term Work:

1. Labs 1-4 are to design and implement an intelligent system using AI techniques.
2. Labs 5-7 are to design and implement an Intelligent System using SC techniques.
3. Perform any one from Lab 8 and lab 9.

The distribution of marks for term work shall be as follows:

Lab Performance (Experiments /case studies):	15
Assignment	05
Attendance (Theory & Practical)	05

Oral examination will be based on the above and **CSC703: 'AI and SC'** Syllabus.

Lab Code	Lab Name	Credits
CSL703	Computational Lab-I	1

Lab Outcome: After successful completion of this course student will be able to:

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.

Description:

Design and implementation of any case study/ applications /experiments / mini project based on departmental level optional courses using modern tools.

Term work:

The distribution of marks for **term work** shall be as follows:

Lab/ Experimental Work	:	15
Report/ Documentation	:	05
Attendance (Theory & Practical)	:	05

Practical & Oral examination is to be conducted based on respective departmental level optional courses by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Title	Credit
CSP705	Major Project- I	3

Objective: The Project work enables students to develop further skills and knowledge gained during the programme by applying them to the analysis of a specific problem or issue, via a substantial piece of work carried out over an extended period. For students to demonstrate proficiency in the design of a research project, application of appropriate research methods, collection and analysis of data and presentation of results.

Guidelines:

1. Project Topic:

- To proceed with the project work it is very important to select a right topic. Project can be undertaken on any subject addressing IT programme. Research and development projects on problems of practical and theoretical interest should be encouraged.
- Project work must be carried out by the group of at least two students and maximum three and must be original.
- Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements.
- The project work can be undertaken in a research institute or organization/company/any business establishment.
- Student must consult internal guide along with external guide (if any) in selection of topic.
- Head of department and senior staff in the department will take decision regarding selection of projects.
- Student has to submit weekly progress report to the internal guide and where as internal guide has to keep track on the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.
- In case of industry projects, visit by internal guide will be preferred.

2. Project Report Format:

At the end of semester a project report should preferably contain at least following details:-

- Abstract
- Introduction
- Literature Survey
 - Survey Existing system
 - Limitation Existing system or research gap
 - Problem Statement and Objective
 - Scope
- Proposed System
 - Analysis/Framework/ Algorithm
 - Details of Hardware & Software
 - Design details
 - Methodology (your approach to solve the problem)

- Implementation Plan for next semester
- Conclusion
- References

3. **Term Work:**

Distribution of marks for term work shall be as follows:

- a. Weekly Attendance on Project Day
- b. Project work contribute
- c. Project Report (Spiral Bound)
- d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. **Oral & Practical :**

Oral & Practical examination of Project-I should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project-I.

Course Code	Course Name	Credits
CSC801	Human Machine Interaction	4

Course Objectives: At the end of the course, students will be able to –

1. Learn the foundation of human machine interaction.
2. Understand the importance of human psychology in designing good interfaces.
3. Be aware of mobile interaction design and its usage in day – to – day activities.
4. Understand various design technologies to meet user requirements.
5. Encourage to indulge into research in Machine Interaction Design.

Course Outcomes: At the end of the course, the students will be able to -

1. Identify User Interface (UI) design principles.
2. Analysis of effective user friendly interfaces.
3. Apply Interactive Design process in real world applications.
4. Evaluate UI design and justify.
5. Create application for social and technical task.

Pre-requisites: Web Technologies; Software Engineering; Experience in designing interfaces for applications and web sites. Basic knowledge of designing tools and languages like HTML, Java, etc

Module No.	Topics	Hrs.
1.0	FOUNDATIONS OF HMI: The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving . The computer: Devices, Memory, processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms.	8
2.0	DESIGN & SOFTWARE PROCESS: Mistakes performed while designing a computer system, Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds .Interactive Design basics, process, scenarios, navigation, Iteration and prototyping. HMI in software process: software life cycle, usability engineering, Prototyping in practice, design rationale. Design rules: principles, standards, guidelines, rules. Recognize the goals, Goal directed design process. Evaluation Techniques: Universal Design.	10
3.0	GRAPHICAL USER INTERFACE: The graphical User Interface: Popularity of graphics, the concept of direct manipulation, graphical systems, Characteristics. Web user Interface: Interface popularity, characteristics. The merging of graphical Business systems and the Web. Principles of user interface design.	8

4.0	SCREEN DESIGNING: Design goals , Screen planning and purpose, organizing screen elements, ordering of screen data and content , screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, Technological consideration in interface design.	10
5.0	INTERFACE DESIGN FOR MOBILE DEVICES: Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications, Games, Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.	8
6.0	INTERACTION STYLES AND COMMUNICATION: Windows:Characteristics, Components, Presentation styles, Types of Windows, Management, operations. Text messages: Words, Sentences, messages and text words, Text for web pages. Icons, Multimedia and colors	8
	Total	52

Text Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, “Human Computer Interaction”, 3rdEdition, Pearson Education, 2004.
2. Wilbert O. Galitz, “The Essential Guide to User Interface Design”, Wiley publication.
3. Alan Cooper, Robert Reimann, David Cronin, “About Face3: Essentials of Interaction design”, Wiley publication.
4. Jeff Johnson, “Designing with the mind in mind”, Morgan Kaufmann Publication.
5. Donald A. Normann, “ Design of everyday things”,Basic Books; Reprint edition 2002.
6. Brian Fling, “Mobile Design and Development”, First Edition , O’Reilly Media Inc., 2009.

Reference Books:

1. Rogers Sharp Preece, ”Interaction Design:Beyond Human Computer Interaction”,,Wiley.
2. Guy A. Boy “The Handbook of Human Machine Interaction”, Ashgate publishing Ltd.
3. Kalbande, Kanade, Iyer, “Galitz’s Human Machine Interaction”, Wiley Publications.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC802	Distributed Computing	04

Course objectives:

1. To provide students with contemporary knowledge in distributed systems
2. To equip students with skills to analyze and design distributed applications.
3. To provide master skills to measure the performance of distributed synchronization algorithms

Course outcomes: On successful completion of course learner will be able to:

1. Demonstrate knowledge of the basic elements and concepts related to distributed system technologies;
2. Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware.
3. Analyze the various techniques used for clock synchronization and mutual exclusion
4. Demonstrate the concepts of Resource and Process management and synchronization algorithms
5. Demonstrate the concepts of Consistency and Replication Management
6. Apply the knowledge of Distributed File System to analyze various file systems like NFS, AFS and the experience in building large-scale distributed applications.

Prerequisite: Java Programming, Operating Systems, Computer Networks

Module No.	Unit No.	Topics	Hrs.
1.0	Introduction to Distributed Systems		06
	1.1	Characterization of Distributed Systems: Issues, Goals, and Types of distributed systems, Distributed System Models, Hardware concepts, Software Concept.	
	1.2	Middleware: Models of Middleware, Services offered by middleware, Client Server model.	
2.0	Communication		10
	2.1	Layered Protocols, Interprocess communication (IPC): MPI, Remote Procedure Call (RPC), Remote Object Invocation, Remote Method Invocation (RMI)	
	2.2	Message Oriented Communication, Stream Oriented Communication, Group Communication	
3.0	Synchronization		10
	3.1	Clock Synchronization, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measure.	
	3.2	Non Token based Algorithms: Lamport Algorithm, Ricart–Agrawala’s Algorithm, Maekawa’s Algorithm	
	3.3	Token Based Algorithms: Suzuki-Kasami’s Broadcast Algorithms, Singhal’s Heuristic Algorithm, Raymond’s Tree based Algorithm, Comparative Performance Analysis.	
4.0	Resource and Process Management		06
	4.1	Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach	
	4.2	Introduction to process management, process migration, Threads,	

		Virtualization, Clients, Servers, Code Migration	
5.0	Consistency, Replication and Fault Tolerance		08
	5.1	Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management	
	5.2	Fault Tolerance: Introduction, Process resilience, Reliable client-server and group communication, Recovery	
6.0	Distributed File Systems and Name Services		12
	6.1	Introduction and features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Case Study: Distributed File Systems (DSF), Network File System (NFS), Andrew File System (AFS)	
	6.2	Introduction to Name services and Domain Name System, Directory Services, Case Study: The Global Name Service, The X.500 Directory Service	
	6.3	Designing Distributed Systems: Google Case Study	
		Total	52

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- a. Question paper will comprise of 6 questions, each carrying 20 marks.
- b. The students need to solve total 4 questions.
- c. Question No.1 will be compulsory and based on entire syllabus.
- d. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. Andrew S. Tanenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2. George Coulouris, Jean Dollimore, Tim Kindberg, , "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005.

Reference Books:

1. A. S. Tanenbaum and M. V. Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Prentice Hall, 2006.
2. M. L. Liu, "Distributed Computing Principles and Applications", Pearson Addison Wesley, 2004.

Course Code	Course Name	Credit
DLO8011	High Performance Computing	04

Course Objectives:

1. To learn concepts of parallel processing as it pertains to high-performance computing.
2. To design, develop and analyze parallel programs on high performance computing resources using parallel programming paradigms.

Course Outcomes: Learner will be able to-

1. Memorize parallel processing approaches
2. Describe different parallel processing platforms involved in achieving High Performance Computing.
3. Discuss different design issues in parallel programming
4. Develop efficient and high performance parallel programming
5. Learn parallel programming using message passing paradigm using open source APIs.

Prerequisite: Computer Organization

Sr.No.	Module	Detailed Content	Hours
1	Introduction	Introduction to Parallel Computing: Motivating Parallelism, Scope of Parallel Computing, Levels of parallelism (instruction, transaction, task, thread, memory, function) Classification Models: Architectural Schemes (Flynn's, Shore's, Feng's, Handler's) and Memory access (Shared Memory, Distributed Memory, Hybrid Distributed Shared Memory) Parallel Architectures: Pipeline Architecture, Array Processor, Multiprocessor Architecture, Systolic Architecture, Data Flow Architecture	6
2	Pipeline Processing	Introduction, Pipeline Performance, Arithmetic Pipelines, Pipeline instruction processing, Pipeline stage design, Hazards, Dynamic instruction scheduling	8
3	Parallel Programming Platforms	Parallel Programming Platforms: Implicit Parallelism: Trends in Microprocessor & Architectures, Limitations of Memory System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines	10
4	Parallel Algorithm Design	Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models	12

5	Performance Measures	Performance Measures : Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl's Law, Gustavson's Law, Performance Bottlenecks	6
6	HPC Programming	Programming Using the Message-Passing Paradigm: Principles of Message Passing Programming, The Building Blocks: Send and Receive Operations MPI: the Message Passing Interface, Topology and Embedding, Overlapping Communication with Computation, Collective Communication and Computation Operations, Introduction to OpenMP	10

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.
2. M. R. Bhujade, "Parallel Computing", 2nd edition, New Age International Publishers, 2009.
3. Kai Hwang, Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill, Second Edition, 2010.
4. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.

Reference Books:

1. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill International Editions, Computer Science Series, 2008.
2. Kai Hwang, Zhiwei Xu, "Scalable Parallel Computing: Technology, Architecture, Programming", McGraw Hill, 1998.
3. Laurence T. Yang, MinyiGuo, "High- Performance Computing: Paradigm and Infrastructure" Wiley, 2006.

Internal Assessment: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of total six questions.
2. All question carry equal marks.
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only Four question need to be solved.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Laboratory Work:

Description: The Laboratory Work (Experiments) for this course is required to be performed and to be evaluated in CSL803: Computational Lab-II

Suggested Experiment List:

Sr. No.	Detailed Content
1	Execution of Simple Hello world program on MPI platform
2	a. Program to send data and receive data to/from processors using MPI b. Program illustrating Broadcast of data using MPI
3	Implement a parallel program to demonstrate the cube of N number within a set range.
4	Write a parallel program for area of a circle/triangle
5	Implement a program to demonstrate balancing of workload on MPI platform
6	Using directives of MPI/OpenMP implement parallel programming for calculator application (add, sub, multiplication and division)
7	Mini Project Evaluate performance enhancement of HPC for any of the following: One-Dimensional Matrix-Vector Multiplication/ Single-Source Shortest-Path/ Sample Sort/Two-Dimensional Matrix-Vector Multiplication

Course Code	Course Name	Credits
DLO8012	Natural Language Processing	4

Course objectives:

1. To understand natural language processing and to learn how to apply basic algorithms in this field.
2. To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics.
3. To design and implement applications based on natural language processing
4. To implement various language Models.
5. To design systems that uses NLP techniques

Course outcomes: On successful completion of course learner should:

1. Have a broad understanding of the field of natural language processing.
2. Have a sense of the capabilities and limitations of current natural language technologies,
3. Be able to model linguistic phenomena with formal grammars.
4. Be able to Design, implement and test algorithms for NLP problems
5. Understand the mathematical and linguistic foundations underlying approaches to the various areas in NLP
6. Be able to apply NLP techniques to design real world NLP applications such as machine translation, text categorization, text summarization, information extraction...etc.

Prerequisite: Data structure & Algorithms, Theory of computer science, Probability Theory.

Module No.	Unit No.	Topics	Hrs.
1	Introduction	History of NLP, Generic NLP system, levels of NLP , Knowledge in language processing , Ambiguity in Natural language , stages in NLP, challenges of NLP ,Applications of NLP	4
2	Word Level Analysis	Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology, Lemmatization, Regular expression, finite automata, finite state transducers (FST) ,Morphological parsing with FST , Lexicon free FST Porter stemmer. N –Grams- N-gram language model, N-gram for spelling correction.	10
3	Syntax analysis	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words. Introduction to CFG, Sequence labeling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).	10
4	Semantic Analysis	Lexical Semantics, Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Robust Word Sense Disambiguation (WSD) ,Dictionary based approach	10

5	Pragmatics	Discourse –reference resolution, reference phenomenon , syntactic & semantic constraints on co reference	8
6	Applications (preferably for Indian regional languages)	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis, Named Entity Recognition.	10

Text Books:

1. Daniel Jurafsky, James H. Martin “Speech and Language Processing” Second Edition, Prentice Hall, 2008.
2. Christopher D.Manning and Hinrich Schutze, “ Foundations of Statistical Natural Language Processing “, MIT Press, 1999.

Reference Books:

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Daniel M Bikel and Imed Zitouni “ Multilingual natural language processing applications” Pearson, 2013
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) “ The Handbook of Computational Linguistics and Natural Language Processing “ ISBN: 978-1-118-
4. Steven Bird, Ewan Klein, Natural Language Processing with Python, O’Reilly
5. Brian Neil Levine, An Introduction to R Programming
6. Niel J le Roux, Sugnet Lubbe, A step by step tutorial : An introduction into R application and programming

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

- 1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Laboratory Work/Case study/Experiments:

Description: The Laboratory Work (Experiments) for this course is required to be performed and to be evaluated in CSL803: Computational Lab-II

The objective of Natural Language Processing lab is to introduce the students with the basics of NLP which will empower them for developing advanced NLP tools and solving practical problems in this field.

Reference for Experiments: <http://cse24-iiith.virtual-labs.ac.in/#>

Reference for NPTEL: <http://www.cse.iitb.ac.in/~cs626-449>

Sample Experiments: possible tools / language: R tool/ Python programming Language

Note: Although it is not mandatory, the experiments can be conducted with reference to any Indian regional language.

1. Preprocessing of text (Tokenization, Filtration, Script Validation, Stop Word Removal, Stemming)
2. Morphological Analysis
3. N-gram model
4. POS tagging
5. Chunking
6. Named Entity Recognition
7. Case Study/ Mini Project based on Application mentioned in Module 6.

Course Code	Course Name	Credits
DLO8013	Adhoc Wireless Networks	4

Course objectives:

1. To Identify the major issues associated with ad-hoc networks
2. To identify the requirements for protocols for wireless ad-hoc networks as compared to the protocols existing for wired network.
3. To explore current ad-hoc technologies by researching key areas such as algorithms, protocols, hardware, and applications.
4. To Provide hands-on experience through real-world programming projects
5. To provide advanced in–depth networking materials to graduate students in networking research.

Course outcomes: On successful completion of course learner will be able to:

1. Identify the characteristics and features of Adhoc Networks.
2. Understand the concepts & be able to design MAC protocols for Ad Hoc networks
3. Implement protocols / Carry out simulation of routing protocols of Adhoc Networks
4. Interpret the flow control in transport layer of Ad Hoc Networks
5. Analyze security principles for routing of Ad Hoc Networks
6. Utilize the concepts of Adhoc Networks in VANETs

Prerequisite: Computer Network, Wireless Networking

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction	04
	1.1	Introduction to wireless Networks. Characteristics of Wireless channel,	
	1.2	Issues in Ad hoc wireless networks, Adhoc Mobility Models:- Indoor and outdoor models,	
	1.3	Introduction to Adhoc networks – definition, characteristics features, applications.	
2.0		MAC protocols for Wireless Ad-Hoc Networks	12
	2.1	Introduction	
	2.2	Issues in designing MAC for Wireless Ad-Hoc Networks	
	2.3	Design Goals and classification of MAC for Wireless Ad-Hoc Networks	
	2.4	Contention based MAC protocols for Wireless Ad-Hoc Networks, with reservation mechanisms, scheduling Mechanisms	
	2.5	MAC protocols using directional antennas, Other MAC Protocols	
	2.6	IEEE standards MAC Protocols: 802.15.1(WPAN based on Bluetooth), 802.15.4 (WSN/Zigbee), 802.15.6 (WBAN).	
3.0		Routing Protocols for Wireless Ad-Hoc Networks	10
	3.1	Introduction, Issues in designing a routing protocol for Wireless Ad-Hoc Networks	
	3.2	Classification of routing protocols, Table driven routing protocols like DSDV, WRP,	

		On- demand routing protocols like ABR, DSR, TORA, AODV, etc.	
	3.3	Hybrid Routing Protocols : ZRP, Routing Protocols with efficient flooding mechanism, Hierarchical Routing Protocols, Power aware routing protocols	
4.0		Transport Layer	10
	4.1	Transport layer protocols for Ad hoc wireless Networks: Introduction,	
	4.2	Issues in designing a transport layer protocol for Ad hoc wireless Networks,	
	4.3	Design goals of a transport layer protocol for Ad hoc wireless Networks,	
	4.4	Classification of transport layer solutions: Split Approach , End-to-End approach :TCP-F,TCP-ELFN, Ad-Hoc TCP, TCP Buffering capability and Sequencing information	
	4.5	End-to-End Quality of Service	
5.0		Security	08
	5.1	Security attacks in wireless Ad hoc wireless Networks, Network security requirements,	
	5.2	Issues & challenges in security provisioning,	
	5.3	Link Layer security attacks: 802.11 MAC , WPA and variations	
	5.4	Network Security Attacks: Routing Protocol Attacks: attacks using falsifying route errors and broadcasting falsifying routes, spoofing attacks, Rushing attacks, Secure routing in Ad hoc wireless Networks	
6.0		Vehicular Ad-Hoc Network (VANET)	08
	6.1	Introduction: Challenges and Requirements, , Layered architecture for VANETs, DSRC /WAVE standard (IEEE 802.11p)	
	6.2	IEEE 802.11p protocol Stack (PHY & MAC) , A Survey on Proposed MAC Approaches for VANETs like TDMA, SDMA and CDMA based approaches, DSRC MAC & LLC	
	6.3	Georouting: CBF, Flooding with broadcast suppression	
	6.4	Delay Tolerant Network, Introduction to Opportunistic Networking in Delay Tolerant Vehicular Ad Hoc Networks	
		Total	52

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Text Books:

1. Siva Ram Murthy and B.S. Manoj , “Ad hoc Wireless Networks Architectures and protocols”, 2nd edition, Pearson Education, 2007 (T1)
2. C. K. Toh, “Adhoc Mobile Wireless Networks”, Pearson Education, 2002 (T2)
3. Charles E. Perkins, “Adhoc Networking”, Addison – Wesley, 2000 (T3)
4. Dipankar Raychaudhuri, Mario Gerla, “Emerging Wireless Technologies and the Future Mobile Internet, D, Cambridge. (T4)

Reference Books:

1. Subir Kumar Sarkar, “Ad-Hoc Mobile Wireless Networks: principles, protocols and applications” CRC Press (R1)
2. Prasant Mohapatra and Sriramamurthy, “Ad Hoc Networks: Technologies and Protocols”, Springer International Edition, 2009, (R2)
3. Stefano Basangi, Marco Conti, Silvia Giordano, Ivan Stojmenovic, “Mobile Ad-Hoc Networking, “ John-Wiley and Sons Publications, 2004,(R3)
4. [Hannes Hartenstein](#), [Kenneth Laberteaux](#), “VANET Applications and Interworking Technologies,” Wiley Publications (R4)
5. [Christoph Sommer](#) , [Falko Dressler](#), “Vehicular Networking,” Cambridge University Press, 2014 (R5)

Laboratory Work**Lab Outcome:**

1. Explore the knowledge of NS2 and NS3 by installing it and make it ready
2. Shall synthesize a simulation and evaluate the performance of WLAN 802.11 and Bluetooth
3. Students will able to analyze and implement MAC & Network layer protocols using open source and synthesis as well as evaluate its performance
4. Implement Transport layer protocols / Carry out simulation of routing protocols of Adhoc Networks
5. Describe and interpret the use security routines and evaluate its performance
6. Explore and understand the capability of SUMO and MOVE as well as Nessi by installing it and analyze it by applying on various scenarios

Description: It is recommended that Network simulation Softwares like NS-2, NS-3, SUMO (Simulation software for Urban MObility) with MOVE. Software like Nessi is also recommended for the event based security attacks simulation and measure.

The Laboratory Work (Experiments) for this course is required to be performed and to be evaluated in CSL803: Computational Lab-II

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Installation of NS2 & NS3 in Fedora 19 (32 bit) OS Linux.
2	Simulating IEEE 802.11 wireless LAN in Ad-Hoc Mode using NS2
3	Implementation a Bluetooth network in NS3 with application as transfer of a file from one device to another
4	To implement and compare MAC layer protocols, MACAW, MACA-BI and MACA with piggybacked Reservation using NS-3

5	Develop sample wireless network in which a. implement AODV and AOMDV protocol b. Calculate the time to receive reply from the receiver using NS2. c. Generate graphs which show the transmission time for packet. Implement wireless network. Capture data frame and identify fields using NS2.
6	Communicate between two different networks (NS-3) which has following specifications: a. One network has Class A network with “TORA protocol” b. Second has Class B network “AODV protocol”
7	To calculate and compare average throughput for various TCP variants like TCP-F (Feedback) and Ad-Hoc TCP using NS-3
8	Explore and use security tools like WEP & WPA and evaluate its performance on mobile terminals
9	Simulation of Urban Mobility (SUMO) along with MOVE is software that helps in simulating the VANETs. Install it on Fedora 19 (32 bit) OS Linux
10	Create a simulation for road traffic with 6 junctions. There are various vehicles going on and your own car also. Select a shortest route for your car. Demonstrate with simulation software SUMO and MOVE.
11	A car acts as a malicious node and can be analyzed for the packet loss before and after malicious activity. Using SUMO and MOVE.
12	Create an Ad-hoc Network using nessi Simulation software and include events incorporate dropped packets, infected flows, compromised machines, unavailable services etc, and check its performance

Digital Material (if Any):

1. <http://www.isi.edu/nsnam/ns/> : NS-2 software download (D1)
2. https://nsnam.isi.edu/nsnam/index.php/NS_manual (D2)
3. <https://www.nsnam.org/> : Ns-3 Software Download (D3)
4. <http://www.nsnam.com/2013/11/vanet-simulator-in-fedora-19-32-bit.html> (D4)
5. http://www.sumo.dlr.de/userdoc/Tutorials/Quick_Start.html (D5)
6. <http://veins.car2x.org/> (D6)
7. <http://www.nessi2.de/> (D7)

Text Books:

1. Ekram Hossain and Teerawat Issariyakul, “Introduction to Network Simulator NS-2,” Springer , Second Edition. (T1)
2. Jack L. Burbank, “Introduction to Network Simulator 3,” Wiley Publications(T2)
3. Siva Ram Murthy and B.S. Manoj , “Ad hoc Wireless Networks Architectures and protocols”, 2nd edition, Pearson Education, 2007 (T3)
4. Michael Gregg, “Build your own security lab,” Wiley India edition (T4)

Course Code	Course Name	Credits
ILO 8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to...

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	5
02	Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	Planning Projects: Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	5.1 Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings 5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit	8

	5.3 Project Contracting Project procurement management, contracting and outsourcing,	
06	6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects 6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

REFERENCES:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK[®] Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Course Code	Course Name	Credits
ILO 8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to...

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	<p>Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.</p> <p>Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p>Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p>Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	06
02	<p>Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.</p> <p>Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.</p>	06
03	<p>Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p>Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.</p>	09
04	<p>Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)</p> <p>Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.</p>	10
05	<p>Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine</p>	05

	Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity’s Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
06	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity’s Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon’s Approach, Walter’s Approach, and Modigliani-Miller Approach	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	Indian Environment for Entrepreneurship: key regulations and legal aspects , MSME Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Outcomes: Learner will be able to...

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	<p>Introduction to HR</p> <ul style="list-style-type: none"> • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues 	5
02	<p>Organizational Behaviour (OB)</p> <ul style="list-style-type: none"> • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study 	7
03	<p>Organizational Structure & Design</p> <ul style="list-style-type: none"> • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. 	6

04	<p>Human resource Planning</p> <ul style="list-style-type: none"> • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning • Training & Development: Identification of Training Needs, Training Methods 	5
05	<p>Emerging Trends in HR</p> <ul style="list-style-type: none"> • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation 	6
06	<p>HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries)</p> <p>Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals</p> <p>Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</p>	10

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to...

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to...

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
03	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	08

05	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	Outcome of Research 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	04

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to...

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	07

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press.

Course Code	Course Name	Credits
ILO 8028	Digital Business Management	03

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	Digital Business Support services: ERP as e –business backbone, knowledge Tote Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure	06
4	Managing E-Business- Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	E-Business Strategy- E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization- Business plan preparation Case Studies and presentations	08

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to...

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing, 2015

Lab Code	Lab Name	Credits
CSL801	Human Machine Interactions Lab	1

Lab Outcome:

- 1: To design user centric interfaces.
- 2: To design innovative and user friendly interfaces.
- 3: To apply HMI in their day-to-day activities.
- 4: To criticize existing interface designs, and improve them.
- 5: To Design application for social Task.
- 6: To Design application for Technical Tasks

Description:

Human Machine Interaction provides the study of user interface and benefit of good design. The design process gives an idea about how people interact with computer and the problems that they fall, so understanding the human characteristics is important as this lays the base for a good interface. It enables the students to apply his/her design skills to develop an appropriate Mobile App or Website. Students also learn the different types of icon, color and its representation with social and ethical concerns. Students can also learn the different software tools used to assemble and build user interface along with the different types of interaction devices and finally try to measure the usability of the application by learning HMI principles.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Problem representation for Designing User Interface
2	Design a Mobile app/ Website that can teach mathematics to children of 4-5 years age in schools in Rural /Urban Sector
3	Design a Mobile App/Website that can help people to sell their handmade products in metro cities
4	ATM machine/KIOSK screen design for rural people.
5	Design a Mobile App/Website to get an experience for passengers whose flight /train is delayed.
6	Design an UI application for Institute event management.
7	Design of User interface for the system using various interaction styles.
8	Statistical Graphics and its use in visualization
9	Design appropriate icons pertaining to a given domain .(Eg. Greeting cards)

10	Design a personal website for an Artisan
11	Design a interface for Home appliances
12	Design an interactive data access using Graphics (QR, BAR Code, Image etc) and generating a print form
13	Redesign of a user interface (Suggest and implement changes in Existing User Interface)
14	Design a navigator for a student new in your Institute.
15	Design a navigator for a person new in tourist city/ village
16	Design UI for Motor paralysis for disabled people.
17	KIOSK design for hospital/school/educational campus/National Institute.
18	To calculate screen complexity of existing Graphical User Interface and redesign the interface to minimize the screen complexity.

Guidelines:

1. Students are expected to use advanced tools and Technologies towards execution of lab work.
2. Students can work individually or only 2-3 Students can form a team if they wish to work in Group.
3. Case Study and assignments may be linked with CSC801 Syllabus.

Term Work:

Laboratory work will be based on above syllabus with minimum 10(Ten) experiments in line with the above Lab outcomes to be incorporated with 13(Thirteen) lab session of 2 (two) hours each. The problem statement can be decided by the instructor in line with the above list of experiments

The distribution of 25 marks for term work shall be as follows:

Lab Performance	15
Mini Project	05
Attendance (Theory & Practical)	05

Oral exam will be based on the above and CSC801:‘HMI Theory’ Syllabus.

Lab Code	Lab Name	Credits
CSL802	Distributed Computing Lab	01

Lab Outcome:

1. Develop, test and debug RPC/RMI based client-server programs.
2. Implement the main underlying components of distributed systems (such as IPC, name resolution, file systems etc.)
3. Implement various techniques of synchronization.
4. Design and implement application programs on distributed systems.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Client/server using RPC/RMI.
2	Implementation of multi tread application
3	Inter-process communication
4	Group Communication
5	Load Balancing Algorithm.
6	Name Resolution protocol.
7	Election Algorithm.
8	Clock Synchronization algorithms.
9	Mutual Exclusion Algorithm.
10	Deadlock management in Distributed systems
11	Distributed File System
12	CORBA

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Laboratory work (experiments): (15) Marks.
 Assignments: (05) Marks.
 Attendance (Theory + Practical)..... (05) Marks
TOTAL: (25) Marks.

Oral exam will be based on the above and CSC802 syllabus.

Lab Code	Course Name	Credits
CSL803	Cloud Computing Lab	2

Lab Objectives: The course will help the learners to get familiar with

1. Key concepts of virtualization.
2. Various deployment models such as private, public, hybrid and community.
3. Various service models such as IaaS and PaaS.
4. Security and Privacy issues in cloud.

Lab Outcomes: On completion of the course learners will be able to

1. Adapt different types of virtualization and increase resource utilization.
2. Build a private cloud using open source technologies.
3. Analyze security issues on cloud.
4. Develop real world web applications and deploy on commercial cloud.
5. Demonstrate various service models.

Module	Detailed Contents	Hours
01	Title: Study of NIST model of cloud computing. Objective: Understand deployment models, service models, advantages of cloud computing.	2
02	Title: Virtualization. Objective: Understand different types of virtualizations, Host and bare metal hypervisors and implement horizontal scalability. Technology: XEN/ Vmwares EXSi	2
03	Title: Infrastructure as a Service. Objective: Implement IaaS using your resources. Technology: Open Stack / Eucalyptus	2
04	Title: Identity Management in Cloud Concept: Simulate identity management in your private cloud. Technology: Open Stack	2
05	Title: Storage as a Service Objective: Explore Storage as a Service for remote file access using web interface. Technology: ownCloud	2
06	Title: Cloud Security Objective: Understand security of web server and data directory. Technology: ownCloud	2
07	Title: Platform as a Service Objective: Deploy web applications on commercial cloud. Technology: Google appEngine/ Windows Azure	2
08	Title: Amazon Web Service Objective: To create and access VM instances and demonstrate various	2

	components such as EC2, S3, Simple DB, DynamoDB. Technology: AWS	
09	Title: Software as a Service Objective: Understand on demand application delivery and Virtual desktop infrastructure. Technology: Ulteo	2
10	Title: Case Study on Fog Computing Objective: To have a basic understanding of implementation/applications of fog computing.	2
11	Title: Mini Project Objective: Using the concepts studied throughout the semester students shall be able to <ol style="list-style-type: none"> 1. Create their private cloud for the institute using the available resources. 2. Apply security concepts to secure a private cloud. 3. Implement efficient load balancing. 4. Compare various virtualization technologies with given resource. 5. Create cloud applications such as messenger, photo editing website, your own social media etc. Note: Evaluators must check if students have used appropriate cloud computing tools for their projects.	6

Digital Material

www.openstack.org

Text Books:

1. Enterprise Cloud Computing by Gautam Shroff, Cambridge,2010
2. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley - India, 2010 ,
3. Getting Started with OwnCloud by Aditya Patawar , Packt Publishing Ltd, 2013

Term Work:

- Term work should consist of at least 6 experiments and a mini project.
- Journal must include at least 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.
- The distribution of marks for term work shall be as follows:
- Laboratory work (experiments): (15) Marks.
- Mini project..... (15) Marks.
- Mini Project Presentation & Report..... (10) Marks
- Assignments..... (05) Marks
- Attendance(05) Marks
- **TOTAL:(50) Marks.**

Practical and Oral examination will be based on Laboratory work, mini project and above syllabus.

Lab Code	Course Name	Credits
CSL804	Computational Lab II	1

Lab Outcome: After successful completion of this course student will be able to:

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.

Description:

Design and implementation of any case study/ applications /experiments / mini project based on departmental level optional courses using modern tools.

Term work:

The distribution of marks for **term work** shall be as follows:

Lab Experimental Work & mini project	:	25
Report/ Documentation/Presentation	:	20
Attendance (Theory & Practical)	:	05

Practical & Oral examination is to be conducted based on departmental level optional courses by pair of internal and external examiners appointed by the University of Mumbai.

Course Code	Title	Credit
CSP805	Major Project- II	6

Objective: The primary objective is to meet the milestones formed in the overall project plan decided in Project - I. The idea presented in Project -I should be implemented in Project -II with results, conclusion and future work. The project will culminate in the production of a thesis by each individual student.

Guidelines:

Project Report Format:

At the end of semester a student need to prepare a project report should be prepared as per the guidelines issued by the University of Mumbai. Along with project report a CD containing: project documentation, Implementation code, required utilities, Software's and user Manuals need to be attached.

Term Work:

Student has to submit weekly progress report to the internal guide and where as internal guide has to keep track on the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks. In case of industry projects, visit by internal guide will be preferred to get the status of project.

Distribution of marks for term work shall be as follows:

- a) Weekly Attendance on Project Day
- b) Project work contributions as per objective
- c) Project Report (Hard Bound)
- d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

Oral & Practical :

Oral & Practical examination of Project- II should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project- II.

Electronics and Telecommunication

Sr. No.	Subject Code	Subject Name	Count
1	ECL301	Electronic Devices and Circuits I Laboratory	1
2	ECL302	Digital System Design Laboratory	1
3	ECL303	OOP using JAVA Laboratory	1
4	ECL401	Electronic Devices and Circuits II Laboratory	1
5	ECL402	Linear Integrated Circuits Laboratory	1
6	ECL403	Principles of Communication Engineering Laboratory	1
7	ELXL501	Microcontrollers and Applications Lab	1
8	ELXL502	Digital Communication Lab.	1
9	ELXL503	Design with Linear Integrated Circuits Lab	1
10	ELX 503	Engineering Electromagnetics	1
11	ELX DLOI50X	Department Level optional course-I Lab	1
12	ELXL601	Embedded System and RTOS Lab.	1
13	ELXL602	Computer Communication Network Lab.	1
14	ELXL603	VLSI Design Lab.	1
15	ELX 604	Signals and systems	1
16	ELXLDLO601X	Department Level Optional courses-II Lab.	1
17	ELXL701	Instrumentation System Design Lab.	1
18	ELXL702	Power Electronics Lab.	1
19	ELXL703	Digital signal processing Lab.	1
20	ELXLDLO703X	Department Level Optional course- III Lab.	1
21	ELXL704	Project-I	1
22	ELXL801	Internet of Things Lab.	1
23	ELXL802	Analog and Mixed VLSI Design Lab.	1
24	ELXLDLO804X	Department Level Optional Courses-IV Lab	1
25	ELXL803	Project-II	1
		Total	25

UNIVERSITY OF MUMBAI



Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics and Telecommunication Engineering

Second Year with Effect from **AY 2017-18**

Third Year with Effect from **AY 2018-19**

Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016-17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

The curriculum in higher education is a living entity. It evolves with time; it reflects the ever changing needs of the society and keeps pace with the growing talent of the students and the faculty. The engineering education in India is expanding in manifolds and the main challenge is the quality of education. All stakeholders are very much concerned about it. The curriculum of Electronics & Telecommunication in Mumbai University is no exception. In keeping with the demands of the changing times, it contains innovative features. The exposure to the latest technology and tools used all over the world is given by properly selecting the subjects. It is designed in such a way to incorporate the requirements of various industries. The major emphasis of this process is to measure the outcomes of the program. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of post-graduation. So the curriculum must be refined and updated to ensure that the defined objectives and outcomes are achieved.

I, as Chairman Ad-hoc Board of Studies in Electronics and Telecommunication Engineering, University of Mumbai, happy to state here that, the heads of the department and senior faculty from various institutes took timely and valuable initiative to frame the Program Educational objectives as listed below.

Objectives:

1. To produce Electronics & Telecommunication engineers, having strong theoretical foundation, good design experience and exposure to research and development.
2. To produce researcher who have clear thinking, articulation and interest to carry out theoretical and/or applied research resulting in significant advancement in the field of specialization.
3. To develop an ability to identify, formulate and solve electronics and telecommunication engineering problems in the latest technology.
4. To develop the ability among students to synthesize data and technical concepts from applications to product design.

These are the suggested and expected main objectives, individual affiliated institutes may add further in the list. I believe that the small step taken in the right direction will definitely help in providing quality education to the stake holders.

This book of curricula is the culmination of large number of faculty members and supporting staff. It also reflects the creative contribution of hundreds of teachers – both serving and retired. I sincerely hope that the faculty and students of Electronics and Telecommunication in Mumbai University will take full advantage of dynamic features of curriculum and make teaching-learning process a truly sublime experience for all.

At the end I must extend my gratitude to all experts and colleagues who contributed to make curriculum competent at par with latest technological development in the field of Electronics & Telecommunication Engineering.

Dr. Uttam D. Kolekar

Chairman, Ad-hoc Board of Studies in Electronics and Telecommunication Engineering

**Program Structure for
B.E. Electronics & Telecommunication Engineering (Rev. 2016)
University of Mumbai
(With Effect from 2017-2018)**

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC301	Applied Mathematics- III	4	-	2@	4	1	5
ECC302	Electronic Devices and Circuits I	4	-	-	4	-	4
ECC303	Digital System Design	4	-	-	4	-	4
ECC304	Circuit Theory and Networks	4	-	2@	4	1	5
ECC305	Electronic Instrumentation and Control	4	-	2@	4	1	5
ECL301	Electronic Devices and Circuits I Laboratory	-	2	-	-	1	1
ECL302	Digital System Design Laboratory	-	2	-	-	1	1
ECL303	OOP using JAVA Laboratory	-	2	-	-	1	1
Total		20	6	6	20	6	26

@ 2 hour to be taken as tutorial classwise

Course Code	Course Name	Examination Scheme							
		Theory			End Sem Exam	Exam Duration (Hrs)	TW	Oral/Prac	Total
		Internal Assessment							
		Test1	Test 2	Avg					
ECC301	Applied Mathematics-III	20	20	20	80	03	25	--	125
ECC302	Electronic Devices and Circuits I	20	20	20	80	03	--	--	100
ECC303	Digital System Design	20	20	20	80	03	--	--	100
ECC304	Circuit Theory and Networks	20	20	20	80	03	25	--	125
ECC305	Electronic Instrumentation and Control	20	20	20	80	03	25	--	125
ECL301	Electronic Devices and Circuits I Laboratory	--	--	--	--	--	25	25	50
ECL302	Digital System Design Laboratory	--	--	--	--	--	25	25	50
ECL303	OOP using JAVA Laboratory	--	--	--	--	--	25	25	50
Total				100	400		150	75	725

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC401	Applied Mathematics- IV	4	-	2@	4	1	5
ECC402	Electronic Devices and Circuits II	4	-	-	4	-	4
ECC403	Linear Integrated Circuits	4	-	-	4	-	4
ECC404	Signals & Systems	4	-	2@	4	1	5
ECC405	Principles of Communication Engineering	4	-	-	4	-	4
ECL401	Electronic Devices and Circuits II Laboratory	-	2	-	-	1	1
ECL402	Linear Integrated Circuits Laboratory	-	2	-	-	1	1
ECL403	Principles of Communication Engineering Laboratory	-	2	-	-	1	1
Total		20	6	4	20	5	25

@ 2 hour to be taken as tutorial classwise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC401	Applied Mathematics- IV	20	20	20	80	03	25	--	125
ECC402	Electronic Devices and Circuits II	20	20	20	80	03	--	--	100
ECC403	Linear Integrated Circuits	20	20	20	80	03	--	--	100
ECC404	Signals & Systems	20	20	20	80	03	25	--	125
ECC405	Principles of Communication Engineering	20	20	20	80	03	--	--	100
ECL401	Electronic Devices and Circuits II Laboratory	--	--	--	--	--	25	25	50
ECL402	Linear Integrated Circuits Laboratory	--	--	--	--	--	25	25	50
ECL403	Principles of Communication Engineering Laboratory	--	--	--	--	--	25	25	50
Total				100	400		125	75	700

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC501	Microprocessor & Peripherals Interfacing	4	-	-	4	-	4
ECC502	Digital Communication	4	-	-	4	-	4
ECC503	Electromagnetic Engineering	4	-	1@	4	1	5
ECC504	Discrete Time Signal Processing	4	-	-	4	-	4
ECCDLO 501X	Department Level Optional Course I	4	-	-	4	-	4
ECL501	Microprocessor & Peripherals Interfacing Lab	-	2	-	-	1	1
ECL502	Digital Communication Lab	-	2	-	-	1	1
ECL503	Business Communication & Ethics Lab	-	2+2*	-	-	2	2
ECL504	Open Source Technology for Communication Lab	-	2	-	-	1	1
ECLDLO 501X	Department Level Optional Lab I	-	-	2#	-	1	1
Total		20	10	3	20	7	27

@ 1 hour to be taken as tutorial classwise #2 hours to be taken as either lab or tutorial based on subject requirement
 *2 hours to be taken as tutorial batchwise

Course Code	Course Name	Examination Scheme									
		Theory					End Sem Exam	Exam Duration (Hrs)	TW	Oral/ Prac	Total
		Internal Assessment			Avg						
		Test1	Test 2								
ECC501	Microprocessor & Peripherals Interfacing	20	20	20	80	03	--	--	100		
ECC502	Digital Communication	20	20	20	80	03	--	--	100		
ECC503	Electromagnetic Engineering	20	20	20	80	03	25	--	125		
ECC504	Discrete Time Signal Processing	20	20	20	80	03	--	--	100		
ECCDLO 501X	Department Level Optional Course I	20	20	20	80	03	--	--	100		
ECL501	Microprocessor & Peripherals Interfacing Lab	--	--	--	--	--	25	25	50		
ECL502	Digital Communication Lab	--	--	--	--	--	25	25	50		
ECL503	Business Communication & Ethics Lab	--	--	--	--	--	50	--	50		
ECL504	Open Source Technology for Communication Lab	--	--	--	--	--	25	25	50		
ECLDLO 501X	Department Level Optional Lab I	--	--	--	--	--	25	--	25		
Total				100	400		175	75	750		

Course Code	Department Level Optional Course I
ECCDLO 5011	Microelectronics
ECCDLO 5012	TV & Video Engineering
ECCDLO 5013	Finite Automata Theory
ECCDLO 5014	Data Compression and Encryption

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC601	Microcontrollers & Applications	4	-	--	4	--	4
ECC602	Computer Communication Networks	4	-	-	4	-	4
ECC603	Antenna & Radio Wave Propagation	4	-	-	4	-	4
ECC604	Image Processing and Machine Vision	4	-	--	4	--	4
ECCDLO 602X	Department Level Optional Course II	4	-	-	4	-	4
ECL601	Microcontroller & Applications Lab	-	2	-	-	1	1
ECL602	Computer Communication Network Lab	-	2	-	-	1	1
ECL603	Antenna & Radio Wave Propagation Lab	-	2	-	-	1	1
ECL604	Image Processing and Machine Vision Lab	-	2	-	-	1	1
ECLDLO 602X	Department Level Optional Lab II	-	2	-	-	1	1
Total		20	10	-	20	5	25

Course Code	Course Name	Examination Scheme									
		Theory					End Sem Exam	Exam Duration (Hrs)	TW	Oral & Prac	Total
		Internal Assessment			Avg						
		Test1	Test 2	Avg							
ECC601	Microcontroller & Applications	20	20	20	80	03	--	--	100		
ECC602	Computer Communication Network	20	20	20	80	03	--	--	100		
ECC603	Antenna & Radio Wave Propagation	20	20	20	80	03	--	--	100		
ECC604	Image Processing and Machine Vision Lab	20	20	20	80	03	--	--	100		
ECCDLO 602X	Department Level Optional Course II	20	20	20	80	03	--	--	100		
ECL601	Microcontroller & Applications Lab	--	--	--	--	--	25	25	50		
ECL602	Computer Communication Network Lab	--	--	--	--	--	25	25	50		
ECL603	Antenna & Radio Wave Propagation Lab	--	--	--	--	--	25	25	50		
ECL604	Image Processing and Machine Vision Lab	--	--	--	--	--	25	25	50		
ECLDLO 602X	Department Level Optional Lab II	--	--	--	--	--	25	--	25		
Total				100	400		125	100	725		

Course Code	Department Level Optional Course II
ECCDLO 6021	Digital VLSI Design
ECCDLO 6022	Radar Engineering
ECCDLO 6023	Database Management System
ECCDLO 6024	Audio Processing

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC701	Microwave Engineering	4	-	-	4	-	4
ECC702	Mobile Communication System	4	-	-	4	-	4
ECC703	Optical Communication	4	-	--	4	-	4
ECCDLO 703X	Department Level Optional Course III	4	-	-	4	-	4
ILO701X	Institute Level Optional Course I	3	-	-	3	-	3
ECL701	Microwave Engineering Lab	-	2	-	-	1	1
ECL702	Mobile Communication System Lab	-	2	-	-	1	1
ECL703	Optical Communication Lab	-	2	-	-	1	1
ECLDLO 703X	Department Level Optional Lab III	-	2	-	-	1	1
ECL704	Project-I	-	6	-	-	3	3
Total		19	14	-	19	7	26

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC701	Microwave Engineering	20	20	20	80	03	--	--	100
ECC702	Mobile Communication System	20	20	20	80	03	--	--	100
ECC703	Optical Communication	20	20	20	80	03	--	--	100
ECCDLO 703X	Department Level Optional Course III	20	20	20	80	03	--	--	100
ILO701X	Institute Level Optional Course I	20	20	20	80	03	--	--	100
ECL701	Microwave Engineering Lab	--	--	--	--	--	25	25	50
ECL702	Mobile Communication System Lab	--	--	--	--	--	25	25	50
ECL703	Optical Communication Lab	--	--	--	--	--	25	25	50
ECLDLO 703X	Department Level Optional Lab III	--	--	--	--	--	25	25	50
ECL704	Project-I	--	--	--	--	--	50	50	100
Total				100	400		150	150	800

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I[#]
ECCDLO7031	Neural Networks and Fuzzy Logic	ILO7011	Product Lifecycle Management
ECCDLO7032	Big Data Analytics	ILO7012	Reliability Engineering
ECCDLO7033	Internet Communication Engineering	ILO7013	Management Information System
ECCDLO7034	CMOS Mixed Signal VLSI	ILO7014	Design of Experiments
ECCDLO7034	Embedded System	ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

Common with all branches

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC801	RF Design	4	-	--	4	--	4
ECC802	Wireless Networks	4	-	-	4	-	4
ECCDLO 804X	Department Level Optional Course IV	4	-	-	4	-	4
ILO802X	Institute Level Optional Course II	3	-	-	3	-	3
ECL801	RF Design Lab	-	2	-	-	1	1
ECL802	Wireless Networks Lab	-	2	-	-	1	1
ECLDLO 804X	Department Level Optional Lab IV	-	2	-	-	1	1
ECL803	Project-II	-	12	-	-	6	6
Total		15	18	-	15	9	24

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC801	RF Design	20	20	20	80	03	--	--	100
ECC802	Wireless Networks	20	20	20	80	03	--	--	100
ECCDLO 804X	Department Level Optional Course IV	20	20	20	80	03	--	--	100
ILO802X	Institute Level Optional Course II	20	20	20	80	03	--	--	100
ECL801	RF Design Lab	--	--	--	--	--	25	25	50
ECL802	Wireless Networks Lab	--	--	--	--	--	25	25	50
ECLDLO 804X	Department Level Optional Lab IV	--	--	--	--	--	25	25	50
ECL803	Project-II	--	--	--	--	--	100	50	150
Total				80	320		175	125	700

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II[#]
ECCDLO8041	Optical Networks	ILO8021	Project Management
ECCDLO8042	Advanced Digital Signal Processing	ILO8022	Finance Management
ECCDLO8043	Satellite Communication	ILO8023	Entrepreneurship Development and Management
ECCDLO8044	Network management in Telecommunication	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

Common with all branches

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC301	Applied Mathematics-III	04	--	@2	04	--	01	05

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC301	Applied Mathematics-III	20	20	20	80	25	--	--	125	

@ 2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Applied Mathematics I
- Applied Mathematics II

Course Objectives:

1. To build the strong foundation in Mathematics of students needed for the field of electronics and Telecommunication Engineering
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice.
4. To prepare students to work as part of teams on multi-disciplinary projects.

Course Outcome:

After successful completion of the course student will be able to

1. Students will demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable.
2. Students will demonstrate an ability to identify and Model the problems of the field of Electronics and Telecommunication and solve it.
3. Students will be able to apply the application of Mathematics in Telecommunication Engineering

Module No.	Unit No.	Detailed Content	Hours
1		Laplace Transform	07
	1.1	Laplace Transform (LT) of Standard Functions: Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace transform of e^{at} , $\sin(at)$, $\cos(at)$, $\sinh(at)$, $\cosh(at)$, Heaviside unit step function, Dirac-delta function, Laplace transform of Periodic function	
	1.2	Properties of Laplace Transform: Linearity, first shifting theorem, second shifting theorem, multiplication by t^n , Division by t , Laplace Transform of derivatives and integrals, change of scale, convolution theorem, Evaluation of integrals using Laplace transform.	
2		Inverse Laplace Transform & its Applications	06
	2.1	Partial fraction method, Method of convolution, Laplace inverse by derivative	
	2.2	Applications of Laplace Transform: Solution of ordinary differential equations, Solving RLC circuit differential equation of first order and second order with boundary condition using Laplace transform (framing of differential equation is not included)	
3		Fourier Series	11
	3.1	Introduction: Orthogonal and orthonormal set of functions, Introduction of Dirichlet's conditions, Euler's formulae.	
	3.2	Fourier Series of Functions: Exponential, trigonometric functions of any period $=2L$, even and odd functions, half range sine and cosine series	
	3.3	Complex form of Fourier series, Fourier integral representation, Fourier Transform and Inverse Fourier transform of constant and exponential function.	
4		Vector Algebra & Vector Differentiation	07
	4.1	Review of Scalar and Vector Product: Scalar and vector product of three and four vectors, Vector differentiation, Gradient of scalar point function, Divergence and Curl of vector point function	
	4.2	Properties: Solenoidal and irrotational vector fields, conservative vector field	

5		Vector Integral	06
	5.1	Line integral	
	5.2	Green's theorem in a plane, Gauss' divergence theorem and Stokes' theorem	
6		Complex Variable & Bessel Functions	11
	6.1	Analytic Function: Necessary and sufficient conditions (No Proof), Cauchy Reiman equation Cartesian form (No Proof) Cauchy Reiman Equation in polar form (with Proof), Milne Thomson Method and it application, Harmonic function, orthogonal trajectories	
	6.2	Mapping: Conformal mapping, Bilinear transformations, cross ratio, fixed points	
	6.3	Bessel Functions: Bessel's differential equation, Properties of Bessel function of order +1/2 and -1/2, Generating function, expression of $\cos(x\sin\theta)$, $\sin(x\sin\theta)$ in term of Bessel functions	

Note: Term Work should be based on Tutorials.

Textbooks :

1. H.K. Das, "Advanced engineering mathematics", S . Chand, 2008
2. A. Datta, "Mathematical Methods in Science and Engineering", 2012
3. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publication

Reference Books:

1. B. V. Ramana, "Higher Engineering Mathematics", Tata Mc-Graw Hill Publication
2. Wylie and Barret, "Advanced Engineering Mathematics", Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, "Advanced Engineering Mathematics", John Wiley & Sons, Inc
4. Murry R. Spieget, "Vector Analysis", Schaum's outline series, Mc-Graw Hill Publication

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC302	Electronic Devices & Circuits-I	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECC302	Electronic Devices & Circuits-I	20	20	20	80	--	--	--	100	

Course Pre-requisite:

- Basic Electrical Engineering
- Applied Physics

Course Objectives:

1. To understand operation of semiconductor devices.
2. To understand DC analysis and AC models of semiconductor devices.
3. To apply concepts for the design of Regulators and Amplifiers
4. To verify the theoretical concepts through laboratory and simulation experiments.
5. To implement mini projects based on concept of electronics circuit concepts.

Course Outcome:

After successful completion of the course student will be able to

1. Understand the current voltage characteristics of semiconductor devices,
2. Analyze dc circuits and relate ac models of semiconductor devices with their physical Operation,
3. Design and analyze of electronic circuits,
4. Evaluate frequency response to understand behaviour of Electronics circuits.

Module No.	Unit No.	Detailed Content	Hours
1		Diode and material science	06
	1.1	Study of various types of resistor, capacitor and inductors	
	1.2	Basic fabrication steps of passive elements.	
	1.3	PN junction Diode characteristics, small signal model	
2		Rectifier, Filters and Regulator	08
	2.1	Analysis and design of rectifier circuit with Filters (L, LC, C,CLC,CRC)	
	2.2	Concept of load and line regulation in power supply circuits.	
	2.3	Analysis and design of zener voltage regulator	
3		Transistor biasing and design	08
	3.1	Operation of BJT, FET (N-CHANNEL, P-CHANNEL) with characteristics and equation.	
	3.2	Bipolar Junction Transistor: BJT characteristics, DC/AC load line, DC analysis and design of fixed bias, collector to base bias and voltage divider bias, stability factor analysis	
	3.3	Junction Field Effect Transistor: Analysis and design of self-bias and voltage divider bias, zero temp drift biasing.	
4		Transistor modeling and Small signal analysis of amplifier	12
	4.1	Hybrid and hybrid-pi model of BJT with graphical representation.	
	4.2	Small signal model of FET with graphical representation.	
	4.3	Small signal analysis (Z_i , Z_o , A_v and A_i) of CE, CB, and CC configurations using hybrid-pi model of BJT	
	4.4	small signal (mid-frequency) analysis of CS, CD and CG amplifiers using FET	
5		High frequency response of BJT and FET amplifiers	08
	5.1	High frequency hybrid-pi equivalent Circuits of BJT and FET, Miller effect and Miller capacitance, gain bandwidth product	
	5.2	Effects of capacitors on frequency response of single stage amplifier using BJT and FET	
	5.3	Analysis of single stage amplifiers at HF and gain bandwidth product.	

6		Design of small signal amplifiers	06
	6.1	Design of single stage RC Coupled CE amplifier.	
	6.2	Design of single stage RC Coupled CS amplifier. (USE of parameters from data sheet compulsory)	

Textbooks :

1. D. A. Neamen, *“Electronic Circuit Analysis and Design,”* Tata McGraw Hill, 2nd Edition.
2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, *“Microelectronic Circuits Theory and Applications,”* International Version, OXFORD International Students, 6th Edition
3. R. S. Dudhe and M. Farhan, *“Electronic Devices and Circuits,”* Synergy Knowledgeware, 1st Edition, 2013.

Reference Books:

1. Boylestad and Nashelsky, *“Electronic Devices and Circuits Theory,”* Pearson Education, 11th Edition.
2. A. K. Maini, *“Electronic Devices and Circuits,”* Wiley.
3. T. L. Floyd, *“Electronic Devices,”* Prentice Hall, 9th Edition, 2012.
4. A. Rockett, *“Material Science of Semiconductors,”* Springer, 1st Edition, 2009
5. A. Mottershead, *“Electronic Devices and Circuits; An Introduction,”*

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC303	Digital System Design	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC303	Digital System Design	20	20	20	80	--	--	--	100	

Course Objectives:

1. To understand number representation and conversion between different representation in digital electronic circuits.
2. To analyze logic processes and implement logical operations using combinational logic circuits.
3. To understand characteristics of memory and their classification.
4. To understand concepts of sequential circuits and to analyze sequential systems in terms of state machines.
5. To understand concept of Programmable Devices, PLA, PAL, CPLD and FPGA and implement digital system using VHDL.
6. To implement combinational and sequential circuits using VHDL.

Course Outcome:

After successful completion of the course student will be able to

1. Develop a digital logic and apply it to solve real life problems.
2. Analyze, design and implement combinational logic circuits.
3. Classify different semiconductor memories.
4. Analyze, design and implement sequential logic circuits.
5. Analyze digital system design using PLD.
6. Simulate and implement combinational and sequential circuits using VHDL systems.

Module No.	Unit No.	Detailed Content	Hours
1		Number Systems and Codes	04
	1.1	Review of Number System, Binary Code, Binary Coded Decimal, Octal Code, Hexadecimal Code and their conversions, Binary Arithmetics, Gray Code	
2		Logic Gates and Combinational Logic Circuits	18
	2.1	Analog and Digital signals and systems, Logic levels, TTL and CMOS Logic families and their characteristics	
	2.2	Digital logic gates, Realization using NAND, NOR gates, Boolean Algebra, De Morgan's Theorem, SOP and POS representation, K Map up to four variables and Quine-McClusky method	
	2.3	Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Serial and Parallel Addition, Carry Look ahead adder and BCD adder. Binary Multiplier, Magnitude Comparator,	
	2.4	Multiplexer and De-multiplexer: Multiplexer operations, cascading of Multiplexer, Boolean Function implementation using multiplexer and basic gates, de-multiplexer, encoder and decoder	
3		Different Types of Memory	02
		Classification and Characteristics of memory, SRAM, DRAM, ROM, PROM, EPROM and Flash memories	
4		Sequential Logic Circuits:	12
	4.1	Flip flops: RS, JK, Master slave flip flops; T & D flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO, Universal shift registers.	
	4.2	Counters: Asynchronous and Synchronous, Up/Down, MOD N, BCD	
	4.3	Applications of Sequential Circuits: Frequency division, Ring Counter, Johnson Counter. models, State transition diagram, Design of Moore and Mealy circuits-Design of Serial Adder and vending Machine	
	4.4	State Reduction Techniques: Row elimination and Implication table methods	
5		Programmable Logic Devices:	09
		Introduction : Programmable Logic Devices (PLD),	

		Programmable Logic Array (PLA), Programmable Array Logic(PAL), CPLD and FPGA, Keyboard Encoder system design using PLD	
6		VHSIC Hardware Description Language (VHDL)	03
	6.1	Data types, Structural modeling using VHDL, Attributes, Data Flow behavioral, Implementation of Priority Encoder-combinational circuit and Fibonacci Series Generator-sequential circuits using VHDL	

Textbooks :

1. John F. Warkerly, “*Digital Design Principles and Practices*”, Pearson Education, Fourth Edition (2008).
2. R. P. Jain, “*Modern Digital Electronics*”, Tata McGraw Hill Education, Third Edition (2003).
3. J. Bhaskar, “*VHDL Primer*”, PHI, Third Edition (2009).
4. Volnei A. Pedroni, “*Digital Electronics and Design with VHDL*” Morgan Kaufmann Publisher (2008)

Reference Books:

1. Morris Mano / Michael D. Ciletti, “*Digital Design*”, Pearson Education, Fourth Edition (2008).
2. Thomas L. Floyd, “*Digital Fundamentals*”, Pearson Prentice Hall, Eleventh Global Edition (2015).
3. Mandal, “*Digital Electronics Principles and Applications*”, McGraw Hill Education, First Edition (2010).
4. Stephen Brown & Zvonko Vranesic, “*Fundamentals of Digital Logic Design with VHDL*”, Second Edition, TMH (2009).
5. Ronald J. Tocci, Neal S. Widmer, “*Digital Systems Principles and Applications*”, Eighth Edition, PHI (2003)
6. Donald P. Leach / Albert Paul Malvino/Gautam Saha, “*Digital Principles and Applications*”, The McGraw Hill, Seventh Edition (2011).

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC304	Circuit Theory and Networks	04	--	@2	04	--	1	05

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC304	Circuit Theory and Networks	20	20	20	80	25	--	--	125	

@ 2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Basic Electrical Engineering
- Solution to Differential Equations and Laplace Transform

Course Objectives:

1. To analyze the Circuits in time and frequency domain
2. To study network Topology, network Functions, two port network
3. To synthesize passive network by various methods

Course Outcome:

After successful completion of the course student will be able to

1. Apply their knowledge in analysing Circuits by using network theorems.
2. Apply the time and frequency method of analysis.
3. Find the various parameters of two port network.
4. Apply network topology for analyzing the circuit
5. Synthesize the network using passive elements.

Module No.	Unit No.	Detailed Content	Hours
1		Electrical circuit analysis	08
	1.1	Analysis of DC & AC Circuits: Analysis of Circuits with and without controlled sources using generalized loop and node matrix methods Circuit Theorems: Superposition, Thevenin's, Norton's, maximum power transfer and reciprocity theorems	
	1.2	Magnetic circuits: Concept of Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit Coupled circuit- solution using mesh analysis	
2		Graph Theory	08
	2.1	Objectives of graph theory, Linear Oriented Graphs, graph terminologies Matrix representation of a graph: Incidence matrix, Circuit matrix, Cut-set matrix, reduced incident matrix, tieset matrix, f-cutset matrix.	
	2.2	Relationship between sub matrices A, B & Q.	
	2.3	KVL & KCL using matrix	
3		Time and frequency domain analysis	08
	3.1	Time domain analysis of R-L and R-C Circuits: Forced and natural response, initial and final values Solution using first order differential equation for impulse, step, ramp, exponential & sinusoidal signals	
	3.2	Time domain analysis of R-L-C Circuits: Forced and natural response, effect of damping factor. Solution using second order equation for step, ramp, exponential & sinusoidal signals.	
	3.3	Frequency domain analysis: Frequency - domain representation of R, L,C , initial value theorem & final value theorem, applications of Laplace Transform in analyzing electrical circuits	
4		Network functions	08
	4.1	Network functions for the one port and two port networks, Driving point and transfer functions, Poles and Zeros of Network functions, necessary condition for driving point functions, necessary condition for transfer functions, calculation of residues by analytical and graphical methods,	

		Time domain behavior as related to the Pole-Zero plot Stability & causality, testing for Hurwitz polynomial	
	4.2	Analysis of ladder & symmetrical lattice network	
5		Two port Networks	08
	5.1	Parameters: Open Circuits, short Circuit, Transmission and Hybrid parameters, relationship among parameters, conditions for reciprocity and symmetry	
	5.2	Interconnections of Two-Port networks T & π representation.	
	5.3	Terminated two-port networks	
6		Synthesis of RLC circuits	08
	6.1	Positive Real Functions: Concept of positive real function , testing for necessary and sufficient conditions for Positive real Functions	
	6.2	Synthesis of LC, RC & RL Circuits: properties of LC, RC & RL driving point functions, LC, RC & RL network Synthesis in Cauer-I & Cauer-II , Foster-I & Foster-II forms	

Note: Term Work should be based on Tutorials.

Textbooks :

1. Franklin F Kuo, “*Network Analysis and Synthesis*”, Wiley Toppan, 2nd.ed. 1966
2. M E Van Valkenburg, “*Network Analysis*”, Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000

Reference Books:

1. A Chakrabarti, “*Circuit Theory*”, Dhanpat Rai & Co., Delhi, 6h Edition
2. A. Sudhakar, Shyammoan S. Palli “*Circuits and Networks*, Tata McGraw-Hill education
3. Smarajit Ghosh, *Network Theory Snalysis & Syntshesis*, PHI learning
4. K.S. Suresh Kumar, *Electric circuit analysis*, Pearson (2013)
5. D Roy Choudhury, *Networks and Systems*, New Age International 1998.

TUTORIALS: At least 10 tutorials covering various topics of the syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC305	Electronic Instrumentation & Control	04	--	@2	04	--	1	05

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECC305	Electronic Instrumentation & Control	20	20	20	80	25	--	--	125	

@ 2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Basic Electrical Engineering

Course Objectives:

1. To provide basic knowledge about the various sensors and data acquisition systems applied in Wireless sensor network.
2. To provide fundamental concepts of control system such as mathematical modeling, time response and frequency response.
3. To develop concepts of stability and its assessment criteria.

Course Outcome:

After successful completion of the course student will be able to

1. Students will be able to explain principle of operation for various sensors.
2. Students will be able to describe functional blocks of data acquisition system.
3. Students will be able to find transfer functions for given system.
4. Students will be able to calculate time domain and frequency domain parameter for given system
5. Students will be able to predict stability of given system using appropriate criteria.

Module No.	Unit No.	Detailed Content	Hours
1		Principle of Measurement, Testing and Measuring instruments	07
	1.1	Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration.	
	1.2	Measurement of Resistance: Kelvin's double bridge, Wheatstone bridge and Mega ohm bridge Measurement of Inductance: Maxwell bridge and Hey bridge Measurement of Capacitance: Schering bridge Q-Meter: Operating principle and applications Energy and power meters: Working of energy and power meter	
2		Sensors and Transducers	08
	2.1	Basics of sensors and Transducers-Active and passive transducers, characteristics and selection criteria of transducers, working principle of Eddy-current sensors, Pizeoelectric transducers, photoelectric and photovoltaic sensors, capacitive sensors	
	2.2	Displacement and pressure- Potentiometers, pressure gauges, linear Variable differential transformers(LVDT) for measurement of pressure and displacement strain gauges	
	2.3	Temperature Transducers- Resistance temperature detectors(RTD). Thermistors and thermocouples , their ranges and applications	
3		Telemetry and Data Acquisition System	08
	3.1	Introduction and characteristics, Landline Telemetry, Radio Telemetry Types of Multiplexing Systems,	
	3.2	Data Acquisition: Components of Analog and Digital Data Acquisition System,	
	3.3	Uses of Data Acquisition System, Use of recorders in Digital systems, Modern Digital Data Acquisition System.	
4		Introduction to control system Analysis	07

	4.1	Introduction: Open and closed loop systems, example of control systems	
	4.2	Modelling: Modelling, Transfer function model of electrical systems, Block diagram reduction techniques and Signal flow graph	
	4.3	Dynamic Response: Standard test signals, transient and steady state behaviour of first and second order systems , steady state errors in feedback control systems and their types	
5		Stability Analysis in Time Domain	08
	5.1	Concept of stability: Routh and Hurwitz stability criterion	
	5.2	Root locus Analysis: Root locus concept, general rules for constructing root-locus ,root locus analysis of control system, concept of design of lag and lead compensator	
6		Stability Analysis in frequency domain	10
	6.1	Introduction: Frequency domain specification, Relationship between time and frequency domain specification of system, stability margins	
	6.2	Bode Plot: Magnitude and phase plot, Method of plotting Bode plot, Stability margins and analysis using bode plot. Frequency response analysis of RC, RL, RLC circuits	
	6.3	Nyquist Criterion: Concept of Polar plot and Nyquist plot, Nyquist stability criterion ,gain and phase margin	

Note: Term Work should be based on Tutorials.

Textbooks :

1. A.K. Sawhney, “*Electrical & Electronic Measurement & Instrumentation*” – DRS . India
2. M.M.S. Anand, “*Electronic Instruments and instrumentation Technology*”.
3. H.S.Kalsi, “*Electronic Instrumentation*”-TMH, 2nd Edition.
4. Nagrath, M.Gopal, “*Control System Engineering*”, Tata McGraw Hill.
5. K.Ogata, “*Modern Control Engineering*, Pearson Education”, IIIrd edition.

Reference Books:

1. Helfrick&Copper, “*Modern Electronic Instrumentation & Measuring Techniques*” – PHI
2. W.D. Cooper, “*Electronic Instrumentation And Measuring Techniques*” – PHI
3. Benjamin C.Kuo, “*Automatic Control Systems*, Pearson education”, VIIth edition

4. Rangan C. S., Sarma G. R. and Mani V. S. V., "*Instrumentation Devices And Systems*", Tata McGraw-Hill, 2nd Ed., 2004.
5. Bell David A. "*Electronic Instrumentation and Measurements*", PHI Pearson Education, 2006.
6. Madan Gopal, "*Control Systems Principles and Design*", Tata McGraw hill, 7th edition, 1997.
7. Normon, "*Control System Engineering*", John Wiley & sons, 3rd edition.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL301	Electronic Devices & Circuits-I Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment								
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECL301	Electronic Devices & Circuits-I Laboratory	--	--	--	--	25	25	--	50	

Laboratory plan

Maximum of 8 practicals including **minimum 2 simulations** should be conducted based on following topics

- Study of different measuring instruments such as CRO, Function Generator, Multimeter, and Power Supply. (Compulsory)
- Filter circuits
- Biasing of BJT and FET
- Frequency response
- Zener regulator
- Single stage amplifiers

Minimum One project based on:

- Design of single stage CE and CS amplifier
- Design of filter and regulator circuits
- Design of power supply
- Any other relevant topic based on syllabus

Note : Small project should be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. **The practical and oral examination will be based on entire syllabus.**

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL302	Digital System Design Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment								
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECL302	Digital System Design Laboratory	--	--	--	--	25	25	--	50	

Laboratory plan

Maximum of 8 practicals including minimum 2 simulations should be conducted.

Suggested list of experiments:

1. Verify different logic gates.
2. Simplification of Boolean functions.
3. Verify Universal gates NAND and NOR and design EXOR and EXNOR gates using Universal gates.
4. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
5. Implement BCD adder using four bit binary adder IC-7483.
6. Flip flops conversion JK to D, JK to T and D to TFF.
7. Implement logic equations using Multiplexer.
8. Design synchronous MOD N counter using IC-7490.
9. Verify encoder and decoder operations.
10. Implement digital circuits to perform binary to gray and gray to binary operations.
11. Verify truth table of different types of flip flops.
12. Verify different counter operations.
13. Write VHDL simulation code for different logic gates.
14. Write VHDL simulation code for combinational and sequential circuits
15. Write VHDL simulation code for 4:1 Multiplexer, 2 line to 4 line binary decoder

Minimum One project

Suggested list of Mini Projects:

1. Design Clock pulse generator.
2. Design Clap operated remote control for Fan.
3. Design BCD counter and show operation on Seven Segment Display.
4. Design digital stop watch.
5. Write VHDL code to implement traffic light controller.
6. Design water level indicator for overhead water tank.
7. Design frequency divider circuit.
8. Design switch debounce circuit.
9. Design sequence generator circuit.
10. Design sequence detector circuit.
11. Design Even/Odd parity generator/checker circuit.
12. Design simple LED flasher circuit.
13. Design digital dice.
14. Design fastest finger first indicator.
15. Design Toggle switch using TFF.

Note : Small project should be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL303	OOP using JAVA laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECL303	OOP using JAVA laboratory	--	--	--	--	25	25	--	50	

Course Pre-requisites:

- Fundamentals of C-Programming
- Control Structures
- Arrays and String

Course Objectives:

1. To understand Object Oriented Programming and its principles.
2. To describe & explain keywords and Data types.
3. Able to implement Methods, Constructors, Arrays, Multithreading and Applet
4. To help students to understand how to use a programming language to resolve problems.

Course Outcomes:

1. Students will be able to code a program using JAVA constructs.
2. Students will be able to understand fundamental features of an object oriented language: object classes and interfaces, exceptions and libraries of object collections.
3. Students will be able to develop a program that efficiently implements the algorithm for given tasks.
4. Students will be able to utilize the knowledge acquired in this course to develop higher level algorithms.

Module No.	Unit No.	Detailed Content	Hours
1		Fundamental Concepts of Object Oriented Programming	06
	1.1	Introduction to Object-Oriented Programming	
	1.2	Classes, Objects, Creating Classes and Objects, Principles of OOP: Abstraction, Encapsulation, Inheritance, Polymorphism	
	1.3	Differences And Similarity Between C and Java	
2		Fundamental Of Java Programming	08
	2.1	Features of Java, JDK Environment & Tools, Structure of Java Program	
	2.2	Java Keywords, Super Keyword, Final Keyword, Abstract Class	
	2.3	Data Types, Variables, Operators, Expressions	
	2.4	Input Output Using Scanner Class	
	2.5	Exception Handling, Object-Oriented Containers	
3		Method, Constructors, Destructors And Arrays	04
	3.1	Passing and Returning Parameters to Methods	
	3.2	Constructor and Types, Destructor	
	3.3	Arrays and Types: Create, One Dimensional Arrays, Two Dimensional Array, Multidimensional Array, String Array	
4		Inheritance, Interface And Package	04
	4.1	Types of Inheritance: Single, Multilevel, Hierarchical	
	4.2	Method Overloading and Method Overriding	
	4.3	Interface	
	4.4	Packages	
5		Multithreading And Applet	04
	5.1	Life Cycle Of Thread	
	5.2	Priority In Multithreading	
	5.3	Applet Life Cycle	
	5.4	Creating Applet, Applet Tag	

Textbooks :

1. Herbert Schidt, “*The Complete Reference*”, Tata McGraw-Hill Publishing Company Limited, Ninth Edition
2. D.T. Editorial Services ,“*Java 8 Programming Black Book*”, Dreamtech Press, Edition: 2015
3. Yashwant Kanitkar, ”*Let Us Java*”, BPB Publications; 2nd Edition edition.

Reference Books:

1. Java: How to Program, 8/e, Dietal, Dietal, PHI
2. Grady Booch, James Rumbaugh, Ivar Jacobson, “*The Unified Modeling Languageser Guide*”, Pearson Education
3. Sachin Malhotra, Saurabh Chaudhary “*Programming in Java*”, Oxford University Press, 2010

Software Tools:

1. Raptor-Flowchart Simulation:<http://raptor.martincarlisle.com/>
2. Eclipse: <https://eclipse.org/>
3. Netbeans:<https://netbeans.org/downloads/>
4. CodeBlock:<http://www.codeblocks.org/>
5. J-Edit/J-Editor/Blue J

Online Repository:

1. Google Drive
2. GitHub
3. Code Guru

Laboratory plan

Maximum of 8 practicals including minimum 2 simulations should be conducted based on following topics

Section	Experiment Name	Module
1.	Write a program using command line argument in java. <ul style="list-style-type: none">• Echoing Command-Line Arguments.• Parsing Numeric Command-Line arguments.	Module 1
2.	Study of simple java programs <ul style="list-style-type: none">• WAP to calculate area & circumference of circle• WAP to swap given two strings• WAP to separate out digits of a number• WAP to convert temperature from Fahrenheit to Celsius• WAP to find a square , squarroot, and Cube of a given no. using abstraction	Module 1
3.	Study of different operators in java <ul style="list-style-type: none">• WAP to compare two numbers.• WAP to print truth table for java logical operators• WAP to read the number & shift left & right by 3 bits.	Module 1
4.	Write a program for various ways of accepting data through keyboard & display its content. <ul style="list-style-type: none">• Read through DataInputStream.• Read input through Scanner.• Read input through BufferedReader.	Module 2
5.	Study of Arrays Write a program for addition, subtraction and multiplication of two matrices.	Module 3
6.	Study of Objects and Classes <ul style="list-style-type: none">• Define a class to represent a bank account. Include the following members: Data: name of the depositor account number	Module 3

	<p>type of account</p> <p>balance amount in the account</p> <p>Methods:</p> <ol style="list-style-type: none"> 1.to assign initial values 2.to deposit an amount 3.to withdraw an amount after checking balance. 4.to display the name & balance <ul style="list-style-type: none"> • WAP using this keyword 	
7.	<p>Study of Strings.</p> <p>Accept the two strings from user & do the following operations</p> <ul style="list-style-type: none"> • convert to lowercase • convert to uppercase • Replace all appearance of one character by another • Compare two strings • Derive the substring of a string • Derive the position of a character in a string • Calculate the length of a string • Derive the nth character of a string 	Module 2
8.	<p>WAP to implement following constructors</p> <ul style="list-style-type: none"> • Default constructor • Parameterized constructor 	Module 3
9.	<p>Study of Interface.</p> <p>Create an interface Area & implement the same in different classes Rectangle ,circle ,triangle.</p>	Module 4
10.	<p>Study of utility package</p> <ul style="list-style-type: none"> • WAP to generate a year using random class and check whether it is leap or not. • Write a program to display current date. Also display Time in hours & 	Module 4

	Minutes using Date class.	
11.	<p>Study of Inheritance</p> <pre> classDiagram class Staff { code } class Typist { subject } class Teacher { subject } class Officer { } class Regular { name } class Casual { dailywedges } Staff -- > Typist Typist -- > Teacher Typist -- > Officer Teacher -- > Regular Teacher -- > Casual </pre>	Module 4
12.	<p>Study of Exception Handling in java.</p> <p>Write a program to use throw finally and try catch to handle exception.</p>	Module 2

13.	Study of Multithreading. WAP to illustrate function yield(), isAlive(), sleep(), join(). Create three threads as P,Q,R. Thread P has maximum priority, thread Q has minimum priority, thread R has normal priority.	Module 5
14.	Study graphics using applet. WAP to draw all geometric shapes and fill them with different colors.	Module 5

Minimum One project

Suggested list of mini projects

1. Inventory Control System
2. Develop Calculator
3. Develop Editor (Example: Notepad)
4. Develop Multimedia App to teach primary students (Shapes, Colors, etc.)
5. Create an audio or video applet or swing based application with play, pause and stop options.

Note : Small project should be considered as a part of term-work.

Term Work:

At least **10** experiments covering entire syllabus should be set to have well predefined inference and conclusion.

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Students are encouraged to share their experiments/mini project codes on online repository.

Practical from any 10 sections out of 14 sections is compulsory . Practical exam slip should cover all at least 10 sections.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC401	Applied Mathematics-IV	04	--	@2	04	--	01	05

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC401	Applied Mathematics-IV	20	20	20	80	25	--	--	125	

@2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Applied Mathematics I
- Applied Mathematics II
- Applied Mathematics III

Course Objectives:

1. To build the strong foundation in Mathematics of students needed for the field of Electronics and Telecommunication Engineering
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice.
4. To prepare students to work as part of teams on multi-disciplinary projects

Course Outcome:

After successful completion of the course student will be able to

1. Demonstrate basic knowledge of Calculus of variation, Vector Spaces, Matrix Theory, Random Variables, Probability Distributions, Correlation and Complex Integration.
2. Demonstrate an ability to identify and Model the problems in the field of Electronics and Telecommunication and solve it.
3. Apply the application of Mathematics in Telecommunication Engineering.

Module No.	Unit No.	Detailed Content	Hours
1		Calculus of Variation:	06
	1.1	Euler's Lagrange equation, solution of Euler's Lagrange equation (only results for different cases for Function) independent of a variable, independent of another variable, independent of differentiation of a variable and independent of both variables	
	1.2	Isoperimetric problems, several dependent variables	
	1.3	Functions involving higher order derivatives: Rayleigh-Ritz method	
2		Linear Algebra: Vector Spaces	06
	2.1	Vectors in n-dimensional vector space: properties, dot product, cross product, norm and distance properties in n-dimensional vector space.	
	2.2	Vector spaces over real field, properties of vector spaces over real field, subspaces	
	2.3	The Cauchy-Schwarz inequality, Orthogonal Subspaces, Gram-Schmidt process	
3		Linear Algebra: Matrix Theory	10
	3.1	Characteristic equation, Eigen values and Eigen vectors, properties of Eigen values and Eigen vectors.	
	3.2	Cayley-Hamilton theorem (without proof), examples based on verification of Cayley- Hamilton theorem.	
	3.3	Similarity of matrices, Diagonalisation of matrices.	
	3.4	Functions of square matrix, derogatory and non-derogatory matrices.	
4		Probability	10
	4.1	Baye's Theorem (without proof)	
	4.2	Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function, expectation, variance.	
	4.3	Moments, Moment Generating Function.	

	4.4	Probability distribution: Binomial distribution, Poisson & normal distribution (For detailed study)	
5		Correlation	04
	5.1	Karl Pearson's coefficient of correlation, Covariance, Spearman's Rank correlation,	
	5.2	Lines of Regression.	
6		Complex integration	12
	6.1	Complex Integration: Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula.	
	6.2	Taylor's and Laurent's Series	
	6.3	Zeros, singularities, poles of $f(z)$, residues, Cauchy's Residue theorem.	
	6.4	Applications of Residue theorem to evaluate real Integrals of different types.	

Note: Term Work should be based on Tutorials.

Textbooks :

1. H.K. Das, "Advanced engineering mathematics", S . Chand, 2008
2. A. Datta, "Mathematical Methods in Science and Engineering", 2012
3. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publication
4. P.N.Wartilar&J.N.Wartikar, "A Text Book of Applied Mathematics" Vol. I & II, Vidyarthi Griha Prakashan, Pune

Reference Books:

1. B. V. Ramana, "Higher Engineering Mathematics", Tata Mc-Graw Hill Publication
2. Wylie and Barret, "Advanced Engineering Mathematics", Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, "Advanced Engineering Mathematics", John Wiley & Sons, Inc
4. Seymour Lipschutz "Beginning Linear Algebra" Schaum's outline series, Mc-Graw Hill Publication
5. SeymourLipschutz "Probability" Schaum's outline series, Mc-Graw Hill Publication

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC402	Electronic Devices & Circuits-II	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC402	Electronic Devices & Circuits-II	20	20	20	80	--	--	--	100	

Course Pre-requisite:

- Electronic Devices & Circuits-I

Course Objectives:

1. To understand the operation of the various bias circuits of MOSFET and Analyze and design MOSFET bias circuits.
2. To understand the operation and design of multistage amplifier for a given specification.
3. To understand the operation and design of transformer coupled various types of power amplifier circuits.
4. To understand the effects of negative feedback on amplifier circuits.
5. To analyze the different *RC* and *LC* oscillator circuits to determine the frequency of oscillation.

Course Outcome:

After successful completion of the course student will be able to

1. Design and analyse the basic operations of MOSFET.
2. Know about the multistage amplifier using BJT and FET in various configuration to determine frequency response and concept of voltage gain.
3. Know about different power amplifier circuits, their design and use in electronics and communication circuits.
4. Know the concept of feedback amplifier and their characteristics.
5. Design the different oscillator circuits for various frequencies

Module No.	Unit No.	Detailed Content	Hours
1		Introduction to MOSFET	08
	1.1	MOSFET - Symbol, Types of MOSFET - Depletion and Enhancement type MOSFET (N channel and P channel),	
	1.2	Construction, Operation, and V-I characteristics of MOSFET	
	1.3	MOSFET biasing - Types of Depletion & enhancement MOSFET biasing,	
	1.4	MOSFET as amplifier	
2		Introduction of Multistage amplifiers	06
	2.1	RC coupled, transformer coupled, direct coupled,	
	2.2	Low and high frequency considerations of cascade amplifier, cascode amplifier (CE-CB), Darlington pair amplifier.	
3		Design of Multistage amplifiers	10
		Analysis and design considerations of multistage amplifiers (CE-CE, CS-CS, CS-CE,), effect of source and load resistance	
4		Large signal amplifiers	08
	4.1	Harmonic distortion and power efficiency of Class A, B, AB, and C amplifiers	
	4.2	Design of Class A, Class B, and Push-Pull Power amplifier design.	
	4.3	Thermal considerations and design selection of heat sinks.	
5		Feedback amplifiers	08
	5.1	Feedback concept, ideal feedback amplifier, classification of feedbacks, Various topologies	
	5.2	Analysis and design of different types of negative feedback.	
6		Oscillators	08
	6.1	Principle of oscillation, RC oscillator, twin T oscillator	
	6.2	Oscillator with LC feedback. Colpitts oscillator, Hartley oscillator, Crystal controlled oscillator.	
	6.3	Design of different oscillator circuits.	

Textbooks :

1. D. A. Neamen, "*Electronic Circuit Analysis and Design*," Tata McGraw Hill, 2nd Edition.
2. R. L. Boylestad, "Electronic Devices and Circuit Theory," Pearson, 11th Edition.
3. T. F. Bogart, "Electronic Devices And Circuit," Merrill, 6th Edition.
4. R. S. Dudhe and M. Farhan, "Electronic Devices and Circuits," Synergy Knowledgeware, 1st Edition

Reference Books:

1. Salivahanan, N. Suresh Kumar, "*Electronic Devices and Circuits*," Tata McGraw Hill, 3rd Edition
2. J. Millman, Christos CHalkias, and Satyabratatajit, Millman's, "*Electronic Devices and Circuits*," McGrawHill, 3rd Edition
3. Muhammad H. Rashid, "*Microelectronics Circuits Analysis and Design*," Cengage Learning, 2nd Edition.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC403	Linear Integrated Circuits	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC403	Linear Integrated Circuits	20	20	20	80	--	--	--	100	

Course Pre-requisite:

- Basic Electrical Engineering
- Electronic Devices & Circuits-I

Course Objectives:

1. To understand the concepts, working principles and key applications of linear integrated circuits.
2. To perform analysis of circuits based on linear integrated circuits.
3. To design circuits and systems for particular applications using linear integrated circuits.

Course Outcome:

After successful completion of the course student will be able to

1. Understand the fundamentals and areas of applications for the integrated circuits.
2. Analyze important types of integrated circuits.
3. Demonstrate the ability to design practical circuits that perform the desired operations.
4. Understand the differences between theoretical, practical & simulated results in integrated circuits.
5. Select the appropriate integrated circuit modules to build a given application.

Module No.	Unit No.	Detailed Content	Hours
1		Introduction to operational amplifiers	08
	1.1	Analysis of differential amplifier circuit configurations using FETs, Effect of Swamping resistor, Current sources using FETs, Widlar current source, Wilson current source, Voltage sources and references, DC level shifters.	
	1.2	Ideal & Practical Operational Amplifiers, Operational amplifier characteristics, Operational amplifier parameters, Operational amplifier open loop and closed loop configurations.	
2		Applications of Operational Amplifier	08
	2.1	Amplifiers: Inverting, non-inverting, buffer, summing & difference amplifiers, integrator & differentiator (ideal & practical), current amplifier, instrumentation amplifier, log and antilog amplifiers..	
	2.2	Converters: Current to voltage converters, voltage to current converters, voltage to frequency converter, frequency to voltage converter.	
	2.3	Active Filters: Second order active low pass, high pass, band pass and band reject filters, Introduction to switch capacitor filters.	
	2.4	Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.	
3		Non-Linear Applications of Operational Amplifier	08
	3.1	Comparators: Inverting comparator, non-inverting comparator, zero crossing detector, window detector, peak detector, sample & hold circuits.	
	3.2	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.	
	3.3	Waveform Generators: Square wave generator and triangular wave generator.	
	3.4	Precision Rectifiers: Half wave and full wave precision rectifiers.	
4		Analog to Digital and Digital to Analog Convertors	08
	4.1	Performance specifications of ADC, single ramp ADC, ADC using DAC, dual slope ADC, successive approximation ADC.	
	4.2	Performance specifications of DAC, binary weighted resistor DAC, R/2R ladder DAC, inverted R/2R ladder DAC.	
5		Special Purpose Integrated Circuits	08
	5.1	Functional block diagram and working of IC 555, design of astable and monostable multivibrator using IC 555, application	

		of IC 555 as pulse position modulator, pulse width modulator and Schmitt Trigger.	
	5.2	Functional block diagram and working of VCO IC 566 and application as frequency modulator, Functional block diagram and working of PLL IC 565 and application as FSK Demodulator, Functional block diagram and working of multiplier IC 534 and application as a phase detector, Functional block diagram and working of waveform generator XR 2206 and application as sinusoidal FSK generator.	
6		Voltage Regulators	08
	6.1	Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM 337) voltage regulators.	
	6.2	Functional block diagram, working and design of general purpose 723 (LVLC, LVHC, HVLC and HVHC) with current limit and current fold-back protection, Switching regulator topologies, Functional block diagram and working of LT1070 monolithic switching regulator.	

Textbooks :

1. Ramakant A. Gayakwad, “*Op-Amps and Linear Integrated Circuits*”, Pearson Prentice Hall, 4th Edition.
2. K. R. Botkar, “*Integrated Circuits*”, Khanna Publishers (2004)
3. D. Roy Choudhury and S. B. Jain, “*Linear Integrated Circuits*”, New Age International Publishers, 4th Edition.

Reference Books:

1. Sergio Franco, “*Design with operational amplifiers and analog integrated circuits*”, Tata McGraw Hill, 3rd Edition.
2. David A. Bell, “*Operation Amplifiers and Linear Integrated Circuits*”, Oxford University Press, Indian Edition.
3. R. F. Coughlin and F. F. Driscoll, “*Operation Amplifiers and Linear Integrated Circuits*”, Prentice Hall, 6th Edition.
4. “J. Millman, Christos CHalkias, and Satyabratatajit, Millman’s, “*Electronic Devices and Circuits*,” McGrawHill, 3rd Edition”.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC404	Signals and Systems	04	--	2@	04	--	01	05

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC404	Signals and Systems	20	20	20	80	25	--	--	125	

@2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Applied Maths-III
- Circuit Theory and Networks

Course Objectives:

1. To introduce students the concept and theory of signals and systems needed in electronics and telecommunication engineering fields.
2. To introduce students to the basic idea of signal and system analysis and its characterization in time and frequency domain

Course Outcome:

After successful completion of the course student will be able to

1. Understand about various types of signals and systems, classify them, analyze them, and perform various operations on them,
2. Understand use of transforms in analysis of signals and system in continuous and discrete time domain.
3. Observe the effect of various properties and operations of signals and systems.
4. Evaluate the time and frequency response of Continuous and Discrete time systems which are useful to understand the behaviour of electronic circuits and communication systems.

Module No.	Unit No.	Detailed Content	Hours
1		Introduction to signals and systems	08
	1.1	Introduction to signals: Definition, sampling theorem, sampling of continuous time signals, elementary signals: exponential, sine, step, impulse, ramp, rectangular, triangular, signum, sinc, operations on signals,	
	1.2	Classification of signals: Continuous and discrete time, deterministic and non-deterministic, periodic and aperiodic, symmetric (even) and asymmetric (odd), energy and power, causal and anti-causal signal, Case study of different signals from communication and biomedical field	
	1.3	Introduction to systems: Definition, Classification of systems: Static and dynamic, time variant and time invariant, linear and nonlinear, causal and non-causal, stable and unstable systems., communication and control system as examples	
2		Time domain analysis of continuous time and discrete time systems	08
	2.1	Representation of systems using differential /difference equation, Impulse, step and exponential response, system stability	
	2.2	Use of convolution integral and convolution sum for analysis of LTI systems, properties of convolution integral/sum, impulse response of interconnected systems	
	2.3	Correlation and spectral Density: auto-correlation, cross correlation, analogy between correlation and convolution, energy spectral density, power spectral density, relation of ESD,PSD with auto-correlation	
3		Frequency domain analysis of continuous and discrete signals:	10
	3.1	Review of Fourier series: Trigonometric and exponential Fourier series representation of signals, Gibbs phenomenon, Discrete Time Fourier Series, properties, analogy between Continuous Time Fourier Series (CTFS) and Discrete Time Fourier Series (DTFS).	
	3.2	Fourier Transform (FT): Fourier Transform and Inverse Fourier Transform on periodic and non-periodic signals, limitations of CT/DT Fourier Transform and need for Laplace/Z Transform.	
	3.3	Overview of Laplace Transform: Need of Laplace Transform, review of unilateral and bilateral Laplace	

		Transform, properties, inverse of Laplace Transform, concept of Region of Convergence (ROC), poles and zeros, relation between continuous time Fourier Transform and Laplace Transform.	
4		Z-Transform	08
	4.1	Need of Z-Transform, definition of unilateral and bilateral Z-Transform, Z-Transform of finite and infinite duration sequences, properties, Inverse Z-Transform, relation between discrete time Fourier Transform and Z-Transform, Z-Transform of standard signals, ROC for ZT, plotting poles and zeros of transfer function.	
	4.2	Analysis of discrete time LTI systems using Z-Transform: Transfer Function, causality and stability of systems, frequency response (impulse and step), relation between Laplace Transform and Z-Transform.	
5		State Space Analysis and Realization Structures	08
	5.1	State Variable Analysis: Introduction to the notion of 'state', systematic procedure for determining state equations, solution of state equations using Laplace transform, definition of $exp(A)$ where A is a matrix, time domain solution of state equations.	
	5.2	Systems with finite duration and infinite duration, impulse response, recursive and non-recursive discrete time system, realization structures: direct form-I, direct form-II, Transpose, cascade, and parallel forms.	
6		Applications of Signals and Systems	06
	6.1	Signal Processing Applications: Speech and Audio Processing, Multimedia (image & video) processing, Underwater acoustic signal processing, Biological signal analysis	
	6.2	Communication and Control System Application: Modulation (Analog and Digital) process, Feedback/Feedforward Control system	

Textbooks :

1. NagoorKani, "Signals and Systems", Tata McGraw Hill, Third Edition, 2011.
2. B.P. Lathi, "Principles of Linear Systems and Signals", Oxford, Second Edition, 2010.
3. S. L. Nalbalwar, A. M. Kulkarni and S. P. Sheth, "Signals and Systems", Synergy Knowledgeware, 2016.
4. Simon Haykin and Barry Van Veen, "Signals and Systems", John Wiley and Sons, Second Edition, 2004.

Reference Books:

1. Hwei. P Hsu, “*Signals and Systems*”, Tata McGraw Hill, Third edition, 2010
2. V. Krishnaveni and A.Rajeshwari, “*Signals and Systems*”, Wiley-India, First Edition 2012.
3. NarayanaIyer, “*Signals and Systems*”, Cenage Learning, First Edition 2011.
4. Michael J Roberts, “*Fundamentals of Signals and systems*”, Tata McGraw Hill, special Indian Economy edition, 2009.
5. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, “*Signals and Systems*”, Pearson Education, Fourth Edition 2009.
6. Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, “*Signals and Systems*”, Prentice-Hall of India, Second Edition, 2002.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned				
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total	
ECC405	Principles of Communication Engineering	04	--	--	04	--	--	04	
Examination Scheme									
Subject Code	Subject Name	Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC405	Principles of Communication Engineering	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Applied Maths III
- Electronic Devices and Circuits I

Course Objectives:

1. To introduce students to various modulation and demodulation techniques of analog communication.
2. To analyze different parameters of analog communication techniques.
3. To study pulse modulation and demodulation.

Course Outcome:

After successful completion of the course student will be able to

1. Use different modulation and demodulation techniques used in analog communication
2. Identify and solve basic communication problems
3. Analyze transmitter and receiver circuits
4. Compare and contrast design issues, advantages, disadvantages and limitations of analog communication systems

Module No.	Unit No.	Detailed Content	Hours
1		Basics of Communication System	06
	1.1	Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels, Introduction to time and frequency domain.	
	1.2	Types of noise, signal to noise ratio, noise figure and noise temperature, Friss transmission formula.	
2		Amplitude Modulation and Demodulation	12
	2.1	Basic concepts, signal representation, need for modulation	
	2.2	Spectrum, waveforms, modulation index, bandwidth, voltage distribution and power calculations	
	2.3	DSBFC: Principles, modulating circuits, low level and high level transmitters DSB suppressed carrier :Multiplier modulator, nonlinear modulator and switching modulator	
	2.4	Amplitude demodulation: Diode detector, practical diode detector, square law detector	
	2.5	Comparison of different AM techniques, Applications of AM and use of VSB in broadcast television	
3		Angle Modulation and Demodulation	12
	3.1	Frequency modulation (FM): Basic concept, mathematical analysis, spectrum of FM wave, sensitivity, phase deviation and modulation index, deviation and percent modulated waves, bandwidth requirement of angle modulated waves, deviation ratio, narrowband FM and wideband FM	
	3.2	Varactor diode modulator, FET reactance modulator, stabilized AFC, Direct FM transmitter, indirect FM Transmitter, noise emphasis and de-emphasis	
	3.3	Phase modulation (PM): Principle and working of transistor direct PM modulator and relationship and comparison between FM and PM	
	3.4	FM demodulation: Balance slope detector, Foster-Seely discriminator, ratio detector, FM demodulator using Phase lock loop (PLL), amplitude limiting and thresholding, comparison between FM demodulators, comparison between AM, FM and PM	
	3.5	Applications of FM and PM	

4		Radio Receivers	06
	4.1	TRF, Super - heterodyne receiver, receiver parameters and choice of IF	
	4.2	AM receiver circuits and analysis, simple AGC, delayed AGC, forward AGC, and communication receiver	
	4.3	FM receiver circuits, comparison with AM receiver	
	4.4	Single and independent sideband (SSB and ISB) receivers	
5		Analog Pulse Modulation & Demodulation	08
	5.1	Sampling theorem for low pass signal, proof with spectrum, Nyquist criteria	
	5.2	Sampling techniques, aliasing error and aperture effect	
	5.3	PAM,PWM, PPM generation and detection	
	5.4	Applications of Pulse Communication	
6		Multiplexing & De-multiplexing	04
	6.1	Frequency Division Multiplexing transmitter & receiver block diagram	
	6.2	Time Division Multiplexing transmitter & receiver block diagram	
	6.3	Examples and applications of FDM and TDM	

Textbooks :

1. Kennedy and Davis, "*Electronics Communication System*", Tata McGraw Hill, Fourth edition.
2. B.P. Lathi, Zhi Ding "*Modern Digital and Analog Communication system*", Oxford University Press, Fourth edition.
3. Wayne Tomasi, "*Electronics Communication Systems*", Pearson education, Fifth edition.

Reference Books:

1. Taub, Schilling and Saha, "*Taub's Principles of Communication systems*", Tata McGraw Hill, Third edition.
2. P. Sing and S.D. Sapre, "*Communication Systems: Analog and Digital*", Tata McGraw Hill, Third edition.
3. Simon Haykin, Michel Moher, "*Introduction to Analog and Digital Communication*", Wiley, Second edition.

4. Dennis Roddy and John Coolen, "*Electronic Communication*", Prentice Hall, Third Edition.
5. Louis Frenzel, "*Communication Electronics*", Tata McGraw Hill, Third Edition.
6. Roy Blake, "*Electronic Communication Systems*", Delmar Publication, Second edition

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL401	Electronic Devices & Circuits-II Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECL401	Electronic Devices & Circuits-II Laboratory	--	--	--	--	25	25	--	50	

Laboratory plan

Minimum 8 practicals including **minimum 2 simulations** should be conducted.

Suggested list of experiments

1. Design and Analyze two stage BJT amplifier (Frequency response and performance parameters)
2. Design and Analyze two stage FET amplifier (Frequency response and performance parameters)
3. Design Multistage BJT amplifier and finding its parameters, Verify.
4. Design and Analyze Voltage series feedback amplifier using BJT/FET and verify its effect on frequency response. x
5. Design and Analyze Current series feedback using BJT/FET and verify its effect on frequency response.
6. Design Multistage JFET amplifier and finding its parameters, verify.
7. Design and Analyze RC Phase shift oscillator for different amplitude and frequency.
8. Design and Analyze Colpitt / Hartley oscillator for different amplitude and frequency.
9. Class C power amplifier and its efficiency

Minimum One project based on:

1. Simple Emergency light.
2. DC servo amplifier using MOSFET.
3. Audio tone control circuit.
4. Public address system.
5. Automatic Door Bell

6. Clapp Switch
7. Topic related to syllabus

Note :Small project should be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL402	Linear Integrated Circuits Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL402	Linear Integrated Circuits Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Minimum 8 practicals including minimum 2 simulations should be conducted.

Suggested list of experiments

1. Discrete Differential Amplifier
2. Inverting, Non inverting, Buffer, Summing & Difference amplifiers
3. Differentiator & Integrator
4. Instrumentation amplifier
5. I to V and V to I converters
6. V to F and F to V convertors
7. Active Filters
8. Wien Bridge Oscillator
9. RC Phase shift Oscillator
10. Inverting & Non inverting Schmitt trigger
11. Square & Triangular wave generator
12. Precision rectifiers
13. Peak detector & Sample & Hold Circuits
14. Analog to Digital converter

15. Digital to Analog converter
16. Multivibrators using IC 555
17. PPM, PWM and Schmitt trigger using 555
18. Frequency modulator using VCO IC 566.
19. FSK Demodulator using PLL IC 565.
20. Phase detector using multiplier IC 534.
21. Sinusoidal FSK generator using XR 2206
22. Voltage Regulators using 78XX/79XX, 317/337, 723

Minimum One project based on:

1. Variable Power Supply
2. Data Acquisition System
3. Function Generator
4. Topic related to syllabus

Note :Small project should be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL403	Principles of Communication Engineering Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECL403	Principles of Communication Engineering Laboratory	--	--	--	--	25	25	--	50	

Laboratory plan

Minimum 8 practicals including minimum 2 simulations should be conducted.

Suggested list of experiments

1. Generation and detection of AM (DSB-FC, DSB-SC,SSB) signal.
2. Generation and detection of FM signal.
3. Study of AM broadcast receiver (Super heterodyne).
4. Generation of PAM signal and verify the sampling theorem.
5. Generation of PPM, PWM signal.
6. Study of TDM and FDM multiplexing techniques.

Suggested list of Minimum projects

1. AM transmitter /receiver.
2. FM transmitter /receiver.
3. PAM,PPM,PWM circuits with IC 555
4. FM remote encoder/decoder circuits,
5. Transistor Intercom circuit
6. Walkie -Talkie Circuit
7. Arduino based communication circuits

8. Electronic voting machine.
9. Electronic Notice Board Using Android.
10. Home security system.

Note :Small project should be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

UNIVERSITY OF MUMBAI

No. UG/42 of 2018-19

CIRCULAR:-

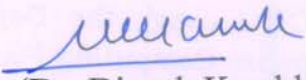
Attention of the Principals of the affiliated Colleges and Directors of the recognized Institutions in Science & Technology Faculty is invited to this office Circular No. UG/239 of 2010, dated 12th August, 2010 relating to syllabus of the Bachelor of Engineering (B.E.) degree course.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Electronics & Telecommunication Engineering at its meeting held on 9th April, 2018 have been accepted by the Academic Council at its meeting held on 5th May, 2018 **vide** item No. 4.53 and that in accordance therewith, the revised syllabus as per the (CBCS) for the T.E. & B.E. in Electronics & Telecommunication Engineering (Sem - V to VIII) has been brought into force with effect from the academic year 2018-19 and 2019-2020, accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI - 400 032

25th June, 2018

To


(Dr. Dinesh Kamble)
I/c REGISTRAR

The Principals of the affiliated Colleges & Directors of the recognized Institutions in Science & Technology Faculty. (Circular No. UG/334 of 2017-18 dated 9th January, 2018.)

A.C/4.53/05/05/2018

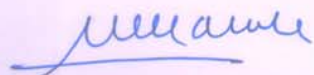
No. UG/42 -A of 2018

MUMBAI-400 032

25th June, 2018

Copy forwarded with Compliments for information to:-

- 1) The I/c Dean, Faculty of Science & Technology,
- 2) The Chairman, Ad-hoc Board of Studies in Electronics & Telecommunication Engineering,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Co-Ordinator, University Computerization Centre,


(Dr. Dinesh Kamble)
I/c REGISTRAR

AC-_____

Item No. _____

UNIVERSITY OF MUMBAI



Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics and Telecommunication Engineering

Third Year with Effect from AY 2018-19

Final Year with Effect from AY 2019-20

As per **Choice Based Credit and Grading System**
with effect from the AY 2016-17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

The curriculum in higher education is a living entity. It evolves with time; it reflects the ever changing needs of the society and keeps pace with the growing talent of the students and the faculty. The engineering education in India is expanding in manifolds and the main challenge is the quality of education. All stakeholders are very much concerned about it. The curriculum of Electronics & Telecommunication in Mumbai University is no exception. In keeping with the demands of the changing times, it contains innovative features. The exposure to the latest technology and tools used all over the world is given by properly selecting the subjects. It is designed in such a way to incorporate the requirements of various industries. The major emphasis of this process is to measure the outcomes of the program. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of post-graduation. So the curriculum must be refined and updated to ensure that the defined objectives and outcomes are achieved.

I, as Chairman Ad-hoc Board of Studies in Electronics and Telecommunication Engineering, University of Mumbai, happy to state here that, the heads of the department and senior faculty from various institutes took timely and valuable initiative to frame the Program Educational objectives as listed below.

Objectives:

1. To produce Electronics & Telecommunication engineers, having strong theoretical foundation, good design experience and exposure to research and development.
2. To produce researcher who have clear thinking, articulation and interest to carry out theoretical and/or applied research resulting in significant advancement in the field of specialization.
3. To develop an ability to identify, formulate and solve electronics and telecommunication engineering problems in the latest technology.
4. To develop the ability among students to synthesize data and technical concepts from applications to product design.

These are the suggested and expected main objectives, individual affiliated institutes may add further in the list. I believe that the small step taken in the right direction will definitely help in providing quality education to the stake holders.

This book of curricula is the culmination of large number of faculty members and supporting staff. It also reflects the creative contribution of hundreds of teachers – both serving and retired. I sincerely hope that the faculty and students of Electronics and Telecommunication in Mumbai University will take full advantage of dynamic features of curriculum and make teaching-learning process a truly sublime experience for all.

At the end I must extend my gratitude to all experts and colleagues who contributed to make curriculum competent at par with latest technological development in the field of Electronics & Telecommunication Engineering.

Dr. Uttam D. Kolekar**Chairman, Ad-hoc Board of Studies in Electronics and Telecommunication Engineering**

**Program Structure for
B.E. Electronics & Telecommunication Engineering (Rev. 2016)
University of Mumbai (With Effect from 2017-2018)
Semester V**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC501	Microprocessor & Peripherals Interfacing	4	-	-	4	-	4
ECC502	Digital Communication	4	-	-	4	-	4
ECC503	Electromagnetic Engineering	4	-	1@	4	1	5
ECC504	Discrete Time Signal Processing	4	-	-	4	-	4
ECCDLO 501X	Department Level Optional Course I	4	-	-	4	-	4
ECL501	Microprocessor & Peripherals Interfacing Lab	-	2	-	-	1	1
ECL502	Digital Communication Lab	-	2	-	-	1	1
ECL503	Business Communication & Ethics Lab	-	2+2*	-	-	2	2
ECL504	Open Source Technology for Communication Lab	-	2	-	-	1	1
ECLDLO 501X	Department Level Optional Lab I	-	-	2#	-	1	1
Total		20	10	3	20	7	27

@ 1 hour to be taken as tutorial classwise #2 hours to be taken as either lab or tutorial based on subject requirement
*2 hours to be taken as tutorial batchwise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC501	Microprocessor & Peripherals Interfacing	20	20	20	80	03	--	--	100
ECC502	Digital Communication	20	20	20	80	03	--	--	100
ECC503	Electromagnetic Engineering	20	20	20	80	03	25	--	125
ECC504	Discrete Time Signal Processing	20	20	20	80	03	--	--	100
ECCDLO 501X	Department Level Optional Course I	20	20	20	80	03	--	--	100
ECL501	Microprocessor & Peripherals Interfacing Lab	--	--	--	--	--	25	25	50
ECL502	Digital Communication Lab	--	--	--	--	--	25	25	50
ECL503	Business Communication & Ethics Lab	--	--	--	--	--	50	--	50
ECL504	Open Source Technology for Communication Lab	--	--	--	--	--	25	25	50
ECLDLO 501X	Department Level Optional Lab I	--	--	--	--	--	25	--	25
Total				100	400		175	75	750

Course Code	Department Level Optional Course I
ECCDLO 5011	Microelectronics
ECCDLO 5012	TV & Video Engineering
ECCDLO 5013	Finite Automata Theory
ECCDLO 5014	Data Compression and Encryption

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC601	Microcontrollers & Applications	4	-	--	4	--	4
ECC602	Computer Communication Networks	4	-	-	4	-	4
ECC603	Antenna & Radio Wave Propagation	4	-	-	4	-	4
ECC604	Image Processing and Machine Vision	4	-	--	4	--	4
ECCDLO 602X	Department Level Optional Course II	4	-	-	4	-	4
ECL601	Microcontroller & Applications Lab	-	2	-	-	1	1
ECL602	Computer Communication Network Lab	-	2	-	-	1	1
ECL603	Antenna & Radio Wave Propagation Lab	-	2	-	-	1	1
ECL604	Image Processing and Machine Vision Lab	-	2	-	-	1	1
ECLDLO 602X	Department Level Optional Lab II	-	2	-	-	1	1
Total		20	10	-	20	5	25

Course Code	Course Name	Examination Scheme									
		Theory					End Sem Exam	Exam Duration (Hrs)	TW	Oral & Prac	Total
		Internal Assessment			Avg						
		Test1	Test 2	Avg							
ECC601	Microcontroller & Applications	20	20	20	80	03	--	--	100		
ECC602	Computer Communication Network	20	20	20	80	03	--	--	100		
ECC603	Antenna & Radio Wave Propagation	20	20	20	80	03	--	--	100		
ECC604	Image Processing and Machine Vision Lab	20	20	20	80	03	--	--	100		
ECCDLO 602X	Department Level Optional Course II	20	20	20	80	03	--	--	100		
ECL601	Microcontroller & Applications Lab	--	--	--	--	--	25	25	50		
ECL602	Computer Communication Network Lab	--	--	--	--	--	25	25	50		
ECL603	Antenna & Radio Wave Propagation Lab	--	--	--	--	--	25	25	50		
ECL604	Image Processing and Machine Vision Lab	--	--	--	--	--	25	25	50		
ECLDLO 602X	Department Level Optional Lab II	--	--	--	--	--	25	--	25		
Total				100	400		125	100	725		

Course Code	Department Level Optional Course II
ECCDLO 6021	Digital VLSI Design
ECCDLO 6022	Radar Engineering
ECCDLO 6023	Database Management System
ECCDLO 6024	Audio Processing

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC701	Microwave Engineering	4	-	-	4	-	4
ECC702	Mobile Communication System	4	-	-	4	-	4
ECC703	Optical Communication	4	-	--	4	-	4
ECCDLO 703X	Department Level Optional Course III	4	-	-	4	-	4
ILO701X	Institute Level Optional Course I	3	-	-	3	-	3
ECL701	Microwave Engineering Lab	-	2	-	-	1	1
ECL702	Mobile Communication System Lab	-	2	-	-	1	1
ECL703	Optical Communication Lab	-	2	-	-	1	1
ECLDLO 703X	Department Level Optional Lab III	-	2	-	-	1	1
ECL704	Project-I	-	6	-	-	3	3
Total		19	14	-	19	7	26

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC701	Microwave Engineering	20	20	20	80	03	--	--	100
ECC702	Mobile Communication System	20	20	20	80	03	--	--	100
ECC703	Optical Communication	20	20	20	80	03	--	--	100
ECCDLO 703X	Department Level Optional Course III	20	20	20	80	03	--	--	100
ILO701X	Institute Level Optional Course I	20	20	20	80	03	--	--	100
ECL701	Microwave Engineering Lab	--	--	--	--	--	25	25	50
ECL702	Mobile Communication System Lab	--	--	--	--	--	25	25	50
ECL703	Optical Communication Lab	--	--	--	--	--	25	25	50
ECLDLO 703X	Department Level Optional Lab III	--	--	--	--	--	25	25	50
ECL704	Project-I	--	--	--	--	--	50	50	100
Total				100	400		150	150	800

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I[#]
ECCDLO7031	Neural Networks and Fuzzy Logic	ILO7011	Product Lifecycle Management
ECCDLO7032	Big Data Analytics	ILO7012	Reliability Engineering
ECCDLO7033	Internet Communication Engineering	ILO7013	Management Information System
ECCDLO7034	CMOS Mixed Signal VLSI	ILO7014	Design of Experiments
ECCDLO7035	Embedded System	ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

Common with all branches

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC801	RF Design	4	-	--	4	--	4
ECC802	Wireless Networks	4	-	-	4	-	4
ECCDLO 804X	Department Level Optional Course IV	4	-	-	4	-	4
ILO802X	Institute Level Optional Course II	3	-	-	3	-	3
ECL801	RF Design Lab	-	2	-	-	1	1
ECL802	Wireless Networks Lab	-	2	-	-	1	1
ECLDLO 804X	Department Level Optional Lab IV	-	2	-	-	1	1
ECL803	Project-II	-	12	-	-	6	6
Total		15	18	-	15	9	24

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC801	RF Design	20	20	20	80	03	--	--	100
ECC802	Wireless Networks	20	20	20	80	03	--	--	100
ECCDLO 804X	Department Level Optional Course IV	20	20	20	80	03	--	--	100
ILO802X	Institute Level Optional Course II	20	20	20	80	03	--	--	100
ECL801	RF Design Lab	--	--	--	--	--	25	25	50
ECL802	Wireless Networks Lab	--	--	--	--	--	25	25	50
ECLDLO 804X	Department Level Optional Lab IV	--	--	--	--	--	25	25	50
ECL803	Project-II	--	--	--	--	--	100	50	150
Total				80	320		175	125	700

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II[#]
ECCDLO8041	Optical Networks	ILO8021	Project Management
ECCDLO8042	Advanced Digital Signal Processing	ILO8022	Finance Management
ECCDLO8043	Satellite Communication	ILO8023	Entrepreneurship Development and Management
ECCDLO8044	Network management in Telecommunication	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

Common with all branches

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC501	Microprocessors & Peripherals	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC501	Microprocessors & Peripherals	20	20	20	80	--	--	--	100

Course prerequisite:

- Digital System Design

Course objectives:

- To understand the basic concepts of microcomputer systems.
- To develop background knowledge and core expertise in 8086 microprocessor and co-processor 8087.
- To write assembly language programs for 8086 microprocessor
- To understand peripheral devices and their interfacing to 8086 and to study the design aspects of basic microprocessor based system.

Course outcomes:

After successful completion of the course student will be able to

- Understand the basic concepts of microcomputer systems.
- Understand the architecture and software aspects of microprocessor 8086.
- Write Assembly language program in 8086.
- Know the Co-processor configurations.
- Interface peripherals for 8086.
- Design elementary aspect of microprocessor based system.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Microcomputer System	06
	1.1	Block diagram of microprocessor based system: CPU, I/O Devices, Clock, Memory, Concept of Address, Data and Control Bus and Tristate logic.	
	1.2	Need of Assembly Language and its Comparison with higher level languages	
	1.3	Need of Assembler and Compiler and their comparison.	
2.0		Architecture of 8086 Microprocessor	06
	2.2	8086 Architecture and organization, pin configuration.	
	2.3	Minimum and Maximum modes of 8086.	
	2.4	Read and Write bus cycle of 8086.	
3.0		Instruction set and programming of 8086	10
	3.1	8086 Addressing modes.	
	3.2	8086 Instruction encoding formats and instruction set.	
	3.3	Assembler directives.	
	3.4	8086 programming and debugging of assembly language program. Programs related to: arithmetic, logical, delay, string manipulation, stack and subroutines. input. output. timer/counters.	
	3.5	Elementary DOS Programming: Introduction to int-21h services.	
4.0		Peripherals interfacing with 8086 and applications.	10
	4.1	8086-Interrupt structure.	
	4.2	Programmable peripheral Interface 8255.	
	4.3	Programmable interval Timer 8254.	
	4.4	Elementary features of 8259A and 8257 and interface.	
	4.5	Interfacing 8255, 8254 with 8086 and their applications	
5.0		ADC, DAC interfacing with 8086 and its application	08
	5.1	Analog to Digital Converter (ADC) 0809	
	5.2	Digital to Analog Converter (DAC) 0808	
	5.3	Interfacing ADC 0809, DAC 0808 with 8086 and their applications.	
	5.4	8086 based data Acquisition system.	
6.0		8086 Microprocessor interfacing	08
	6.1	8087 Math co-processor, its data types and interfacing with 8086.	
	6.2	Memory interfacing with 8086 microprocessor	
		Total	48

Text Books:

1. John Uffenbeck: "8086/8088 family: "Design, Programming and Interfacing", Prentice Hall, 2nd Edition
2. B. B. Brey: "The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro Processor", Pearson Pub, 8th Edition
3. Hall D.V: "Microprocessor and Interfacing Programming and Hardware", Tata McGraw Hill, 2nd Edition.
4. Yu-Cheng Liu/Glenn A. Gibson: "Microcomputer Systems: The 8086/8088 Family Architecture, Programming and Design", Phi Learning.

Reference Books:

1. Peter Abel: "IBM PC ASSEMBLY LANGUAGE & PROGRAMMING", Phi Learning.
2. A. K. Ray and K. M. Burchandi: "Advanced Microprocessor and Peripherals, Architecture Programming and Interfacing", Tata McGrawHill, 3rd Edition
3. Don Anderson, Tom Shanley: "Pentium Processor System Architecture", MindShare Inc., 2nd Edition
4. National Semiconductor: Data Acquisition Linear Devices Data Book
5. Intel Peripheral Devices: Data Book.
6. The Intel 8086 family user manual.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC502	Digital Communication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECC502	Digital Communication	20	20	20	80	--	--	--	100	

Prerequisites:

- Analog Communication

Course objectives:

- To identify the signals and functions of its different components,
- To learn about theoretical aspects of digital communication system and Draw signal space diagrams, compute spectra of modulated signals,
- To learn about error detection and correction to produce optimum receiver.

Course outcomes:

After successful completion of the course student will be able to

- Understand random variables and random processes of signal,
- Apply the concepts of Information Theory in source coding,
- Evaluate different methods to eliminate Inter-symbol interference,
- Compare different band-pass modulation techniques,
- Evaluate performance of different error control codes.

Module No.	Unit No.	Topic	Hrs.
1.0		Probability Theory & Random Variables and	08
	1.1	Information, Probability, Conditional Probability of independent events, Relation between probability and probability Density , Raleigh Probability Density , CDF, PDF.	
	1.2	Random Variables, Variance of a Random Variable, correlation between Random Variables, Statistical Averages(Means),Mean and Variance of sum of Random variables, Linear mean square Estimation, Central limit theorem, Error function and Complementary error function Discrete and Continuous Variable, Gaussian PDF, Threshold Detection, Statistical Average, Chebyshev In-Equality, Auto-correction.	
	1.3	Random Processes	
2.0		Information Theory and Source Coding	06
	2.1	Block diagram and sub-system description of a digital communication system, measure of information and properties, entropy and it's properties	
	2.2	Mini Source Coding, Shannon's Source Coding Theorem, Shannon-Fano Source Coding, Huffman Source Coding	
	2.3	Differential Entropy, joint and conditional entropy, mutual information and channel capacity, channel coding theorem, channel capacity theorem	
3.0		Error Control Systems	12
	3.1	Types of error control, error control codes, linear block codes, systematic linear block codes, generator matrix, parity check matrix, syndrome testing ,error correction, and decoder implementation	
	3.2	Systematic and Non-systematic Cyclic codes: encoding with shift register and error detection and correction	
	3.3	Convolution Codes: Time domain and transform domain approach, graphical representation, code tree, trellis, state diagram, decoding methods.	
4.0		Bandpass Modulation & Demodulation	10
	4.1	Band-pass digital transmitter and receiver model, digital modulation schemes	
	4.2	Generation, detection, signal space diagram, spectrum, bandwidth efficiency, and probability of error analysis of: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK)Modulations, Binary Phase Shift Keying (BPSK) Modulation, Quaternary Phase Shift Keying QPSK), M- ary PSK Modulations, Quadrature Amplitude Modulation (QAM), Minimum Shift Keying (MSK)	

5.0		Baseband Modulation & Transmission	04
	5.1	Discrete PAM signals and it's power spectra	
	5.2	Inter-symbol interference, Nyquist criterion for zero ISI, sinusoidal roll-off filtering, correlative coding, equalizers, and eye pattern	
6.0		Optimum Reception of Digital Signal	08
	6.1	Baseband receiver	
	6.2	Probability of Error	
	6.3	Optimum Receiver and Filter	
	6.4	Matched Filter and its probability of error	
	6.5	Coherent Reception	
		Total	48

Text Books:

1. H. Taub, D. Schilling, and G. Saha, "Principles of Communication Systems," Tata Mc- Graw Hill, New Delhi, Third Edition, 2012.
2. Lathi B P, and Ding Z., "Modern Digital and Analog Communication Systems," Oxford University Press, Fourth Edition, 2009.
3. Haykin Simon, "Digital Communication Systems," John Wiley and Sons, New Delhi, Fourth Edition, 2014.

Reference Books:

1. Sklar B, and Ray P. K., "Digital Communication: Fundamentals and applications," Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.
2. T L Singal, "Analog and Digital Communication," Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
3. P Ramakrishna Rao, "Digital Communication," Tata Mc-Graw Hill, New Delhi, First Edition, 2011.
4. M F Mesiya, "Contemporary Communication systems", Mc-Graw Hill, Singapore, First Edition, 2013.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC503	Electromagnetic Engineering	04	--	@1	04	--	01	05

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECC503	Electromagnetic Engineering	20	20	20	80	25	--	--	125	

@ 1 hour to be taken as tutorial class wise

Course prerequisite:

- Vector Algebra and vector Calculus
- Various Co-ordinate system
- Two port network

Course objectives:

- To learn electromagnetics, including static and dynamic electromagnetic fields and waves within and at the boundaries of media.
- To learn mathematical skills, including Vectors and phasors and Partial differential equations.
- To learn Electromagnetic radiation and propagation in space and within transmission lines

Course outcomes:

After successful completion of the course student will be able to explain and evaluate EM fields and key physical parameters for:

- Fields and energies in simple planar, cylindrical, and spherical geometries, Fields within conducting and anisotropic media
- Electric and magnetic forces on charges, wires, and media Sinusoids and transients on TEM lines with mismatched impedances and tuning

Module No.	Unit No.	Topics	Hrs.
1.0		Electrostatics	07
	1.1	Coulomb's Law & Electric Field Intensity, Electric Field due to point charge, line charge and surface charge distributions	
	1.2	Electric Flux Density, Gauss's Law and its Application to differential volume element, divergence, divergence theorem.	
	1.3	Electric potential, Relationship between Electric field & potential, Potential Gradient., electric dipole	
2.0		Electric Fields in Material Space	06
	2.1	Energy density in electrostatic field, Current and current Density, continuity equation, Polarization in dielectrics	
	2.2	Capacitance, capacitance of parallel plate; spherical; cylindrical capacitors with multiple di-electrics, Boundary conditions	
	2.3	Poisson's and Laplace's equation, General procedures for solving Poisson's and Laplace's equations.	
3.0		Steady Magnetic Field	07
	3.1	Biot-Savart's Law, Ampere's Circuital Law and its Applications, magnetic flux density, Magnetic Scalar and vectors potentials, Derivations of Biot-Savart's law and Ampere's law based on Magnetic Potential	
	3.2	Forces due to magnetic field, magnetic dipole, Classification of Magnetic Materials, Magnetic boundary conditions.	
4.0		Maxwell's Equation and Electromagnetic Wave Propagation	12
	4.1	Faraday's law, Displacement current, Maxwell's equations in point form and integral form, Boundary conditions for time varying field, magnetic vector potential, Time harmonic field, Introduction to the concept of Uniform Plane Wave and Helmholtz equation.	
	4.2	Wave Propagation in Free Space, Lossy and Lossless Dielectrics and in Good Conductors. Reflection of Plane Wave, Poynting Vector, Wave Power, Skin Effect, Wave Polarization and Standing Wave Ratio	
5.0		Transmission Lines	10
	5.1	Transmission line parameters, Transmission line equations, Input impedance, Standing wave ratio, Power, Transients on transmission lines.	
	5.2	Smith Chart, Applications of Smith Chart in finding VSWR, and reflection coefficient, admittance calculations, impedance calculations over length of line.	

6.0		Applications of Electromagnetics	06
	6.1	Electrostatic discharge, Materials with high dielectric constant, Graphene, Inkjet printer, RF mems, Multidielectric systems, magnetic levitation, Memristor, Optical nanocircuits, Metamaterials, Microstrip lines and characterization of Data cables, RFID	
		Total	48

Text Books:

1. Engineering Electromagnetics, William H Hayt and John A Buck - Tata McGraw-Hill Publishing Company Limited, Seventh Edition
2. Principles of Electromagnetics, Matthew N. O.Sadiku ,S.V.Kulkarni- Oxford university press, Sixth edition

Reference Books:

1. Electromagnetics with applications by J.D.Krauss and Daniel Fleisch fifth edition
2. Electromagnetic Field Theory Fundamentals, Bhag Singh Guru, Hüseyin R. Hiziroglu Cambridge University Press, Second Edition.
3. Electromagnetics, Joseph Edminister, , Mahmood Nahvi, Schaum Outline Series, Fourth edition.
4. R. K. Shevgaonkar, “Electromagnetic Waves” Tata McGraw Hil

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC504	Discrete Time Signal Processing	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC504	Discrete Time Signal Processing	20	20	20	80	--	--	--	100	

Course prerequisite:

- Signals & Systems

Course objectives:

- To develop a thorough understanding of DFT and FFT and their applications.
- To teach the design techniques and performance analysis of digital filters
- To introduce the students to digital signal processors and its applications.

Course outcomes:

After successful completion of the course student will be able to

- Understand the concepts of discrete-time Fourier transform and fast Fourier transform.
- Apply the knowledge of design of IIR digital filters to meet arbitrary specifications.
- Apply the knowledge of design of FIR digital filters to meet arbitrary specifications.
- Analyze the effect of hardware limitations on performance of digital filters.
- Apply the knowledge of DSP processors for various applications.

Module No.	Unit No.	Topics	Hrs.
1.0		Discrete Fourier Transform & Fast Fourier Transform	10
	1.1	Definition and Properties of DFT, IDFT, Circular convolution of sequences using DFT and IDFT. Filtering of long data sequences: Overlap-Save and Overlap-Add Method for computation of DFT	
	1.2	Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, inverse FFT, and introduction to composite FFT.	
2.0		IIR Digital Filters	10
	2.1	Types of IIR Filters (Low Pass, High Pass, Band Pass, Band Stop and All Pass), Analog filter approximations: Butterworth, Chebyshev I, Elliptic.	
	2.2	Mapping of S-plane to Z-plane, impulse invariance method, bilinear transformation method, Design of IIR digital filters (Butterworth and Chebyshev-I) from Analog filters with examples.	
	2.3	Analog and digital frequency transformations with design examples.	
3.0		FIR Digital Filters	10
	3.1	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase Filters. Frequency response, location of the zeros of linear phase FIR filters.	
	3.2	Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackmann, Kaiser), Design of FIR filters using Frequency Sampling technique, Comparison of IIR and FIR filters.	
4.0		Finite Word Length effects in Digital Filters	06
	4.1	Quantization, truncation and rounding, Effects due to truncation and rounding, Input quantization error, Product quantization error, Co-efficient quantization error, Zero-input limit cycle oscillations, Overflow limit cycle oscillations, Scaling.	
	4.2	Quantization in Floating Point realization of IIR digital filters, Finite word length effects in FIR digital filters.	
5.0		DSP Processors	06
	5.1	Introduction to General Purpose and Special Purpose DSP processors, fixed point and floating point DSP processor, Computer architecture for signal processing, Harvard Architecture, Pipelining, multiplier and accumulator (MAC), Special Instructions, Replication, On-chip memory, Extended Parallelism.	

	5.2	General purpose digital signal processors, Selecting digital signal processors, Special purpose DSP hardware, Architecture of TMS320CX fixed and floating DSP processors.	
6.0		Applications of Digital Signal Processing	06
	6.1	Application of DSP for ECG signals analysis.	
	6.2	Application of DSP for Dual Tone Multi Frequency signal detection.	
	6.3	Application of DSP for Radar Signal Processing.	
		Total	48

Text Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, “*Digital Signal Processing*”, A Practical Approach by, Pearson Education
2. Tarun Kumar Rawat, “ *Digital Signal Processing*”, Oxford University Press, 2015

Reference Books:

1. Proakis J., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education.
2. Sanjit K. Mitra , Digital Signal Processing – A Computer Based Approach – 4th Edition McGraw Hill Education (India) Private Limited.
3. Oppenheim A., Schafer R., Buck J., "*Discrete Time Signal Processing*", 2nd Edition, Pearson Education.
4. B. Venkata Ramani and M. Bhaskar, “*Digital Signal Processors, Architecture, Programming and Applications*”, Tata McGraw Hill, 2004.
5. L. R. Rabiner and B. Gold, “*Theory and Applications of Digital Signal Processing*”, Prentice-Hall of India, 2006.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5011	Microelectronics	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECCDLO 5011	Microelectronics	20	20	20	80	--	--	--	100	

Course prerequisite:

- Electronics Devices and Circuits- I
- Electronics Devices and Circuits- II

Course objectives:

- To understand integrated circuit biasing using MOSFET.
- To analyze single stage active load MOS amplifier.
- To analyze active load differential amplifier
- To understand implementation of passive components in ICs.

Course outcomes:

After successful completion of the course student will be able to

- Analyze various constant current source circuit using MOS
- Design and implement active load MOS amplifier.
- Design and implement active load differential amplifier

Module No.	Unit No.	Topics	Hrs.
1.0		Basics of MOSFETs	08
	1.1	Introduction to various fabrication process(in brief) Fabrication of NMOS and PMOS transistors along with mask layout diagram, Multi finger transistor, Scaling of MOSFET, Various Short channel effects in MOSFET, Second order effects in MOSFET, MOS as controlled resistor, MOS device capacitances	
2.0		Integrated Circuit Biasing & Active Loads using MOSFET	08
	2.1	Current Mirror, cascade current source, Wilson current source, bias independent current source using MOSFET,DC analysis and small signal analysis of MOS active load, DC analysis and small signal analysis of MOS advanced active load	
3.0		Single Stage MOS Active Load amplifiers	08
	3.1	CS amplifier with current source load, CS amplifier with diode connected load, CS amplifier with current source load, Common gate circuit, Cascode amplifier, Double Cascoding, Folded Cascode.	
4.0		Active Load MOSFET Differential Amplifier	10
	4.1	Basic MOS Differential Amplifier, DC transfer characteristics, small signal equivalent analysis, MOS differential amplifier with active load, MOS differential amplifier with cascode active load,	
5.0		Passive Device Fabrication in IC	07
	5.1	Fabrication of inductors, fabrication of transformers, fabrication of varactors, and fixed value capacitors.	
6.0		Power Amplifiers	07
	6.1	Class A, class B, Class C, Class D, Class E, Class F using MOSFET	
		Total	48

Text Books:

1. A. Sedra, K. Smith, adapted by A. Chanorkar “Microelectronic Circuits-Theory and Application *Advanced engineering mathematics*”, Oxford Higher Education, 7th Edition
2. D. Neamen, “Electronic Circuits Analysis and Design”, McGraw Hill Education, 3rd Edition
3. B. Razavi, “Design of Analog Integrated Circuits”, McGraw Hill Education, Indian Edition

Reference Books:

1. B. Razavi, ”R F Microelectronics”, Pearson Publication, 2nd Edition

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

3. Question paper will comprise of 6 questions, each carrying 20 marks.
4. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5012	TV & Video Engineering	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 5012	TV & Video Engineering	20	20	20	80	--	--	--	100

Course objectives:

- To understand basic concepts of TV system .
- To understand compression techniques
- To introduce to advanced systems and dvb standards

Course outcomes:

After successful completion of the course student will be able to

- Understand overview of TV system.
- Understand details of compression technique.
- Know about different dvb standards.
- Understand advanced digital systems

Module No.	Unit No.	Topics	Hrs.
1.0		Fundamentals of TV system	10
	1.1	Interlaced scanning, Composite video signal, VSB(Vestigial sideband transmission), Channel bandwidth, Study of transmitter and receiver block diagram of monochrome Television	
	1.2	Camera Tubes: Vidicon, Image Orthicon	
2.0		Colour Television	10
	2.1	Colour Fundamentals, Chromaticity diagram, Frequency interleaving, compatibility considerations	
	2.2	NTSC system characteristics, Encoder and Decoder block diagram, PAL system characteristics, Encoder and Decoder block diagram, Comparison of NTSC and PAL systems	
3.0		Digital Video	08
	3.1	Basics of digital video	
	3.2	Chroma subsampling:4:4:4,4:2:2,4:2:0,4:1:1 digital video formats	
	3.3	Video compression standards:MPEG2:DCT coding, codec structure. Introduction to H.264/MPEG-4 AVC, Introduction to H.265	
	3.4	Set-Top Box	
4.0		Digital Video Broadcasting	06
	4.1	Introduction to DVB-T,DVB-T2,DVB-H,DVB-S,DVB-C	
	4.2	Satellite Television	
5.0		Advanced Digital TV Systems	10
	5.1	MAC MACd2	
	5.2	HDTV,SUHDTV	
	5.3	Smart TV and its functions	
	5.4	Introduction to IPTV	
	5.5	Application of TV system as CCTV	
6.0		Displays & Streaming Media Device	04
	6.1	LCD,LED	
	6.2	Chromcast	
		Total	48

Text Books:

1. Monochrome and colour Television by R.R.Gulathi
2. Television and video engineering by A.M. Dhake

Reference Books:

1. Digital Television (Practical guide for Engineers) by Fischer

Websites:

1. <https://www.dvb.org/resources/public/factsheets>
2. https://en.wikipedia.org/wiki/Digital_Video_broadcasting

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5013	Finite Automata Theory	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECCDLO 5013	Finite Automata Theory	20	20	20	80	--	--	--	100	

Course prerequisite:

- Digital System Design

Course objectives:

This course provides in-depth knowledge of switching theory and the design techniques of digital circuits, which is the basis for design of any digital circuit. The main objectives are:

- To understand learn basic techniques for the design of digital circuits and fundamental concepts used in the design of digital systems.
- To design combinational logic circuits and its optimization and fault detection.
- To study Mealy and Moore synchronous and asynchronous sequential circuits design and their applications.

Course outcomes:

After successful completion of the course student will be able to

- Manipulate simple Boolean expressions using the theorems and postulates of Boolean algebra and to minimize combinational functions.
- Design and analyze small combinational circuits and to use standard combinational functions/building blocks to build larger more complex circuits.
- Design and analyze small sequential circuits and devices and to use standard sequential functions/building blocks to build larger more complex circuits.
- Design finite state machine understand the fundamentals and areas of applications for the integrated circuits.
- Perform symmetric and cascade threshold function and element

Module No.	Unit No.	Topics	Hrs.
1.0		Combinational Logic	09
	1.1	Notations of sets, Relations and Lattices, Venn diagram	
	1.2	Switching Algebra and functions, Boolean algebras and functions, Minimization of Boolean functions using map method and Tabulation Method, Prime implicant chart, Reduction of the chart, Branching method	
	1.3	Design of combinational Logic circuits, Contact networks, Functional decomposition and symmetric functions. Identification of symmetric functions	
2.0		Threshold Logic & Synthesis of Threshold Networks	06
	2.1	Threshold Logic, Threshold elements, Capabilities and limitations of threshold logic, elementary properties, Linear separability, Unate functions, Synthesis of threshold functions, Cascading of threshold elements.	
3.0		Testing of Combinational Circuits	09
	3.1	Reliable Design and fault Diagnosis, Fault Detection in combinational circuits, Fault location experiments, Fault Detection by Boolean Differences and path sensitization, Synthesis for testability, Multiple fault detection using map method, failure-Tolerant Design.	
4.0		Sequential Circuits	12
	4.1	Synchronous sequential circuits and iterative networks: Memory elements and their excitation functions; Synthesis of synchronous sequential circuits, Capabilities and limitations, State equivalence and Minimization, Minimization of completely specified and Incompletely specified sequential machines, Partition technique, Merger methods	
	4.2	Asynchronous sequential circuits: Hazards, Synthesis, State assignment and minimization	
	4.3	Finite state Machines – Mealy and Moore synchronous and asynchronous sequential circuits Design,	
5.0		Structure and testing of Sequential Circuits	08
	5.1	Structure of sequential Machines, Lattice of closed partitions, State Assignment using partitions, Reduction of output dependency, Input Independence and Autonomous clock.	
	5.2	Homing sequence, synchronizing sequence, Distinguishing sequence, Checking experiments, Machine identification, Recent Trends/Developments	

6.0		Algorithmic State Machine	04
	6.1	Introduction and components of ASM charts, Representation of sequential circuits using ASM charts, Example using ASM chart: 2 bit counter, binary multiplier, Weighing machine etc.	
		Total	48

Text Books:

1. Zvi Kohavi and Niraj K. Jha. “*Switching and Finite Automata Theory*”, 3 Editions, Cambridge University Press.
2. Zvi Kohavi, “*Switching Theory and Finite Automata*”, 2nd edition, Tata McGraw Hill
3. R. P. Jain, “*Switching Theory and Logic Design*”, Tata McGraw Hill Education, 2003.
4. Lee Samuel C.,” *Modern Switching Theory and Digital Design*”, Prentice Hall PTR

Reference Books:

1. Morris Mano, “*Digital Logic and Computer Design*”, Pearson Education
2. Samuel Lee, “*Digital Circuits and Logic design*”, Prentice Hall.
3. William I. Fletcher, “*An Engineering Approach to Digital Design*”, Prentice Hall.
4. John F. Wakerly, “*Digital Design - Principles and Practices*”, Pearson Education
5. A. Anand Kumar, “*Switching Theory and Logic Design*”, PHI Learning private limited, 2014

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5014	Data Compression & Encryption	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECCDLO 5014	Data Compression & Encryption	20	20	20	80	--	--	--	100	

Course objectives:

To teach the students

- Lossless and Lossy compression techniques for different types of data.
- Data Encryption Techniques.
- Network and Web Security.

Course outcomes:

After successful completion of the course student will be able to

- Implement text, audio and video compression techniques.
- Understand Symmetric and Asymmetric Key Cryptography schemes.
- Understand network security.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Data Compression	12
	1.1	Data Compression : Modelling and Coding, Statistical Modelling, Dictionary Schemes, LZ, Lossy Compression	
	1.2	Shannon – Fano Algorithm, Huffman Algorithm, Adaptive Huffman Coding	
	1.3	Difficulties in Huffman Coding, Arithmetic Coding – Decoding, Dictionary Based Compression, Sliding Window Compression: LZ-77, LZ-78, LZW	
2.0		Image Compression	06
	2.1	DCT, JPEG, JPEG – LS, Differential Lossless Compression, DPCM, JPEG – 2000 Standards	
3.0		Video and Audio Compression	08
	3.1	Analog Video, Digital Video, MPEG – 2, H – 261 Encoder and Decoder	
	3.2	Sound, Digital Audio, μ -Law and A-Law Companding, MPEG – 1 Audio Layer (MP3 Audio Format)	
4.0		Data Security	06
	4.1	Security Goals, Cryptographic Attacks, Techniques	
	4.2	Symmetric Key: Substitution Cipher, Transposition Cipher , Stream and Block Cipher	
	4.3	DES, AES	
5.0		Number Theory and Asymmetric Key Cryptography	08
	5.1	Prime Numbers, Fermat's and Euler's Theorem, Chinese Remainder Theorem, Discrete Logarithms	
	5.2	Principles of Public Key Crypto System, RSA	
	5.3	Key Management, Diffie-Hellman Key Exchange	
	5.4	Message Integrity, Message Authentication and Hash Functions, SHA, HMAC, Digital Signature Standards	
6.0		Network Security	08
	6.1	Email, PGP, S/MIME, Intrusion Detection System	
	6.2	Web Security Considerations, SSL Architecture, SSL Message Formats, TLS, Secure Electronic Transactions	
	6.3	Kerberos, X.509 Authentication Service, Public Key Infrastructure	
		Total	48

Text Books:

1. Mark Nelson, Jean-Loup Gailly, "The Data Compression Book", 2nd edition, BPB Publications
2. Khalid Sayood, "Introduction to Data Compression", 2nd Edition Morgan Kaufmann.
3. William Stallings, "Cryptography and Network Security Principles and Practices 5th Edition", Pearson Education.
4. Behrouz A. Forouzan, "Cryptography and Network Security", Tata McGraw-Hill.

Reference Books:

1. David Salomon, "Data Compression: The Complete Reference", Springer.
2. Matt Bishop, "Computer Security Art and Science", Addison-Wesley.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL501	Microprocessors & Peripherals Interfacing Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECL501	Microprocessors & Peripherals Interfacing Laboratory	--	--	--	--	25	25	--	50	

Suggested Experiment List

Experiments can be conducted on Assembler, Emulator or Hardware kits, in Assembly language.

- To write an assembly language program to perform 8-bit addition using multiple addressing modes, viz., direct, indirect, register, etc. addressing mode.
- To write an assembly language program to perform 16-bit Logical operations, viz., AND, OR, EOX, NAND, etc.
- To write an assembly language program to perform 32-bit Subtraction
- To write an assembly language program to generate 10 msec delay using software (register) and 8254
- To write an assembly language program to move 10 memory locations using String Instruction
- To write an assembly language subroutine (program) that takes a number as input and returns the square of it
- To write an assembly language program for interfaced 7 segment display or keypad or both, through 8255
- To write an assembly language program to read and save value from ADC
- To write an assembly language program to generate square / triangular / ramp waveforms using DAC
- To write an assembly language program for performing floating point division using 8087
- To write an assembly language program to use INT 21h DOS Functions, viz. read character, write character, get system date, etc

Note: Mini Project can be considered as a part of termwork (Topic based on syllabus)

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL502	Digital Communication Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECL502	Digital Communication Laboratory	--	--	--	--	25	25	--	50	

Experiments should be performed on Bread-board or on experimentation kits.

Suggested Experiment List

- To understand sampling theorem and reconstruction
- To understand Various line codes
- To observe the performance of Return to Zero (RZ) types of line code
- To observe the performance of Non- Return to Zero (NRZ) types of line code
- Modulation and Demodulation of Binary Amplitude Shift Keying
- Modulation and Demodulation of Binary Frequency Shift Keying
- Modulation and Demodulation of Binary Phase Shift Keying
- Modulation and Demodulation of Quadrature Phase Shift Keying
- To observe the effect of signal Distortion using EYE-Diagram
- To Study and perform Linear Block codes
- To Study and perform cyclic codes

Note: Mini Project can be considered as a part of termwork (Topic based on syllabus)

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every

experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL503	Business Communication & Ethics Laboratory	2 (classwise)	2 (batch wise)	--	--	2	--	2

Subject Code	Subject Name	Examination Scheme									
		Theory Marks					End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2	--					
		Test 1	Test2	Test 3							
ECL503	Business Communication & Ethics Laboratory	--	--	--	--	--	50	--	--	50	

Course objectives:

To teach the students

- To inculcate professional and ethical attitude.
- To enhance effective communication and interpersonal skills.
- To build multidisciplinary approach towards all life tasks.

Course outcomes:

After successful completion of the course student will be able to

- Design a technical document using precise language, suitable vocabulary and apt style.
- Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
- Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
- Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
- Deliver formal presentations effectively implementing the verbal and non-verbal skills.

Module No.	Unit No.	Topics	Hrs.
1.0		Report Writing	05
	1.1	Objectives of Report Writing	
	1.2	Language and Style in a report	
	1.3	Types : Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports (Memo, Letter, Short and Long Report)	
2.0		Technical Writing	03
	2.1	Technical Paper Writing (IEEE Format)	
	2.2	Proposal Writing	
3.0		Introduction to Interpersonal Skills	09
	3.1	Emotional Intelligence	
	3.2	Leadership and Motivation	
	3.3	Team Building	
	3.4	Assertiveness	
	3.5	Conflict Resolution and Negotiation Skills	
	3.6	Time Management	
	3.7	Decision Making	
4.0		Meetings & Documentations	02
	4.1	Strategies for conducting effective meetings	
	4.2	Notice, Agenda and Minutes of a meeting	
	4.3	Business meeting etiquettes	
5.0		Introduction to Corporate Ethics	02
	5.1	Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.)	
	5.2	Introduction to Intellectual Property Rights	
	5.3	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	
6.0		Employment Skills	07
	6.1	Group Discussion	
	6.2	Resume Writing	
	6.3	Interview Skills	
	6.4	Presentation Skills	
	6.5	Statement of Purpose	
		Total	28

References

1. Fred Luthans, “*Organizational Behavior*”, McGraw Hill, edition
2. Lesiker and Petit, “*Report Writing for Business*”, McGraw Hill, edition
3. Huckin and Olsen, “*Technical Writing and Professional Communication*”, McGraw Hill
4. Wallace and Masters, “*Personal Development for Life and Work*”, Thomson Learning, 12th edition
5. Heta Murphy, “*Effective Business Communication*”, Mc Graw Hill, edition
6. Sharma R.C. and Krishna Mohan, “*Business Correspondence and Report Writing*”, Tata McGraw-Hill Education
7. Ghosh, B. N., “*Managing Soft Skills for Personality Development*”, Tata McGraw Hill.
8. Lehman, Dufrene, Sinha, “BCOM”, Cengage Learning, 2nd edition
9. Bell, Smith, “Management Communication” Wiley India Edition, 3rd edition.
10. Dr. Alex, K., ”Soft Skills”, S Chand and Company
11. Subramaniam, R., “Professional Ethics” Oxford University Press.
12. Robbins Stephens P., “Organizational Behavior”, Pearson Education
13. <https://grad.ucla.edu/asis/agep/advsopestem.pdf>

List of Assignments:

1. Report Writing (Theory)
2. Technical Proposal
3. Technical Paper Writing (Paraphrasing a published IEEE Technical Paper)
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work:

Term work will consist of all assignments from the list. The distribution of marks for term

Work will be as follows:

Book Report.....	(10) Marks
Assignments	(10) Marks
Project Report Presentation.....	(15) Marks
Group Discussion.....	(10) Marks
Attendance	(05) Marks
TOTAL:	(50) Marks

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL504	Open Source technology for Communication Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECL504	Open Source technology for Communication Lab	--	--	--	--	25	25	--	50	

Prerequisites:

- Principals of Communication Engineering
- Digital System Design
- Signals and Systems
- Electronics Circuits and Devices

Course objectives:

- Introduction to open source tools for communication lab.
- To simulate and analyze the various parameters of communication systems.
- To understand and implement the communication system/sub system.

Course outcomes:

After successful completion of the course student will be able to

- Learn open source programming tools for communication technology.
- Simulate and analyze the performance of communication system.
- Implement the communication system/subsystem.

Sample List of Experiments:

Note: These are few examples of experiments; teachers may prepare their own list.

Sr. No	Title	Resource
1	Installation of a. Python, NumPy and commPy or b. Octave or c. Scilab or d. Xilinx using HDL Or e. LT SPICE Or f. SEQUEL Note: Any one tool or a combination of tools .	See the E-resource Links
2	Write a program to represent analog signal to digital signal (A to D conversion)	http://www.scilab.in/files/textbooks/ProfSenthikumar/DC.pdf
3	Write a program to generate basic functions a. Unit Impulse Signal b. Unit Step Signal c. Generate Ramp Signal d. Exponential Sequence e. Generate Sine Sequence f. Cos Sequence	See the E-resource Links
4	Write a program to perform convolution and correlation on the given signal.	See the E-resource Links
5	Plot the ASK, FSK and PSK Waveforms using scilab/python	See the E-resource Links
6	Write a program to apply Low/High Pass Filter on the given signal.	See the E-resource Links
7	Write a program to read a speech signal and plot it and play it.	See the E-resource Links

8	Write a program to apply Low/High Pass Filter on the given signal.	See the E-resource Links
9	Write a code to design Butterworth/Chebyshev filter using Scilab/Octave/Python.	See the E-resource Links
10	Write a program to calculate Hamming distance using Scilab/python.	See the E-resource Links
11	Encoding and decoding of convolutional codes	1. https://github.com/veeresht/CommPy/blob/master/commPy/examples/conv_encode_decode.py 2. https://media.readthedocs.org/pdf/commPy/latest/commPy.pdf
12	Design and programming of of 1-bit Full adder and testing using Testbench.	See the E-resource Links
13	Design and programming of 4-bit adder using Full adder and testing using Testbench	See the E-resource Links
14	Design and programming of 8:1 Mux and testing using Testbench	See the E-resource Links
15	Design and programming of 3:8 Decoder and testing using Testbench	See the E-resource Links
16	Design and programming of D Latch and D Flip Flop and testing using Testbench	See the E-resource Links
17	Design and programming of T FF and testing using Testbench	See the E-resource Links
18	Design and programming of Counter and testing using Testbench	See the E-resource Links
19	Design and programming of RAM and testing using Testbench	See the E-resource Links
20	Design and Programming of FSM and testing using	See the E-resource Links

	Testbench	
21	Design and Simulation of Basic diode Circuits like Clipper, Clapper, Voltage Doubler using Sequel or LT Spice	See the E-resource Links
22	Design and simulation of single stage and Multistage BJT amplifier using Sequel or LT SPICE	See the E-resource Links
23	Design and simulation of Differential amplifier and current mirror circuit using Sequel or LT SPICE	See the E-resource Links
24	Design and Simulation of Basic Op-circuits like Inverting amplifier , Non-Inverting amplifier, Difference amplifier, I to V convertor, V to I Convertor etc using Sequel ot LT SPICE.	See the E-resource Links
25	Design and Simulation of oscillators and Filters using Op-amp using LT SPICE or Sequel.	See the E-resource Links
26	Simulation of non-linear applications of Op-amp like Schmitt Trigger, Window Detector, Precision Rectifier, Square Wave Generator etc using LT SPICE or Sequel.	See the E-resource Links

List of Mini projects:

Note: These are few examples of mini projects; teachers may prepare their own list.

1. Implementing liner block code of (7,4).
2. Implementing FSK TX and RX.
3. Implementing Nyquist criteria with noisy environment.

Suggested List of Mini Projects on Xilinx using HDL Programming

4. 16 bit Multiplier
5. 32 Bit CLA adder
6. Shift and Add Multiplier
7. GCD Calculator
8. 3-bit FIR Filter design
9. 4 Bit ALU
10. 4-bit Comparator
11. 2's Complement adder

Suggested List of Mini Projects using LT SPICE or SEQUEL

12. Audio Equalizer using Op-amp.
13. Strain Gauge amplifier Circuit.
14. Synchronous DC-DC Buck Convertor.
15. RTD based 4 to 20mA transmitter circuit.

Online Repository Sites:

1. Google Drive
2. GitHub
3. Code Guru

E-Resources:

1. Spoken Tutorial : <http://spoken-tutorial.org/>
2. Scilab: <http://www.scilab.org/>
3. Octave: <https://www.gnu.org/software/octave/>
4. Python: <https://www.python.org/>
5. Xilinx using HDL: <https://www.xilinx.com/products/design-tools/ise-design-suite/ise-webpack.html>
6. LT SPICE : <http://www.linear.com/designtools/software/>
7. SEQUEL: <https://www.ee.iitb.ac.in/~sequel/>

Note: Mini Project can be considered as a part of termwork (Topic based on syllabus)

Term Work:

At least 08 Experiments covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 5011	Microelectronics Laboratory	--	--	02	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECLDLO 5011	Microelectronics Laboratory	--	--	--	--	25	--	--	25	

Term Work:

At least 08 tutorials covering entire syllabus must be given during the “**Tutorial session batch wise**”

Term work assessment must be based on the overall performance of the student with every tutorial graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 5012	TV & Video Laboratory	--	--	02	--	1	--	1

Subject Code	Subject Name	Examination Scheme									
		Theory Marks					End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2						
		Test 1	Test2	Test 3							
ECLDLO 5012	TV & Video Laboratory	--	--	--	--	25	--	--	25		

Suggested List of Experiments

- To study CVS
- Measurement of horizontal and vertical scanning frequency
- To study sound section of TV receiver
- To study receiver sections by using fault simulation switches
- To study DTH receiver
- To study HDTV
- To study set top box trainer
- To study LCD display
- To study LED display

Term Work:

At least 8 Practicals/ Tutorials covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 5013	Finite Automata Theory	--	--	02	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2	Test 3						
ECLDLO 5013	Finite Automata Theory	--	--	--	--	25	--	--	25	

List of Mini Projects:

1. Combinational circuits
2. Synchronous sequential circuits (Finite state machine)
3. Asynchronous sequential circuits (Finite state machine)
4. Algorithmic state machine

Note: Mini Project can be considered as a part of term-work.

Term Work:

At least 8 Tutorials covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 5014	Data Compression & Encryption	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECLDLO 5014	Data Compression & Encryption	--	--	--	--	25	--	--	25	

Suggested Practical List:

- Huffman Code.
- Adaptive Huffman Code.
- Arithmetic Code.
- LZW Compression and Decompression.
- Companding Implementation.
- Implementation of DCT.
- RSA and MD5 Algorithm.
- Packet Analyzer.
- PGP (Pretty Good Privacy).
- Vulnerability Scanner.
- Intrusion Detection System.
- Firewall.
- SSL

Note: Mini Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful,

interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC601	Microcontrollers & Applications	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC601	Microcontrollers & Applications	20	20	20	80	--	--	--	100	

Course objectives:

- To develop background knowledge and core expertise in microcontrollers.
- To understand peripheral devices and their interfacing to microcontrollers.
- To write programs for microcontrollers and their applications in Assembly and Embedded C Language.

Course outcomes:

After successful completion of the course student will be able to

- Understand the detailed architecture of 8051 and ARM7 microcontroller.
- Study the in-depth working of the microcontrollers and their Instruction set.
- Interface various peripheral devices to the microcontrollers.
- Write Assembly language and Embedded C program for microcontrollers.

Module No.	Unit No.	Topics	Hrs.
1.0		8051 Microcontroller	12
	1.1	Comparison between Microprocessor and Microcontroller	
	1.2	Features, architecture and pin configurations	
	1.3	CPU timing and machine cycle	
	1.4	Input / Output ports	
	1.5	Memory organization	
	1.6	Counters and timers	
	1.7	Interrupts	
	1.8	Serial data input and output	
2.0		8051 Programming	08
	2.1	Instruction set	
	2.2	Addressing mode	
	2.3	Assembler Directives	
	2.4	Programs related to: arithmetic, logical, delay, input, output, timer, counters, port, serial communication, and interrupts	
3.0		8051 Interfacing and Applications	06
	3.1	Interfacing of Display: LED, LCD and Seven Segment display	
	3.2	Stepper Motor and Relay	
	3.3	UART	
4.0		ARM7: A 32 bit Microcontroller	08
	4.1	The RISC and the CISC design philosophy	
	4.2	Concept of Cortex-A, the Cortex-R and the Cortex-M	
	4.3	Features of ARM Microcontroller	
	4.4	Pipeline Architecture	
	4.5	Registers	
	4.6	Exceptions, Interrupt and Vector Table	
	4.7	Memory Management	
5.0		ARM7 Programming	08
	5.1	Data Processing Instructions	
	5.2	Conditional and Branching Instructions	
	5.3	ARM-THUMB Interworking	
	5.4	Single-Register Load-Store Instructions	
	5.5	Stack Instructions	
	5.6	Software Interrupt Instructions	
6.0		ARM Programming with Embedded C	06
	6.1	General Purpose Input Output	
	6.2	Timer Mode	
	6.3	Pulse –Width Modulator Configuration	
		Total	48

Text Books:

1. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, “*The 8051 Microcontroller & Embedded systems*”, Pearson Publications, Second Edition 2006.
2. C. Kenneth J. Ayala and D. V. Gadre, “*The 8051 Microcontroller & Embedded system using assembly & ‘C’*”, Cengage Learning, Edition 2010.
3. Satish Shah, “*The 8051 Microcontrollers*”, Oxford publication first edition 2010.
4. Andrew Sloss, Dominic Symes, and Chris Wright, “*ARM System Developer’s Guide*” Morgan Kaufmann Publishers, First Edition 2004.
5. Lyla Das, “*Embedded Systems: An Integrated Approach*”, Pearson Publication, First Edition 2013
6. James A. Langbridge, “*Professional Embedded Arm Development*”, Wrox, John Wiley Brand& Sons Inc., Edition 2014

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC602	Computer Communication Networks	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC602	Computer Communication Networks	20	20	20	80	--	--	--	100

Course Pre requisite:

- Analog Communication

Course objectives:

- To introduce analysis and design of computer and communication networks.
- To design and configure a network for an organization. To implement client-server socket programs.
- To analyse the traffic flow and the contents of protocol frames.

Course outcomes:

After successful completion of the course student will be able to

- Design a small or medium sized computer network including media types, end devices, and interconnecting devices that meets a customer's specific needs.
- Perform basic configurations on routers and Ethernet switches.
- Demonstrate knowledge of programming for network communications.
- Learn to simulate computer networks and analyse the simulation results.
- Troubleshoot connectivity problems in a host occurring at multiple layers of the OSI model.
- Develop knowledge and skills necessary to gain employment as computer network engineer and network administrator.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction	06
	1.1	Network Applications	
	1.2	Network Hardware	
	1.3	Network Software	
	1.4	Reference Models, overview of TCP/IP, layer Functions, services, sockets and ports, Encapsulation.	
2.0		Introduction to Physical layer Services and System	08
	2.1	Introduction to physical media, Coax, RJ 45 , fiber, twisted pair, DSL, HFC, WiMax, cellular, satellite, and telephone networks, bit transmission, frequency division multiplexing. time division multiplexing.	
3.0		The Data Link Layer	08
	3.1	Data link Layer Design Issues	
	3.2	Error Detection and Correction	
		Elementary Data Link Protocols, Sliding Window Protocols	
		Example Data Link Protocols: HDLC: High-Level Data Link Control, The Data Link Layer in The Internet.	
4.0		The Medium Access Sub- Layer	06
	4.1	Channel Allocation Problem.	
	4.2	Multiple Access Protocols.	
5.0		The Network Layer	10
	5.1	Network Layer Design Issues.	
	5.2	Routing Algorithms.	
	5.3	Congestion Control Algorithms, Quality of Service.	
	5.4	Internetworking.	
	5.5	The Network Layer In The Internet: The IP Protocol, IPv4 header, IP Addressing, Subnetting.	
	5.6	Internet Control Protocols, The Interior Gateway Routing Protocol: OSPF, The Exterior Gateway Routing Protocol: BGP.	
6.0		The Transport Layer	10
	6.1	The Transport Service.	
	6.2	Elements of Transport Protocols.	
	6.3	The Internet Transport Protocol: UDP	
	6.4	The Internet Transport Protocol: TCP:-Introduction to TCP, The TCP Service Model. The TCP Protocol.	
	6.5	The TCP Segment Header.	
	6.6	TCP Connection Establishment, TCP Connection Release.	
	6.7	Modeling TCP Connection Management.	
	6.8	TCP Transmission Policy.	
	6.9	TCP Congestion Control.	
	6.10	TCP Timer Management, Transactional TCP.	

		Total	48
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Text Books:

1. A. S. Tanenbaum, "Computer Networks", 4th edition, Prentice Hall
2. B. F. Ferouzan, "Data and Computer Communication", Tata McGraw Hill.

Reference Books:

1. Peterson & Davie, "Computer Networks", 2nd Edition, Morgan Kaufmann.
2. Kurose, Ross, "Computer Networking", Addison Wesley
3. S. Keshav, "An Engg, Approach To Computer Networking", Addison Wesley.
4. W. Richard Stevens, "TCP/IP Volume1, 2, 3", Addison Wesley.
5. D. E. Comer, "Computer Networks And Internets", Prentice Hall.
6. B. F. Ferouzan, "TCP/IP Protocol Suite", Tata McGraw Hill.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC603	Antenna & Radio Wave Propagation	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC603	Antenna & Radio Wave Propagation	20	20	20	80	--	--	--	100	

Prerequisites:

- Electromagnetic Field
- Two port network
- Transmission Line

Course objectives:

- To learn fundamental parameters of Antenna
- To learn about linear wire antenna elements and Antenna arrays
- To learn about Special types of Antennas
- To learn about Antenna measurements and radio wave propagation

Course outcomes:

After successful completion of the course student will be able to

- Define Basic antenna parameters like radiation pattern, directivity and gain.
- Derive the field equations for the basic radiating elements like linear wire antenna and loop antenna.
- Design of uniform linear and planar antenna arrays using isotropic and directional Sources.
- Implement special types of Antennas like microstrip antennas and reflectors.

Module No.	Unit No.	Topics	Hrs.
1.0		Antenna Fundamentals	08
	1.1	Introduction, Radiation Mechanism, basic antenna parameters, Radiation pattern, radiation power density, radiation intensity, Beamwidth, directivity, Antenna efficiency, Gain, beam efficiency, bandwidth, polarization, input impedance, antenna vector effective length and equivalent areas, Antenna radiation efficiency, Friis transmission equation	
	1.2	Basic concepts of Maxwell's equation, vector potential, wave equation, near field and far field radiation, dual equations for electric and magnetic current sources.	
2.0		Wire Elements: Dipoles, Monopoles, Loops and Helical	12
	2.1	Infinitesimal dipole, radiation fields, radiation resistance, radiation sphere, near field, far field directivity, small dipole, finite length dipole, half wave length dipole, linear elements near or on infinite perfect conductors, Monopole antenna, Folded dipole. Design of dipole and monopole antenna	
	2.2	Loop Antenna: Small circular loop, comparison of small loop with short dipole, Ferrite loop, radiation patterns its parameters and their application.	
	2.3	Helical Antennas: Input impedance matching, Axial mode and normal mode propagation, Circular polarization using Helical Antenna	
3.0		Arrays	12
	3.1	Linear arrays, Array of two isotropic point sources, linear arrays of N elements, principle of pattern multiplication applicable to non-isotropic sources, Phase scanning arrays, broadside and End-fire Array, Increased Directivity end fire array, Calculations of Directivity, Beam width, Maxima and null directions for N-element Array.	
	3.2	Introduction to planar and circular arrays	
	3.3	Design of Yagi antenna and Log Periodic antenna	
4.0		Aperture Antennas	06
	4.1	Horn Antennas :E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn, Conical Horn	
	4.2	Reflector Antennas: Introduction, Plane Reflector, Corner Reflector, Parabolic Reflector, Design considerations	
5.0		Patch Antenna	04
	5.1	Microstrip antenna (MSA): Introduction, Feeding Techniques, Regular Shape MSAs (Rectangular, Circular, Equilateral Triangular), Design of Regular shape MSAs	
6.0		Antenna Measurements & Wave Propagation	06

	6.1	Antenna Measurements: Measurement of Antenna parameters: Input Impedance, Radiation Pattern, Gain (Two and Three antenna method), Polarization.	
	6.2	Ground Wave Propagation: Ground waves, effect of Earth's Curvature on Ground wave propagation, impact of imperfect earth	
	6.3	Sky Wave Propagation Ionosphere and Earth magnetic field effect, Critical frequency, Angle of incidence, Maximum usable frequency, Skip distance, Virtual height, Variations in ionosphere and Attenuation and fading of waves in ionosphere	
	6.4	Space Wave Propagation	
		Total	48

Text Books:

1. C. A. Balanis, Antenna Theory: Analysis and Design (3rd eds.), John Wiley & Sons, Hoboken, NJ, 2005.
2. J. D. Kraus, R. J. Marhefka, A.S. Khan “Antennas & Wave Propagation”, McGraw Hill Publications, 4th Edition, 2011
3. G. Kumar, K. P. Ray, Broadband Microstrip Antenna, Artech House, 2002.

Reference Books:

1. Stutzman, Theile, “ Antenna Theory and Design”, John Wiley and Sons , 3rd Edition
2. R. E. Collin, “Antennas and Radio Wave Propagation”, International Student Edition, McGraw Hill.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC604	Image Processing & Machine Vision	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC604	Image Processing & Machine Vision	20	20	20	80	--	--	--	100	

Prerequisites:

- Signals and Systems
- Discrete Time Signal Processing

Course objectives:

- To cover the fundamentals and mathematical models in digital image processing and Machine Vision
- To develop time and frequency domain techniques for image enhancement.
- To expose the students to classification techniques in Machine Vision
- To develop Applications using image processing and Machine Vision

Course outcomes:

After successful completion of the course student will be able to

- Understand theory and models in image processing.
- Interpret and analyze 2D signals in Spatial and frequency domain through image transforms.
- Apply quantitative models of image processing for segmentation and restoration for various applications.
- Find shape using various representation techniques and classify the object using different classification methods.

Module No.	Unit No.	Topics	Hrs.
1.0		Digital Image Fundamentals	04
	1.1	Introduction – Origin – Steps in Digital Image Processing , Components, Elements of Visual Perception – Image Sensing and Acquisition, Image Sampling and Quantization – Relationships between pixels, Transformation: Orthogonal, Euclidean, Affine	
	1.2	Color Image Processing: Color Fundamentals Color models.	
2.0		Image Transforms	06
	2.1	1-D DFT, 2-D Discrete Fourier Transform and Its Inverse, Some Properties of 2D DFT ,Walsh -Hadamard, Discrete Cosine Transform, Haar Transform	
3.0		Image Enhancement	08
	3.1	Image Negative, Log Transform, Power Law transform, Histogram equalization and Histogram Specification	
	3.2	Spatial Domain: Basics of Spatial Filtering, The Mechanics of Spatial Filtering, Generating Spatial Filter Masks–Smoothing and Sharpening Spatial Filtering	
	3.3	Frequency Domain: , The Basics of Filtering in the Frequency Domain, Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Laplacian, Unsharp Masking and Homomorphic filters	
4.0		Morphological & Image Restoration	06
	4.1	Morphology: Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation.	
	4.2	Restoration :Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters	
5.0		Patch Antenna	12
	5.1	Point, Line, and Edge Detection: Detection of Isolated Points, Line detection, edge models, basic and advance edge detection, Edge linking and boundary detection , Canny's edge detection algorithm	
	5.2	Thresholding : Foundation, Role of illumination, Basic Global thresholding	
	5.3	Region Based segmentation: Region Growing, Region Splitting and merging	
	5.4	Region Identification , chain code, simple geometric border representation, Fourier Transform of boundaries, Boundary description using segment sequences, B-spline representation	
6.0		Boundary Description & Object Recognition	12

	6.1	Texture: Statistical Texture Description Methods- Methods based on spatial frequencies, co-occurrence matrices, edge frequency, primitive length, Law's texture energy measures	
	6.2	Object Recognition Knowledge representation, Classification Principles, Classifier setting, Classifier Learning, Support vector machine, cluster analysis	
		Total	48

Text Books:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" Cengage Engineering, 3rd Edition, 2013
2. Gonzales and Woods, "Digital Image Processing", Pearson Education, India, Third Edition,

Reference books:

1. Anil K.Jain, "Fundamentals of Image Processing", Prentice Hall of India, First Edition, 1989.
2. W Pratt, "Digital Image Processing", Wiley Publication, 3rd Edition, 2002

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6021	Digital VLSI Design	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 6021	Digital VLSI Design	20	20	20	80	--	--	--	100

Prerequisites:

- Digital System Design
- Microelectronics

Course objectives:

- To highlight the circuit design issues in the context of Digital VLSI technology
- A profound understanding of Digital VLSI design circuits using different design styles.
- To provides an exposure to RTL design and programming

Course outcomes:

After successful completion of the course student will be able to

- Understand the semiconductor technology, scaling and performance.
- Realize logic circuits with different design styles.
- To understand operation of memory, storage circuits and data path elements.
- Simulate and synthesize digital circuits using HDL language.
- Demonstrate an understanding of system level design issues such as protection, clocking, and routing.
- Learn the RTL design techniques and methodologies

Module No.	Unit No.	Topics	Hrs.
1.0		MOS Circuit Design Styles	10
	1.1	Static CMOS, Dynamic CMOS , Pseudo NMOS, Domino, C ² MOS, NORA logic, NP Domino logic	
	1.2	Realization of Multiplexer (upto 4:1 Mux) , Encoder, Decoder, SR Latch, JK FF, D FF, 1 Bit Shift Register with different design styles and their layouts	
2.0		Memory and Storage circuits	08
	2.1	ROM array, SRAM (operation, design strategy, leakage currents, read/write circuits), layout of SRAM	
	2.2	DRAM (Operation of 1T, 3T, operation modes, leakage currents, refresh operation, Input-Output circuits), layout of DRAM	
	2.3	Flash memory: NAND and NOR flash memory	
3.0		Data path design	08
	3.1	Full adder, Ripple carry adder, CLA adder, Carry Skip Adder, Carry Save Adder and carry select adder	
	3.2	Array Multiplier	
	3.3	Barrel shifter	
4.0		VLSI Clocking, Protection and Interconnect	06
	4.1	CMOS clocking styles, pipelined systems, Clock generation, stabilization and distribution	
	4.2	ESD protection, Input circuits, Output circuits, power distribution scheme	
	4.3	Interconnect delay model, interconnect scaling and crosstalk	
5.0		Design methods	08
	5.1	Semicustom, Full custom design, ASIC	
	5.2	PLA, PLD, PAL, FPGA	
	5.3	System based and Data path design using HDL	
6.0		RTL Design	08
	6.1	High Level state machines, RTL design process	
	6.2	Soda dispenser machine, laser based distance measure, Sum of absolute	
	6.3	FIR filter design	
		Total	48

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, “*CMOS Digital Integrated Circuits Analysis and Design*”, Tata McGraw Hill, 3rd Edition, 2012.
2. P. Uyemura, “*Introduction to VLSI Circuits and Systems*”, John Wiley & Sons.
3. Frank Vahid, “*Digital Design with RTL design, VHDL and VERILOG*”, John Wiley and Sons Publisher 2011.

4. Neil H. E. Weste, David Harris and Ayan Banerjee, “*CMOS VLSI Design: A Circuits and Systems Perspective*”, Pearson Education, 3rd Edition.
5. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”, PHI, Second Edition
6. Douglas L. Perry “VHDL: Programming by Example”, McGrawHill, 4th Edition

Reference Books:

1. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, “Digital Integrated Circuits: A Design Perspective”, Pearson Education, 2nd Edition..
2. Volnei A. Pedroni, “Circuit Design and Simulation with VHDL”, MIT Press, 2nd Edition

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6022	Radar Engineering	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCDLO 6022	Radar Engineering	20	20	20	80	--	--	--	100	

Prerequisites:

- Communication Fundamentals
- Electromagnetic field
- Transmission Lines and Antenna

Course objectives:

- To interpret Radar equations
- To explain different types of radar
- To design RADAR transmitters and receivers for given conditions

Course outcomes:

After successful completion of the course student will be able to

- Explain generalized concept of RADAR.
- Solve problems using radar equations.
- Describe different types of radar for specific application.
- Explain concept of tracking radar.
- Evaluate the design constraints for transmitter.
- Evaluate the design constraints for receiver.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Radar	04
	1.1	Basics Radar, Radar equation	
	1.2	Block Diagram, Radar Frequencies	
	1.3	Applications of Radar	
2.0		Radar Equation	08
	2.1	Detection of signal in noise	
	2.2	Receiver Noise and Signal-to-noise Ratio	
	2.3	Probability of detection and false alarm: Simple , complex Targets	
	2.4	Pulse Repetition Frequency	
3.0		MTI and Pulse Doppler Radar	12
	3.1	Introduction to Doppler and MTI radar, Doppler frequency shift	
	3.2	Simple CW Doppler radar, MTI radar block diagram	
	3.3	Delay line canceler	
	3.4	Moving-target-detection	
	3.5	Pulse Doppler radar	
4.0		Tracking Radar	08
	4.1	Monopulse tracking	
	4.2	Conical scan and sequential lobbing	
	4.3	Limitation of tracking accuracy	
	4.4	Low angle tracking	
5.0		Radar Transmitters	10
	5.1	Radar RF power sources: Klystron, Travelling wave tube	
	5.2	Solid state RF power source: low power transmitter, high power transmitter, Advantages of solid state RF power source	
	5.3	Magnetron: coaxial magnetron	
	5.4	Crossed field amplifiers: CFA operation, modulating a CFA, system implementation	
6.0		Radar Receivers	06
	6.1	Receiver noise figure	
	6.2	Superheterodyne Receiver	
	6.3	Radar Display: Types of displays	
		Total	48

Text Books:

1. Merill Skolnik, –Introduction to RADAR Systems, Tata McGraw Hill, Third Edition
2. Merill Skolnik, –Radar Handbook, TataMcgraw Hill, Second Edition

Reference books:

1. Mark A. Richards, James A. Scheer, William A. Holm, “Principles of Modern Radar Basic Principals”, Scitech Publishing.
2. Simon Kingsley, Shaun Quegon, “Understanding Radar Systems”, Scitech Publishing Inc.
3. G. S. N. Raju, “Radar Engineering and Fundamentals of Navigational Aids”, I. K International publishing House Pvt. Ltd.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6023	Database Management System	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2		End Sem. Exam			
ECCDLO 6023	Database Management System	20	20	20	80	--	--	--	100

Prerequisites:

- Basic knowledge of programming

Course objectives:

- Learn and practice data modeling using the entity-relationship and developing database designs.
- Understand the use of Structured Query Language (SQL) and learn SQL syntax.
- Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access

Course outcomes:

After successful completion of the course student will be able to

- Understand the different issues involved in the design and implementation of a database system.
- Transform an information model into a relational database schema and to use a data definition language and/or utility to implement the schema using a DBMS.
- Demonstrate an understanding of normalization theory and apply such knowledge to the normalization of a database.
- Understand the concepts of constraints, views, concurrency control, deadlock

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Databases and Transactions	02
	1.1	Introduction to databases, History of database system, Benefits of Database system over file system, relational databases, database architecture, transaction management	
2.0		Data Models	06
	2.1	The importance of data models, Basic building blocks, Business rules, Evolution of data models (hierarchical, Network, Relational, Entity relationship and object model), Degrees of data abstraction.	
3.0		Database Design, ER-Diagram and Unified Modeling Language	10
	3.1	Database design and ER Model: overview, ER-Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain and Normalization (1NF, 2NF, 3NF, BCNF).	
4.0		Relational Algebra and Calculus	10
	4.1	Relational algebra: introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.	
5.0		Constraints, Views and SQL	10
	5.1	What is constraints, types of constrains, Integrity constraints, Views: Introduction to views, data independence, security, updates on views, comparison between tables and views SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers.	
6.0		Transaction management and Concurrency control	10
	6.1	Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.	
		Total	48

Text Books:

1. A Silberschatz, H Korth, S Sudarshan, “Database System and Concepts”, Fifth Edition McGraw-Hill
2. Rob, Coronel, “Database Systems”, Seventh Edition, Cengage Learning.
3. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database System”, Seventh Edition, Person.
4. G. K. Gupta: “Database Management Systems”, McGraw – Hill.

Reference Books:

1. Peter Rob and Carlos Coronel, “Database Systems Design, Implementation and Management”, Thomson Learning, 5th Edition.
2. P.S. Deshpande, “SQL and PL/SQL for Oracle 11g, Black Book”, Dreamtech Press
3. Mark L. Gillenson, Paulraj Ponniah, “Introduction to Database Management”, Wiley
4. Raghu Ramkrishnan and Johannes Gehrke, “Database Management Systems”, TMH
5. Debabrata Sahoo “Database Management Systems” Tata McGraw Hill, Schaum’s Outline

E-Resources:

1. <https://www.tutorialspoint.com/dbms/index.htm>
2. <https://www.studytonight.com/dbms/>
3. <https://beginnersbook.com/2015/04/dbms-tutorial/>
4. <https://www.w3schools.in/dbms/>
5. <https://www.tutorialcup.com/dbms>

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1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6024	Audio Processing	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCDLO 6024	Audio Processing	20	20	20	80	--	--	--	100	

Prerequisites

- Signal System

Course objectives:

- To understand basic concepts and methodologies for the analysis and modeling of speech signal.
- To characterize the speech signal as generated by a speech production model.
- To understand the mechanism of speech and audio perception.
- To understand the digital representation of the speech waveform.
- To perform the analysis of speech signal using STFT.
- To extract the information of the speech or audio signals.
- To provide a foundation for developing application in this field.

Course outcomes:

After successful completion of the course student will be able to

- Demonstrate advanced Knowledge in Digital model representation of speech signal.
- Design and implement algorithms for processing speech and audio signals considering the properties of acoustic signals and human hearing.
- Analyze speech signal to extract the characteristic of vocal tract (formants) and vocal cords (pitch).
- Formulate and design a system for speech recognition and speaker recognition.
- Acquired knowledge about audio and speech signal estimation and detection.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction	06
	1.1	Review of digital signal and systems, Transforms representations of signal and systems, Sampling Theorem, Goertzel algorithm, Chirp algorithm.	
2.0		Digital Models for Speech signals	06
	2.1	Speech production and acoustic tube modeling, acoustic phonetics, anatomy, and physiology of the vocal tract and ear, hearing and perception.	
3.0		Digital Representations of the Speech Waveform	08
	3.1	Sampling speech signals, Instantaneous quantization, Adaptive quantization, Differential quantization, Delta Modulation, Differential PCM, Comparison of systems, Direct digital code conversion.	
4.0		Time Domain Models for Speech Processing	12
	4.1	Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech V/S silence discrimination using energy & Zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, Median smoothing.	
5.0		Short time Fourier Transform	10
	5.1	Introduction- Definition and Properties, Fourier Transform Interpretation ,Linear Filtering Interpretation ,Sampling rates of X_n ($e^{j\omega}$) in Time and Frequency ,Filter Bank Summation Method of Short -Time Synthesis ,Overlap Addition Method for Short -Time Synthesis.	
6.0		Speech and Audio Processing	06
	6.1	Vocoder- Voice excited channel vocoder, Voice excited and error signal excited LPC vocoders. Adaptive predictive coding of speech, Auditory Modeling. Audio signal processing for Music applications. Speech recognition pattern comparison techniques, Artificial Neural Network.	
		Total	48

Text Books:

1. L R Rabiner and S W Schafer, "Digital processing of speech signals", Pearson Education, 2009.
2. L R Rabiner, B H Juang, B Yegnanarayana, "Fundamentals of speech Recognition", Pearson Education, 1993.

Reference Books

1. Thomas F Quateri, "Discrete Time Speech Signal Processing" Pearson Edition, 2006.
2. Ben Gold and Nelson Morgan, "Speech & Audio Signal Processing", Wiley, 2007.
3. Douglas O Shaughnessy, "Speech Communications", 2nd Edition, Oxford university press, 2000.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

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1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL601	Microcontroller & Applications Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECL601	Microcontroller & Applications Laboratory	--	--	--	--	25	25	--	50	

Suggested Experiment List

1. Perform Arithmetic and Logical Operations
2. Transfer of data bytes between Internal and External Memory
3. Experiments based on General Purpose Input-Output, Timers, Interrupts, Delay, etc
4. Interfacing of LED,LCD, Stepper Motor, UART

Mini project based on any application related to 8051 or ARM7 can be implemented.

Note: Mini Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL602	Computer Communication Network Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECL602	Computer Communication Network Laboratory	--	--	--	--	25	25	--	50	

Suggested Experiment List

1. Create a Virtual Network using NETKIT emulator and use networking commands like route, arp, netstat, traceroute, ping on created topology.
2. To study installation and configuration of NS 2.35 simulator.
3. Design a connectionless and connection oriented network topology for static routing and dynamic routing with the help of NS2 simulator.
4. To study three way handshaking process as well as working process for connection oriented Protocols like FTP, TELNET and analysing packets generated by using packet capturing tool like tcpdump
5. To implement stream socket that can serve multiple clients at the same time.
6. To study requirements and scope of Subnetting and Network Translation by using Netkit Emulator.
7. Case Study: To study installation of linux operating system by using DHCP, TFTP and any repository server like HTTP, FTP or NFS.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL603	Antenna & Radio Wave Propagation Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECL603	Antenna & Radio Wave Propagation Laboratory	--	--	--	--	25	25	--	50	

Suggested Experiment List

- Introduction to different Antenna parameters and its importance
- Introduction to Different Antenna Types
- Study of Radiation pattern of dipole, folded dipole and Monopole antenna
- Study of Antenna Arrays – N element array for given angle, Parametric study for various arrays parameters
- Study of Yagi-Uda Antenna
- Study of Aperture Antennas – Horn / Reflector Antennas
- Design, implementation and Pattern measurement of Regular shape MSA
- Case Study of Recent reported variations of Antenna types (Paper from reputed journal is to be referred and thoroughly study and present the report, maximum four students per group)

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL604	Image Processing and Machine Vision Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECL604	Image Processing and Machine Vision Laboratory	--	--	--	--	25	25	--	50	

Suggested Experiment List

- At least 8 programs written in C/MATLAB software

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 6021	Digital VLSI Design Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECLDLO 6021	Digital VLSI Design Laboratory	--	--	--	--	25	--	--	25	

Suggested Experiment List

- At least **08** experiments covering entire syllabus of Digital VLSI should be set to have well predefined inference and conclusion.
- The first 05 experiments as described below can be conducted by using Free or Professional tools
 - 01** experiments on Layouts of NAND and NOR gates to understand design rules
 - 01** experiment on Layout design of logical expression
 - 01** experiments on NAND/NOR gate implementation using at least 03 design styles
 - 02** experiment on Multiplexer/Decoder/Flip flop/Memory etc design
- Last **03** experiments on HDL

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 6022	Radar Engineering Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECLDLO 6022	Radar Engineering Laboratory	--	--	--	--	25	--	--	25	

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 6023	Database Management System Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECLDLO 6023	Database Management System Laboratory	--	--	--	--	25	--	--	25	

Suggested Experiment List

- Design a Database and create required tables. For e.g. Bank, College Database
- Apply the constraints like Primary Key, Foreign key, NOT NULL to the tables.
- Write a sql statement for implementing ALTER, UPDATE and DELETE
- Write the queries to implement the joins
- Write the query for implementing the following functions: MAX (), MIN (), AVG (), COUNT ()
- Write the query to implement the concept of Integrity constrains
- Write the query to create the views
- Perform the queries for triggers
- Perform the following operation for demonstrating the insertion, updation and deletion using the referential integrity constraints
- Write the query for creating the users and their role

List of Mini projects:

Note: These are few examples of mini projects; teachers may prepare their own list.

1. Library Management System
2. Hospital Management System
3. Pharmacy Management System
4. Human Resource Database Management System in Java
5. Student Database Management System
6. Employee Management System
7. Inventory Control Management Database

8. Pay Roll Management System
9. Railway System Database
10. Airline Reservation System
11. Blood Donation System
12. School Management System

Online Repository Sites:

1. Google Drive
2. GitHub
3. Code Guru

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 6024	Audio Processing Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECLDLO 6024	Audio Processing Laboratory	--	--	--	--	25	--	--	25	

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC701	Microwave Engineering	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC701	Microwave Engineering	20	20	20	80	--	--	--	100	

Prerequisites:

- Electromagnetic Engineering
- Antenna and Radio Wave Propagation
- Communication Engineering

Course objectives:

- To learn fundamentals of microwave systems.
- To learn to make system level design decisions.
- To learn passive and active device characteristics

Course outcomes:

After successful completion of the course student will be able to

- Characterize devices at higher frequencies.
- Design and analyze microwave circuits.
- Design and analyze amplifiers and oscillators at microwave frequencies.
- Demonstrate skills of planning, design and deployment of microwave networks.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Microwaves	08
	1.1	Microwave Frequency Bands in Radio Spectrum, Characteristics, Advantages and Applications of Microwaves.	
	1.2	Scattering parameters: Characteristics and Properties.	
	1.3	Strip lines, Microstrip lines and coupled lines: Analysis and design.	
	1.4	Design of Impedance matching network using lumped and distributed parameters.	
2.0		Waveguides and Passive Devices	08
	2.1	Rectangular and circular waveguides: Construction, Working and Mode analysis.	
	2.2	Resonators, Re-entrant cavities, Tees, Hybrid ring, Directional couplers, Phase shifters, Terminations, Attenuators and Ferrite devices such as Isolators, Gyrotors, and Circulators.	
3.0		Microwave Tubes	10
	3.1	Two Cavity Klystron, Multi-Cavity Klystron and Reflex Klystron.	
	3.2	Helix Travelling Wave Tube and Cross Field Amplifier.	
	3.3	Backward Wave Oscillator, Cylindrical Magnetron and Gyrotron.	
4.0		Microwave Semiconductor Devices	10
	4.1	Diodes: Varactor, PIN, Tunnel, Point Contact, Schottky Barrier, Gunn, IMPATT, TRAPATT, and BARITT.	
	4.2	Transistors: BJT, Hetro junction BJT, MESFET, and HEMT	
	4.3	Parametric Amplifiers and Applications.	
5.0		Microwave Measurements	06
	5.1	VSWR, Frequency, Power, Noise, Q -Factor, Impedance, Attenuation, Dielectric Constant, Antenna Gain.	
6.0		Microwave Integrated Circuits (MIC)	06
	6.1	MIC Materials.	
	6.2	Types of MIC: Hybrid and Monolithic MIC.	
	6.3	Chip Mathematics.	
		Total	48

Text Books :

1. Samuel Liao, "Microwave Devices and Circuits", Prentice Hall
2. David Pozar, "Microwave Engineering", Wiley Publication, Fourth Edition
3. Matthew M. Radmanesh, "Radio Frequency and Microwave Electronics", Pearson Education.
4. Annapurna Das and S. K Das, "Microwave Engineering", McGraw Hill Education, Third Edition.

References:

1. Colin, Foundations of Microwave Engineering, Second Edition, Wiley Interscience, 2nd Edition.
2. Devendra Misra, "Radio Frequency and Microwave Communication Circuits- Analysis and Design", John Wiley & Sons, 2nd Edition

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC702	Mobile Communication System	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC702	Mobile Communication System	20	20	20	80	--	--	--	100	

Prerequisites:

- Analog Communication
- Digital Communication
- Computer Communication and Networks

Course objectives:

- To understand the cellular fundamentals and different types of radio propagation models.
- To study the system architecture of 2G, 2.5 G and 3G.
- To develop the concepts of emerging technologies for 4 G standards and beyond.

Course outcomes:

After successful completion of the course student will be able to

- Explain the cellular fundamentals and estimate the coverage and capacity of cellular systems.
- Classify different types of propagation models and analyze the link budget.
- Illustrate the fundamentals and system architecture of GSM, 2.5G and IS-95.
- Apply the concepts of 3G technologies of UMTS and CDMA 2000.
- Elaborate the principles of 3GPP LTE.
- Identify the emerging technologies for upcoming mobile communication systems.

Module No.	Unit No.	Topics	Hrs.
1.0		Fundamentals of Mobile Communication	08
	1.1	Introduction to wireless communication: Mobile radio telephony, Examples of Wireless Communication Systems, Related design problems.	
	1.2	The Cellular Concept System Design Fundamentals: Frequency Reuse, Channel Assignment Strategies, Interference and System Capacity, Trunking and Grade of Service, Improving Coverage and Capacity in Cellular Systems	
2.0		Mobile Radio Propagation	08
	2.1	Large scale fading: Free space propagation model, the three basic propagation mechanisms, reflection, ground reflection (two-ray) model, diffraction, scattering, practical Link budget design using path loss models	
	2.2	Small scale fading: Small scale multipath propagation, parameters of mobile multipath channels, types of small-scale fading, Rayleigh and Ricean distributions.	
	2.3	Features of all conventional multiple access techniques: Frequency division multiple access(FDMA), time division multiple access(TDMA),space spectrum multiple access (SSMA), space division multiple access (SDMA),OFDM-PAPR,OFDMA	
3.0		2G Technologies	10
	3.1	GSM: GSM Network architecture, GSM signalling protocol architecture, identifiers used in GSM system, GSM channels, frame structure for GSM, GSM speech coding, authentication and security in GSM, GSM call procedures, GSM hand-off procedures, GSM services and features	
	3.2	GSM evolution: GPRS And EDGE- architecture, radio specifications, channels.	
	3.3	IS-95: Architecture of CDMA system, CDMA air interface, power control in CDMA system, power control, handoff, rake receiver	
4.0		3G Technology	06
	4.1	UMTS: Objectives, standardisation and releases, network architecture, air interface specifications, channels, security procedure, W-CDMA air interface, attributes of W-CDMA system, W-CDMA channels	
	4.2	Cdma2000 cellular technologies: Forward And Reverse Channels, Handoff And Power Control.	
5.0		3GPP LTE	08

	5.1	Introduction, system overview: Frequency bands and spectrum flexibility, network structure, protocol structure	
	5.2	Physical layer: Frames, slots, and symbols, modulation, coding, multiple-antenna techniques	
	5.3	Logical and Physical Channels: Mapping of data onto (logical) sub-channels.	
	5.4	Physical layer procedures: Establishing a connection, retransmissions and reliability, scheduling, power control, handover.	
6.0		Advanced techniques for 4G deployment	08
	6.1	Multi-antenna Techniques: Smart antennas, multiple input multiple output systems	
	6.2	Cognitive radio: Architecture, spectrum sensing	
	6.3	Relaying multi-hop and cooperative communications: Principles of relaying, fundamentals of relaying	
		Total	48

Text Books :

1. Theodore S. Rappaport “wireless communications - principles and practice”, PEARSON , Second edition.
2. T L Singal “wireless communications”, Mc Graw Hill Education.
3. Andreas F. Molisch “wireless communications” WILEY INDIA PVT LTD, Second edition.

References:

1. Upena Dalal “Wireless and Mobile Communications”, Oxford university Press.
2. Vijay K.Garg “Wireless Communications and Networking”,Morgan–Kaufmann series in Networking-Elsevier

E-Resources:

1. MIT Open Course ware : <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-452-principles-of-wireless-communications-spring-2006/>
2. NPTL: <http://nptel.ac.in/courses/117104099/>
3. Virtual Lab : <http://vlab.co.in/>

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC703	Optical Communication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2	Test 3						
ECC703	Optical Communication	20	20	20	80	--	--	--	100	

Prerequisites:

- Physics
- Electromagnetic wave propagation
- Electronics devices and circuits
- Principles of communication

Course objectives:

- List, write and explain fundamentals and transmission characteristics of optical fiber communication
- List, write and explain principles and characteristics of various sources ,detectors and various fiber optic components
- Calculate parameters for optical link budgeting and analyze the link

Course outcomes:

After successful completion of the course student will be able to

- List, write and explain fundamentals and transmission characteristics of optical fiber Communication.
- List, write and explain principles and characteristics of various sources ,detectors and various fiber optic components
- Calculate parameters for optical link budgeting and analyze the link

Module No.	Unit No.	Topics	Hrs.
1.0		Optical Fiber and their properties	10
	1.1	Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, Ray theory, cylindrical fiber (no derivations), single mode fiber, cutoff wave length, and mode field diameter. Wave guiding principles, Theory of optical wave propagation, Types and classification of optical fibers, loss and bandwidth	
2.0		Transmission Characteristics of Optical Fiber	12
	2.1	Attenuation, absorption, linear and nonlinear scattering losses, bending losses, modal dispersion, waveguide dispersion, dispersion and pulse broadening, dispersion shifted and dispersion flattened fibers. General Overview of nonlinearities , Stimulated Raman Scattering, Stimulated Brillouin Scattering , Self Phase modulation , Cross –Phase modulation , Four wave mixing and its mitigation , Solitons. Measurements of attenuation, dispersion and OTDR	
3.0		Optical Sources	06
	3.1	Working principle and characteristics of sources (LED, LASER), Tunable lasers Quantum well lasers , Charge capture in Quantum well lasers, Multi Quantum well Laser diodes, Surface Emitting Lasers: Vertical cavity Surface Emitting Lasers	
4.0		Optical Detectors	06
	4.1	Working principle and characteristics of detectors (PIN, APD), Material requirement for RCEPD ,Resonant cavity enhancement (RCE) Photo Detector ,Noise analysis in detectors, coherent and non-coherent detection, receiver structure, bit error rate of optical receivers, and receiver performance	
5.0		Fiber Optic Components	08
	5.1	Fiber fabrication (VAD,MCVD), fiber joints, fiber connectors, splices Couplers, multiplexers, filters, fiber gratings, Fabry Perot filters, switches and wavelength converters, Optical amplifiers, basic applications and types, semiconductor optical amplifiers, EDFA.	
6.0		Optical Link	06
	6.1	Introduction, Point to point links, system considerations, link power budget, and rise time budget. RF over fiber, key link parameters, Radio over fiber links, microwave photonics.	
		Total	48

Text Books :

1. Optical Fiber Communication – Gerd Keiser, 4th Ed., MGH, 2008.
2. Optical Fiber Communications– – John M. Senior, Pearson Education. 3rd Impression, 2007.

References:

1. Fiber optics communications-Harold Kolimberis
2. Introduction to optical fibers, Cheri, McGraw Hill.
3. An introduction to fiber optics, A. Ghatak and K.Thyagrajan, Cambridge Univ, press 10
4. Optical fiber communication and sensors-M. Arumugam Agencies, 20002 optic sensors.
5. Fiber optic communication– Joseph C Palais: 4th Edition, Pearson Education.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7031	Neural networks & Fuzzy Logic	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCDLO 7031	Neural networks & Fuzzy Logic	20	20	20	80	--	--	--	100	

Prerequisites:

- Numerical Methods
- Optimization Techniques

Course objectives:

- To introduce the concepts and understanding of artificial neural networks
- To provide adequate knowledge about supervised and unsupervised neural networks
- To introduce neural network design concepts
- To expose neural networks based methods to solve real world complex problems
- To teach about the concept of fuzziness involved in various systems and provide adequate knowledge about fuzzy set theory, and fuzzy logic
- To provide knowledge of fuzzy logic to design the real world fuzzy systems

Course outcomes:

After successful completion of the course student will be able to

- Comprehend the concepts of biological neurons and artificial neurons
- Analyze the feed-forward and feedback neural networks and their learning algorithms.
- Calculate Comprehend the neural network training and design concepts
- Analyze the application of neural networks to non linear real world problem
- Comprehend the concept of fuzziness involved in various systems, fuzzy set theory and fuzzy logic
- Apply fuzzy logic to real world problems.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Neural Networks and their basic concepts:	07
	1.1	Biological neurons and Artificial neuron, McCulloch-Pitts models of neuron, Types of activation functions and Neural Network architectures, Pre-requisites for training of neural networks. Linearly separable and linearly non-separable systems with examples, Features and advantages of Neural Networks over statistical techniques, Knowledge representation, Terminologies related to artificial neural networks, Concepts of Supervised learning, Unsupervised learning, Reinforcement	
2.0		Supervised Learning Neural Networks:	08
	2.1	Perceptron - Single Layer, Multilayer and their architecture, Error back propagation algorithm, Generalized delta rule, Concept of Training, Testing and Cross-validation data sets for design and validation of networks. Over-fitting. Stopping criterion for training.	
3.0		Unsupervised Learning Neural Networks:	09
	3.1	Competitive Learning Networks – Maxnet, Mexican Hat Net, Kohonen Self-Organizing Networks – architecture, training algorithm, K-means and LMS algorithms, Radial Basis Function (RBF) neural network – architecture and algorithm, and Discrete Hopfield networks. Introduction to the concept of Support Vector Machine based classifier.	
4.0		Applications of Neural Networks:	06
	4.1	Applications of Neural networks in pattern classification, Character Recognition, Face recognition, Image compression and Decompression	
5.0		Fuzzy logic:	12
	5.1	Introduction to fuzzy logic, Basic Fuzzy logic theory, Fuzzy sets - properties & operations, Fuzzy relation - Operations on fuzzy relations, Fuzzy Membership functions, Fuzzy Rules and Fuzzy Reasoning, Fuzzification and Defuzzification methods, Fuzzy Inference Systems, Mamdani Fuzzy Models, Fuzzy knowledge based controllers.	
6.0		Applications of Fuzzy Logic and Fuzzy Systems:	06
	6.1	Fuzzy pattern recognition, fuzzy image processing, Simple applications of Fuzzy knowledge based controllers like washing machines, home heating system, and train break control.	
		Total	48

Text Books :

1. S. N. Sivanandam and S. N. Deepa *Introduction to Soft computing*, Wiley India Publications
2. Timothy J. Ross, *Fuzzy Logic with Engineering Applications*, Wiley India Publications
3. John Yen and Reza Langari, *Fuzzy Logic- Intelligence, Control and Information*, Pearson Publications.
4. S. Rajasekaran and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic, and Genetic Algorithms*, PHI
5. Satish Kumar, *Neural Networks: A classroom Approach*, Tata McGraw-Hill.
6. Meherotra Kishan, Mohan C. K., Ranka Sanjay, *Elements of artificial neural networks*, Penram Publications

References:

1. Hagan, Demuth, and Beale, *Neural Network Design*, Thomson Learning
2. Simon Haykin, *Neural Network- A Comprehensive Foundation*, Pearson Education
3. Christopher M Bishop, *Neural Networks For Pattern Recognition*, Oxford University Press
4. William W Hsieh, *Machine Learning Methods in the Environmental Sciences Neural Network and Kernels*, Cambridge Publications
5. S. N. Sivanandam, S. Sumathi, and S. N. Deepa, *Introduction to Neural Network Using Matlab* Tata McGraw-Hill Publications
6. Bart Kosko, *Neural networks and Fuzzy Systems*, Pearson Education
7. J. S. R. Jang, C.T. Sun, and E. Mizutani, *Neuro-Fuzzy and Soft Computing*, PHI
8. J. M. Zurada, *Introduction to Artificial Neural Systems*, Jaico publishers

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7032	Big Data Analytics	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECCDLO 7032	Big Data Analytics	20	20	20	80	--	--	--	100	

Prerequisites:

- Data Base Management System

Course objectives:

- To Provide an Overview of an exciting growing field of Big Data Analytics.
- To introduce the tools required to manage and analyze big data like Hadoop, NoSql, Map Reduce.
- To teach the fundamental techniques in achieving big data analytics with scalability and streaming capability.

Course outcomes:

After successful completion of the course student will be able to

- Understand the key issues in big data management.
- Acquire fundamental enabling techniques using tools in big data analytics.
- Achieve adequate perspectives of big data analytics in various applications like sensor, recommender systems, social media applications etc.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Big Data Analytics	06
	1.1	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach.	
	1.2	Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions.	
2.0		Hadoop	06
	2.1	Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem, Physical Architecture, Hadoop limitations.	
3.0		NoSQL	08
	3.1	Introduction to NoSQL, NoSQL business drivers, NoSQL case studies.	
	3.2	NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns.	
	3.3	Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems	
4.0		MapReduce	08
	4.1	MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization.	
		MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.	
		Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations by MapReduce, Matrix Operations, Matrix Multiplication by MapReduce.	
5.0		Techniques in Big Data Analytics	12
	5.1	Finding Similar Item: Nearest Neighbor Search, Similarity of Documents	
	5.2	Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis	
	5.3	Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce	
	5.4	Frequent Itemset Mining : Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu	
6.0		Big Data Analytics Applications	08

	6.1	Recommendation Systems: Introduction, A Model for Recommendation Systems, Collaborative-Filtering System: Nearest-Neighbor Technique, Example.	
	6.2	Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Network. Clustering of Social Graphs: Applying Standard Clustering Techniques, Counting triangles using MapReduce.	
		Total	48

Text Books :

1. Radha Shankarmani and M Vijayalakshmi “Big Data Analytics”, Wiley
2. Alex Holmes “Hadoop in Practice”, Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly “Making Sense of NoSQL” – A guide for managers and the rest of us, Manning Press.

References:

1. Bill Franks , “Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics”, Wiley
2. Chuck Lam, “Hadoop in Action”, Dreamtech Press

Internal Assessment:

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End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7033	Internet Communication Engineering	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCDLO 7033	Internet Communication Engineering	20	20	20	80	--	--	--	100	

Prerequisites:

- Analog communication
- Digital Communication
- Computer Communication and Networks

Course objectives:

- To focus on Internet protocol, standards, services and administration.
- To discuss the Internet security protocol and security services
- To discuss multimedia communication standards and compression techniques
- To discuss the Multimedia communication across the networks

Course outcomes:

After successful completion of the course student will be able to

- Explain the operation of the components of a router including, DHCP, NAT/PAT, Routing function, Switching function.
- Describe how DNS works in the global Internet including caching and root servers.
- Understand the current state-of-the-art developments in Internet technologies for multimedia communications.
- Understand the security protocol and services In the Internet
- Appreciate the principles used in designing multimedia protocols, and so understand why standard protocols are designed the way that they are.
- Understand the system design principles of multimedia communications systems.
- Solve problems and design simple networked multimedia systems.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Internet	06
	1.1	What is the Internet, ,Evolution of the Internet, Brief History and Growth of Internet , service description, Network protocol, the network edge	
	1.2	Overview of TCP/IP, layer functions,	
	1.3	Application Layer- Host configuration, DHCP Domain Name System (DNS),Multicast DNS	
	1.4	Remote Login, TELNET and SSH , HTTPs, electronic mail	
2.0		Transport Layer	10
	2.1	Properties of reliable stream delivery, Overview of TCP segment, TCP connection	
	2.2	Flow control, error control, congestion control	
	2.3	User datagram protocol(UDP) header, pseudo header	
	2.4	SCTP, introduction, Packet format ,	
	2.5	Flow control, error control, congestion control	
3.0		Internetworking layer	08
	3.1	Overview of Internet protocol (IP) datagram, IP address classes, subnets and supernets	
	3.2	Private IP addresses, classless inter domain routing (CIDR), CIDR subnet addressing, variable length in CIDR subnet addressing, ICMP	
	3.3	Internet Protocol version 6 (IPv6), Packet format, Transition from IPv4 to IPv6, ICMPv6	
4.0		Internet Security	06
	4.1	Network layer security(AH, ESP, IPsec),	
	4.2	Transport layer security(SSL), Application layer security(secure Email-PGP, S/MIME),	
	4.3	VPN Firewall, Intrusion Detection System.	
5.0		Multimedia Communications	10
	5.1	Information Representation- text, images, audio and video, Text and image compression, Audio and video compression, video	
	5.2	compression standards: H.261, H.263, P1.323, MPEG 1, MPEG 2, Other coding formats for text, speech, image and video	
	5.3	Multimedia Communication Across Networks- Layered video coding, error resilient video coding techniques,	

	5.4	multimedia transport across IP networks and relevant protocols such as RSVP, RTP, RTCP, DVMP, Signalling Protocols: Real-Time Streaming Protocol (RTSP) ,Multimedia across wireless- (Mobiles Networks – Broadcasting Networks – Digital Television infrastructure for interactive multimedia services)	
6.0		Quality of Services (QoS)	08
	6.1	Integrated services (intserv): Architecture and Service Model, Resource Reservation Protocol (RSVP), Packet Scheduling Disciplines in the Internet	
	6.2	Differentiated Services (diffserv): Framework and Concept, Assured and Expedited Services, Packet Classification, Routers Internals and Packet Dropping Techniques	
		Total	48

Text Books :

1. B. Forouzan, —*TCP/IP Protocol Suite*, 4th Edition, McGraw-Hill Publication
2. K. R. Rao, Zaron S. Bojkovic, Dragorad A. Milocanovic, *Multimedia Communication Systems*, Prentice Hall India, 2002. ISBN: 81-203-2145-6.

References:

1. Steve Heath, *Multimedia and Communication Technology*, Second Edition, Focal Press, 2003.
2. ISBN: 81-8147-145-8. Ted Wallingford, —*Switching to VoIP*, O'Reilly Publication
3. Fred Halsall, “*Multimedia Communications*”, Pearson education, 2001
4. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, “*Multimedia Communication Systems*”, Pearson education, 2004
5. Raif steinmetz, Klara Nahrstedt, “*Multimedia: Computing, Communications and Applications*”, Pearson education, 2002
6. Tay Vaughan, “*Multimedia: Making it Work*”, 6th edition, Tata McGraw Hill, 2004
7. Pallapa Venkataram, “*Multimedia information systems*”, Pearson education (InPress),2005.
8. *Multimedia Communication Techniques and Standards*

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7034	CMOS Mixed Signal VLSI	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCDLO 7034	CMOS Mixed Signal VLSI	20	20	20	80	--	--	--	100	

Prerequisites:

- Electronic Devices and Circuits I
- Electronic Devices and Circuits II
- Linear Integrated Circuits
- Microelectronics
- Digital VLSI

Course objectives:

- Importance of CMOS and Mixed Signal VLSI design in the field of Electronics and Telecommunication.
- Underlying methodologies for analysis and design of fundamental CMOS Mixed signal Circuits like Data Converters.
- The issues associated with high performance Mixed Signal VLSI Circuits

Course outcomes:

After successful completion of the course student will be able to

- Analyze and design single stage MOS Amplifiers.
- Analyze and design Operational Amplifiers.
- Analyze and design data converter circuits.
- Identify design requirements of analog and mixed signal circuits
- Analyze and design CMOS based switched capacitor circuits
- Understand Oscillators and Phase Locked Loops.

Module No.	Unit No.	Topics	Hrs.
1.0		Fundamentals of MOS Amplifiers	10
	1.1	MOS Single-stage Amplifiers: Basic concepts of common source stage, source follower, common gate stage, Differential Amplifiers:	
	1.2	Current mirrors: Basic current mirror, cascode current mirror, active current mirror, Wilson and Widlar current mirrors, voltage and current references.	
2.0		Design of MOS operational amplifier	08
	2.1	General considerations, One-Stage Op amps, Two-Stage Op amps, Gain Boosting, Input Range Limitation.	
	2.2	Frequency Response and Compensation, Slew Rate.	
3.0		Oscillators and Phase Locked Loops	08
	3.1	General Considerations, Ring Oscillators, LC Oscillators, Voltage Controlled Oscillators (VCO), tuning range, tuning linearity Mathematical Model of VCO.	
	3.2	Simple PLL-phase detector, Charge-pump PLL's, Non ideal effects in PLL, Delay locked Loops, applications of PLL.	
4.0		Switched Capacitor circuits	06
	4.1	Theory of sampled data systems, Basic sampling circuits for analog signal sampling, performance metrics of sampling circuits, design and analysis of switched capacitor circuits.	
	4.2	Switched capacitor amplifiers (SC), switched capacitor integrators, first and second order switched capacitor circuits.	
5.0		Data converters	06
	5.1	Analog versus digital discrete time signals, converting analog signals to data signals, sample and hold characteristics. DAC specifications, ADC specifications.	
	5.2	Mixed signal Layout issues, Floor planning, power supply and Ground issues, other interconnect Considerations.	
6.0		Data Converter Architectures	10
	6.1	DAC architectures: R-2R ladder networks, current steering, charge scaling DACs, Cyclic DAC, pipeline DAC, Switched capacitor based DAC design.	
	6.2	ADC architectures: flash, 2-step flash ADC, pipeline ADC, integrating ADC, and successive approximation ADC, Switched capacitor based ADC design	
		Total	48

Text Books :

1. Razavi, "Design of analog CMOS integrated circuits", McGraw Hill, Edition 2002.
2. Jacob Baker, "CMOS Mixed-Signal circuit design", IEEE Press, 2009.
3. P. E. Allen and D R Holberg, "*CMOS Analog Circuit Design*", second edition, Oxford University Press, 2002.
4. Baker, Li, Boyce, "CMOS: Circuit Design, layout and Simulation", PHI, 2000.
5. Sedra/Smith, "Microelectronic Circuits", Oxford University Press.

Internal Assessment:

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End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7035	Embedded Systems	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCDLO 7035	Embedded Systems	20	20	20	80	--	--	--	100	

Course objectives:

- To develop background knowledge Embedded Systems.
- To understand communication techniques.
- To write programs for embedded systems and real time operating systems

Course outcomes:

After successful completion of the course student will be able to

- Understand the detailed processor design techniques and methods of communication.
- Study the in-depth program modelling concepts.
- Study the concepts of Real time operating systems and write programs
- Design embedded system applications using RTOS

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction:-	08
	1.1	Definition of Embedded System, Embedded Systems Vs General Computing Systems, Classification, Major Application Areas	
	1.2	Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency. Embedded Product development life cycle	
	1.3	Program modeling concepts: DFG, FSM, Petri-net, UML	
2.0		Processor	08
	2.1	Overview of Custom Single-Purpose Processors, General-Purpose Processors,	
	2.2	Parallel Port example, Standard Single-Purpose Processors	
	2.3	RISC and CISC architectures	
	2.4	GCD example	
3.0		Communication	06
	3.1	CAN bus, I2C, MOD bus, SPI,	
	3.2	Examples on Parallel Communication, Serial Communication, Wireless Communication	
4.0		Real Time Operating Systems[RTOS]	07
	4.1	Operating system basics	
	4.2	Types of OS	
	4.3	Tasks, process,Threads	
	4.4	Multiprocessing and ,Multitasking	
	4.5	Task scheduling	
	4.6	Threads, Process , Scheduling :- Putting them all together	
5.0			07
	5.1	Task communications,	
	5.2	Task synchronization	
	5.3	Device drivers	
	5.4	How to choose RTOS	
	5.5	Examples of RTOS	
6.0		Design examples and case studies of program model and programming with RTOS	12
	6.1	Digital Camera:-Introduction to simple digital camera, Requirements and specifications, Design using Microcontroller and Microcontroller and CCDPP	
	6.2	Automatic Chocolate Vending Machine	
	6.3	Adaptive Cruise Control in car	
		Total	48

Text Books :

1. Frank Vahid, and Tony Givargis, “Embedded System Design: A unified Hardware/Software Introduction”, Wiley Publication.
2. Raj Kamal,” Embedded Systems Architecture, Programming and design”, Tata MCgraw-Hill Publication.
3. Iyer, Gupta,” Embedded real systems Programming”, TMH
4. David Simon, “Embedded systems software primer’, Pearson
5. Shibu K.V,” Introduction to Embedded Systems”, Mc Graw Hill, 2nd edition.
6. K.V.K.K. Prasad, “Embedded Real Time Systems: Concepts, Design & Programming”, Dreamtech Publication.

Internal Assessment:

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End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7011	Product Lifecycle Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 7011	Product Lifecycle Management	20	20	20	80	--	--	--	100	

Course objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Course outcomes:

After successful completion of the course student will be able to

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Product Lifecycle Management (PLM)	10
	1.1	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications	
	1.2	PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	
2.0		Product Design	09
	2.1	Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
3.0		Product data Management	05
	3.1	Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	
4.0		Virtual Product Development Tools	05
	4.1	For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
5.0		Integration of Environmental Aspects in product Design	05
	5.1	Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
6.0		Life Cycle Assessment and Life Cycle Cost Analysis	05

	6.1	Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	
		Total	39

References :

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Internal Assessment:

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End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
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3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7012	Reliability Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 7012	Reliability Engineering	20	20	20	80	--	--	--	100	

Course objectives:

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Course outcomes:

After successful completion of the course student will be able to

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Module No.	Unit No.	Topics	Hrs.
1.0		Probability Theory	08
	1.1	Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	
2.0			08
	2.1	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	
3.0		System Reliability	05
	3.1	System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	
4.0		Reliability Improvement	08
	4.1	Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	
5.0		Maintainability and Availability	05
	5.1	System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
6.0		Failure Mode, Effects and Criticality Analysis	05
	6.1	Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	
		Total	39

References :

1. L. S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.

2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B. S. Dhillon, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Internal Assessment:

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2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCIO 7013	Management Information System	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCIO 7013	Management Information System	20	20	20	80	--	--	--	100	

Course objectives:

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Course outcomes:

After successful completion of the course student will be able to

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction To Information Systems (IS)	04
	1.1	Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	
2.0		Data and Knowledge Management	07
	2.1	Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	
3.0		Ethical issues and Privacy	07
	3.1	Information Security. Threat to IS, and Security Controls	
4.0		Social Computing (SC)	07
	4.1	Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	
5.0			06
	5.1	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	
6.0		Information System within Organization	08
	6.1	Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	
		Total	39

References :

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K. C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7014	Design of experiments	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 7014	Design of experiments	20	20	20	80	--	--	--	100	

Course objectives:

- To understand the issues and principles of Design of Experiments (DOE)
- To list the guidelines for designing experiments
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Course outcomes:

After successful completion of the course student will be able to

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action
- Apply the methods taught to real life situations
- Plan, analyze, and interpret the results of experiments

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction	06
	1.1	Strategy of Experimentation	
	1.2	Typical Applications of Experimental Design	
	1.3	Guidelines for Designing Experiments	
	1.4	Response Surface Methodology	
2.0		Fitting Regression Models	08
	2.1	Linear Regression Models	
	2.2	Estimation of the Parameters in Linear Regression Models	
	2.3	Hypothesis Testing in Multiple Regression	
	2.4	Confidence Intervals in Multiple Regression	
	2.5	Prediction of new response observation	
	2.6	Regression model diagnostics	
	2.7	Testing for lack of fit	
3.0		Two-Level Factorial Designs	07
	3.1	The 2^2 Design	
	3.2	The 2^3 Design	
	3.3	The General 2^k Design	
	3.4	A Single Replicate of the 2^k Design	
	3.5	The Addition of Center Points to the 2^k Design,	
	3.6	Blocking in the 2^k Factorial Design	
	3.7	Split-Plot Designs	
4.0		Two-Level Fractional Factorial Designs	07
	4.1	The One-Half Fraction of the 2^k Design	
	4.2	The One-Quarter Fraction of the 2^k Design	
	4.3	The General 2^{k-p} Fractional Factorial Design	
	4.4	Resolution III Designs	
	4.5	Resolution IV and V Designs	
	4.6	Fractional Factorial Split-Plot Designs	
5.0		Response Surface Methods and Designs	07
	5.1	Introduction to Response Surface Methodology	
	5.2	The Method of Steepest Ascent	
	5.3	Analysis of a Second-Order Response Surface	
	5.4	Experimental Designs for Fitting Response Surfaces	
6.0		Taguchi Approach	04
	6.1	Crossed Array Designs and Signal-to-Noise Ratios	
	6.2	Analysis Methods	
	6.3	Robust design examples	
		Total	39

References :

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7015	Operations Research	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 7015	Operations Research	20	20	20	80	--	--	--	100	

Course objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models

Course outcomes:

After successful completion of the course student will be able to

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Understand the applications of integer programming and a queuing model and compute important performance measures

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Operations Research	14
	1.1	Introduction, , Structure of the Mathematical Model, Limitations of Operations Research	
	1.2	Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method,	
	1.3	Duality , Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis	
	1.4	Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel’s approximation method. Optimality test: the stepping stone method and MODI method.	
	1.5	Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	
	1.6	Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory’s cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
2.0		Queuing Models	05
	2.1	Queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	
3.0		Simulation	05
	3.1	Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	
4.0		Dynamic programming	05
	4.1	Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	
5.0		Game Theory	05

	5.1	Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	
6.0		Inventory Models	05
	6.1	Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	
		Total	39

References :

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7016	Cyber Security and Laws	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 7016	Cyber Security and Laws	20	20	20	80	--	--	--	100	

Course objectives:

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Course outcomes:

After successful completion of the course student will be able to

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Cybercrime	04
	1.1	Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the	
2.0		Cyber Offenses & Cybercrime	09
	2.1	How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	
3.0		Tools and Methods Used in Cyberline	06
	3.1	Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	
4.0		The Concept of Cyberspace	08
	4.1	E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
5.0		Indian IT Act	06
	5.1	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	
6.0		Information Security Standard compliances	06
	6.1	SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	
		Total	39

References :

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai

5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008-TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional
<https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7017	Disaster Management and Mitigation Measures	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECCILO 7017	Disaster Management and Mitigation Measures	20	20	20	80	--	--	--	100	

Course objectives:

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Course outcomes:

After successful completion of the course student will be able to

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction	03
	1.1	Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change	
2.0		Natural Disaster and Manmade disasters	09
	2.1	Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion	
	2.2	Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters	
3.0		Disaster Management, Policy and Administration	06
	3.1	Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management	
	3.2	Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
4.0		Institutional Framework for Disaster Management in India	06
	4.1	Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.	
		Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	
5.0		Financing Relief Measures	09
	5.1	Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.	
	5.2	International relief aid agencies and their role in extreme events	
6.0		Preventive and Mitigation Measures	06

	6.1	Pre-disaster, during disaster and post-disaster measures in some events in general	
	6.2	Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication	
	6.3	Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans	
	6.4	Do's and don'ts in case of disasters and effective implementation of relief aids.	
		Total	39

References :

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7018	Energy Audit and Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 7018	Energy Audit and Management	20	20	20	80	--	--	--	100	

Course objectives:

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Course outcomes:

After successful completion of the course student will be able to

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Module No.	Unit No.	Topics	Hrs.
1.0		Energy Scenario	04
	1.2	Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	
2.0		Energy Audit Principles	08
	2.1	Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Benchmarking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring & targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	
3.0		Energy Management and Energy Conservation in Electrical System	10
	3.1	Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
4.0		Energy Management and Energy Conservation in Thermal Systems	10
	4.1	Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	
5.0		Energy Performance Assessment	04
	5.1	On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	
6.0		Energy conservation in Buildings	03

	6.1	Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	
		Total	39

References :

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Internal Assessment:

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End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 7019	Development Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 7019	Development Engineering	20	20	20	80	--	--	--	100	

Course objectives:

- To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
- To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
- An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
- To understand the Nature and Type of Human Values relevant to Planning Institutions

Course outcomes:

After successful completion of the course student will be able to

- Apply knowledge for Rural Development.
- Apply knowledge for Management Issues.
- Apply knowledge for Initiatives and Strategies
- Develop acumen for higher education and research.
- Master the art of working in group of different nature.
- Develop confidence to take up rural project activities independently

Module No.	Unit No.	Topics	Hrs.
1.0			08
	1.1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	
2.0			04
	2.1	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	
3.0			06
	3.1	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
4.0			04
	4.1	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	
5.0			10

	5.1	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	
6.0			04
	6.1	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	
		Total	36

References :

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL701	Microwave Engineering Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECL701	Microwave Engineering Laboratory	--	--	--	--	25	25	--	50	

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL702	Mobile Communication System Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL702	Mobile Communication System Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

- To observe the effect of velocity and direction of arrival of a vehicle on Doppler frequency
- To observe the effect of N on C/I ratio and comment on the voice quality
- To observe the effect of incidence angle on reflection coefficient using MATLAB
- To observe the effect of different propagation models on coverage distance
- To observe the effect of C/I ratio in a sectorised cell site and perform worst case analysis for different values of N and degree of sectorisation
 - A) Worst case C/I in a 3 sector cellular system for K=7
 - B) Worst case C/I in a 3-sector cellular system for K=4
 - C) Worst case C/I in a 6 sector cellular system for K=7
 - D) Worst case C/I in a 6 sector cellular system for K=4
- To generate Pseudo noise code used in a CDMA system
- To generate Walsh Codes using Hadamard Matrix.
- To plot Knife edge diffraction gain as a function of Fresnel diffraction parameter
- To plot channel capacity versus SNR for different MIMO systems
- Simulation of OFDMA system
- Simulation of spectrum sensing using energy detection method in cognitive radio

List of Mini projects:

Note: These are few examples of mini projects; teachers may prepare their own list.

1. Developing automated Notification based System using GSM

2. Mobile Communication Based App development
3. Creating Virtual Lab Experiments.

Software Tools:

1. Ns-2: <http://www.isi.edu/nsnam/ns/>
2. Virtual Lab : <http://vlab.co.in/>
3. Scilab Experiments Book:
http://www.scilab.in/textbook_companion/generate_book/2081

Online Repository Sites:

1. Google Drive
2. GitHub
3. Code Guru

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL703	Optical Communication Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL703	Optical Communication Laboratory	--	--	--	--	25	25	--	50

Suggested Experiment List

- Calculation of Numerical aperture
- Calculation of dispersion for given fiber
- Calculation of link Loss for given link
- Performance analysis of Single mode fiber
- Performance Analysis of Optical Link with Different Sources
- Performance Analysis of Optical Link with Different Detectors
- Performance Analysis of Optical Amplifier
- Calculation of link Loss for given link with nonlinearities

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 7031	Neural networks & Fuzzy Logic Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECLDLO 7031	Neural networks & Fuzzy Logic Laboratory	--	--	--	--	25	25	--	50	

Suggested List of Experiments

- Write a program for implementing perceptron based linear functions AND and OR function. Conclude about the noise tolerance of the function.
- Write a program for implementing optimal neural network based XOR functions. Conclude about the noise tolerance of the function
- Write a program for training and testing of Multilayer Perceptron for pattern classification application
- Write a program for training and testing of Multilayer Perceptron for interpolation application
- Program for Support vector Machine based classifiers and compare result with that of Multilayer Perceptron based neural network classification
- Program for application of Multilayer perceptron for character recognition
- Program to develop Fuzzy Inference System for Speed control of DC motor
- Program for fuzzy logic based train brake control with suitable input variable assumptions
- Program to develop Fuzzy Inference System for fuzzy control of washing machines

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project

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can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 7032	Big Data Analytics Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECLDLO 7032	Big Data Analytics Laboratory	--	--	--	--	25	25	--	50	

Suggested Experiment List

- Study of Hadoop ecosystem
- Programming exercises on Hadoop
- Programming exercises in No SQL
- Implementing simple algorithms in Map- Reduce - Matrix multiplication, Aggregates.

List of Mini project

1. Design and implementation of any case study/ applications based on standard Datasets available on the web
 - a. Twitter data analysis
 - b. Fraud Detection
 - c. Text Mining etc. using modern tools.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades

will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 7033	Internet Communication Engineering Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECLDLO 7033	Internet Communication Engineering Laboratory	--	--	--	--	25	25	--	50	

Suggested Experiment List

- Simulation study on congestion control
- Multimedia networking
- Multimedia streaming
- Assignments / Practicals can be given on writing the programs to encode and decode the various kinds of data by using the algorithms. Students can collect several papers from journals/conferences/Internet on a specific area of Internet and multimedia communications and write a review paper and make a presentation.
- Form small groups to complete projects in audio, image and video coding. The use of C/C++ is encouraged
- Conduct network simulations using OPNET and protocol analysis using Wireshark.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECLDLO 7034	CMOS Mixed Signal VLSI Laboratory	--	--	02	--	--	01	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECLDLO 7034	CMOS Mixed Signal VLSI Laboratory	--	--	--	--	25	25	--	50	

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 7035	Embedded System Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECLDLO 7035	Embedded System Laboratory	--	--	--	--	25	25	--	50	

Suggested Experiment List

- Interfacing of I2C,CAN,SPI,zigbee etc with ARM
- Simulation of multitasking using RTOS
- Simulation of mutex using RTOS
- Simulation of mailboxes using RTOS
- Interprocess communication using semaphore in RTOS
- Simulation of message queues using RTOS

Minimum One project based on any application related to RTOS and embedded system can be implemented.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL704	Project Stage-I	--	06	--	--	3	--	3

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL704	Project Stage-I	--	--	--	--	50	50	--	100

Objective: The Project work enables the students to develop the required skills and knowledge gained during the programme by applying them for the analysis of a specific problem or issue, via a substantial piece of work which is carried out over an extended period. It also enables the students to demonstrate the proficiency in the design of a research project, application of appropriate research methods, collection and analysis of data and presentation of results.

Guidelines:

1. Project Topic:

- To proceed with the project work it is very important to select a right topic. Project can be undertaken on any domain of electronics and telecommunication programme. Research and development projects on problems of practical and theoretical interest should be encouraged.
- Project work must be carried out by the group of at least two students and maximum four and must be original.
- Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements.
- The project work can be undertaken in a research institute or organization/company/any business establishment.
- Student must consult internal guide along with external guide (if any) in selection of topic.
- Head of department and senior staff in the department will take decision regarding selection of projects.
- Student has to submit weekly progress report to the internal guide and whereas internal guide has to keep track on the progress of the project and also has to maintain attendance report. This progress report can be used for awarding the term work marks.

- In case of industry projects, visit by internal guide will be preferred.

2. **Project Report Format:**

At the end of semester a project report should preferably contain at least following details:-

- Abstract
- Introduction
- Literature Survey
 - a) Survey Existing system
 - b) Limitation of the Existing system or research gap
 - c) Problem Statement and Objective
 - d) Scope
- Proposed System
 - a) Analysis/Framework/ Algorithm
 - b) Details of Hardware & Software
 - c) Design details
 - d) Methodology (your approach to solve the problem)
- Implementation Plan for next semester
- Conclusion
- References

3. **Term Work:**

Distribution of marks for term work shall be as follows:

- a) Weekly Attendance on Project Day
- b) Contribution in the Project work
- c) Project Report (Spiral Bound)
- d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. **Oral & Practical :**

Oral & Practical examination of Project-I should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project- I.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC801	RF Design	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC801	RF Design	20	20	20	80	--	--	--	100	

Prerequisites:

- Electromagnetic Engineering
- Antenna & Radio Wave Propagation
- Communication Engineering
- Microwave Engineering

Course objectives:

- To learn RF circuit fundamentals for designing various circuit building blocks in a typical RF transceiver
- To learn importance of EMI/EMC

Course outcomes:

After successful completion of the course student will be able to

- Design impedance matching networks and passive RF filters.
- Design and appraise RF amplifiers and oscillators.
- Analyze EMI and EMC in RF circuits.

Module No.	Unit No.	Topics	Hrs.
1.0		RF Filter Design	10
	1.1	Image parameter method	
	1.2	Insertion loss method- Maximally flat low pass prototype, Equal ripple low pass prototype, Filter transformation and filter implementation	
2.0		Amplifier Design	08
	2.1	Two-port power gain stability	
	2.2	Single stage amplifier design: Design for maximum gain, design for specified gain, low noise amplifier design	
	2.3	Power amplifier design.: Characteristics of power amplifier and classes of amplifiers, design of class A power amplifier	
3.0		Frequency Generation & Mixer	08
	3.1	One-port and two-port microwave oscillator design.	
	3.2	Analysis of phase noise in oscillators.	
	3.3	Mixers: Characteristics, Various types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, Image reject mixers and other types of mixers.	
4.0		Frequency Synthesizers	06
	4.1	Direct Frequency Synthesis, Frequency Synthesis by Phase Lock, Effects of Reference Frequency on Loop Performance,	
	4.2	Variable-Modulus Dividers, Down Conversion, Methods for Reducing Switching Time, Direct Digital Synthesis, Synthesizer Design .	
	4.3	Phase Noise: A Model for Oscillator Phase Noise, Phase Noise in Phase-Locked Loops, Effect of Frequency Division and Multiplication on Phase Noise.	
5.0		Electromagnetic Interference in RF circuits	08
	5.1	Introduction. Natural and Nuclear Sources of EMI, EMI From Apparatus and Circuits. Quantification Of Communication System EMI	
	5.2	Elements Of Interference, Including Antennas, Transmitters, Receivers And Propagation. Electronic Equipment And System EMI Concepts. Examples Of EMI Coupling Modes	
	5.3	Equipment Emissions And Susceptibilities- Types of coupling: Common-Mode Coupling: Common-Mode Coupling Mechanisms Including Field To Cable, Ground Impedance, Ground Loop And Coupling Reduction Techniques Differential-Mode Coupling : Differential-Mode Coupling Mechanisms Including Field To Cable, Cable To Cable And Coupling Reduction Techniques.	
	5.4	Other Coupling mechanisms: Power Supplies And Victim Amplifiers	

6.0		Electromagnetic Compatibility	08
	6.1	The Importance Of Grounding For Achieving EMC. Grounding, Including The Reasons (I.E., Safety, Lightning Control, EMC, Grounding Schemes (Single Point, Multi-Point And Hybrid), Shield Grounding And Bonding. Shielding Effectiveness, Shielding Considerations (Reflective And Absorptive), Shielding Compromises (I.E., Apertures, Gaskets, Waveguide Beyond Cut-Off)	
	6.2	EMI Diagnostics And Fixes: Techniques Used In EMI Diagnostics And Fixes	
	6.3	EMC Specifications, Standards And Measurements. A Discussion Of The Genesis Of EMC Documentation Including A Historical Summary, The Rationale, And A Review Of MIL-Stds, FCC And CISPR Requirements.	
		Total	48

Text Books

1. David M Pozar, Microwave Engineering, John Wiley and Sons, 2005
2. Ludwig R. and Bogdanov G, RF Circuit Design, Prentice Hall, 2007.
3. Jack Smith, Modern Communication circuits, Tata McgrawHill.
4. W. Prasad Kodali, Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models, 2nd Edition, ISBN: 978-0-7803-4743-4, January 2001, Wiley-IEEE Press
5. David. A. Weston, Electromagnetic Compatibility-principles and applications, Second Edition, Publisher: Marcel Dekker, Inc. 2001, ISBN 0-8247-8889-3

References:

1. Guillermo Gonzalez, 'Microwave Transistor Amplifiers Analysis and Design', Prentice Hall, 2nd Edition.
2. Devendra Misra, 'Radio Frequency and Microwave Communication Circuits-Analysis and Design', John Wiley & Sons, 2nd Edition.
3. Clayton R. Paul, 'Electromagnetic Compatibility', John Wiley & Sons, 2nd Edition.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC802	Wireless Networks	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECC802	Wireless Networks	20	20	20	80	--	--	--	100	

Prerequisites:

- Mobile Communication

Course objectives:

- Introduction to wireless Body Networks and study emerging technologies like Bluetooth and Zigbee
- To study Wireless LAN, PAN & MAN.
- Understanding Ultra Wideband communication.
- Introduction to Femtocells

Course outcomes:

After successful completion of the course student will be able to

- Explain the working of different wireless technologies like bluetooth and zigbee.
- Understand the working of wireless LAN, PAN & MAN
- Analyze the different types of Wireless Networks like LAN,PAN & MAN
- Comprehend the working of Femtocells.

Module No.	Unit No.	Topics	Hrs.
1.0		Wireless Body Area Networks	12
	1.1	Introduction to WBAN, Network Architecture, Network Components	
	1.2	Network Protocol: Physical Layer, Data Link layer, Media Access Control (MAC) Layer, Network Layer	
	1.3	WBAN Technologies: Bluetooth: Concept of Piconet, Scatternet, Protocol Stack Connection establishment Zigbee: Components, Protocol Stack, Architecture & Network Topologies	
2.0		Wireless LAN	10
	2.1	Introduction to wireless LAN, Transmission Techniques	
	2.2	Medium Access Control Protocol Issues: Hidden Terminal Problem, Reliability, Collision Avoidance, Congestion Avoidance, Congestion Control, Energy Efficiency	
	2.3	IEEE 802.11 Standard for Wireless LAN: Network Architecture, Physical Layer, MAC Layer, Security, System design and considerations	
	2.4	Enhancements to IEEE 802.11 MAC: Power Control, Spatial Reusability & QoS Provisioning	
3.0		Wireless PAN	08
	3.1	Introduction to wireless PAN, Need of Wireless PAN	
	3.2	Bluetooth Technology: History & Applications, Technical Overview, Bluetooth Specifications, Piconet Synchronization, master-slave switch, Bluetooth security.	
	3.3	Enhancements to Bluetooth: Bluetooth Interface issues, Intra & Inter Piconet Scheduling, Scatternet Formation, QoS Assignment	
	3.4	IEEE 802.15 Working group for WPAN, IEEE 802.15.3 & IEEE 802.15.4	
	3.5	Comparison between WPAN System & Comparison between WLAN & WPAN	
4.0		Wireless MAN	08
	4.1	Introduction to Wireless Metropolitan Area Networks, IEEE 802.16 Standards Advantages of IEEE 802.16	
	4.2	WMAN Network Architecture: Network Components, features of WiMAX, WiMAX Mobility Support	
	4.3	Network Protocols : Physical Layer, MAC Layer	
		WMAN Applications: Banking Networks, Educational Networks, Public Safety	
5.0		Ultra wideband Communication	06
	5.1	Introduction, UWB indoor channel, UWB capacity	

	5.2	Pulsed UWB: Pulse shape, Modulation & Multiple access techniques, Pulsed UWB transceivers,	
	5.3	Multiband UWB: Modulation of pulsed multiband UWB, MB-OFDM UWB	
6.0		Femtocells	04
	6.1	Introduction to Femtocell, Femtocell Attributes, Femtocell Standards,	
	6.2	Concept of Femtocells, Types of Femtocells	
	6.3	Applications of Femtocells.	
		Total	

Text Books & References :

1. Carlos de Morais Cordeiro, Dharma Prakash Agrawal, “AD HOC & Sensor Networks – Theory & Applications ”, Cambridge University Press India Pvt. Ltd.
2. KE- LIN DU & M. N. S. Swamy, “Wireless Communication Systems”, Cambridge University Press India Pvt. Ltd.
3. D. E. Comer, “Femtocells- Opportunity & Challenges for Business & Technology”, Wiley Publications.
4. Dr. Sunilkumar S. Manvi, Mahabaleshwar S. kakkasageri, “Wireless & Mobile Networks: Concepts and Protocols”.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8041	Optical Networks	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECCDLO 8041	Optical Networks	20	20	20	80	--	--	--	100	

Prerequisites:

- Principles of Communication Engineering
- Digital Communication
- Antenna Wave Propagation
- Optical Communication

Course objectives:

- The issues related to signal degradation due to linear impairment
- High data rate WDM optical transport networks
- Link budget and optical networks, design and management.

Course outcomes:

After successful completion of the course student will be able to

- Identify the issues related to signal degradation and multiplexing.
- Explore concepts of designing and operating principles of modern optical communication systems and networks.
- Apply the knowledge developed in-class to contemporary optical fiber communication research and industrial areas.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Optical Components and Networks	06
	1.1	OPTICAL Components - Couplers, Isolators and Circulators, Multiplexes and Filters Optical Amplifiers. Transmitters, Detectors, Switches, Wavelength Converters	
	1.2	OPTICAL Networks - Telecommunication networks, First generation optical networks, Multiplexing techniques, Second generation optical networks, System and network evolution	
2.0		Optical Networks Architecture	08
	2.1	SONET/SDH, Computer interconnects, MANS, Layered architecture for SONET and second generation networks.	
	2.2	Broadcast and Select Networks – Topologies for Broadcast Networks, Media-Access Control Protocols,	
	2.3	Operational principle of WDM, WDM network elements and Architectures, Introduction to DWDM, Solitons	
3.0		Packet Switching and Access Networks	08
	3.1	Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing,	
	3.2	Synchronization, Broadcast OTDM networks, Switch-based networks	
	3.3	Access Networks – Network Architecture overview, Future Access Networks,	
	3.4	Optical Access Networks Architectures; and OTDM networks	
4.0		Wavelength Routing Networks	10
	4.1	Optical layer, Node design, Network design and operation, routing and wavelength assignment architectural variations	
	4.2	Optical Network Routing Principles - Impairment Aware Routing Optical Circuit Switching ,Optical Packet Switching Optical Burst Switching	
	4.3	Energy Awareness in Optical Networking ,Network Modeling Tools Network Design Guidelines	
5.0		Design of Optical Networks	10
	5.1	Core Optical Networks, Metro Optical networks, Access Optical Networks	
	5.2	Wavelength Routing and Assignment, Traffic Grooming and Protection, Multilayer Network Structure	
	5.3	Transmission system model, power penalty-transmitter, receiver optical amplifiers, crosstalk, dispersion, wavelength stabilization	
6.0		Virtual topology, Network Control and Management	06
	6.1	Virtual topology design problem, Combines SONET/WDM network design, an ILP formulation, Regular virtual topologies,	

	6.2	Control and management, Network management configuration management, Performance management, fault management. Network management functions, Optical safety	
		Total	48

Text Books :

1. Kumar Sivarajan and Rajiv Ramaswamy, Morgan Kauffman, Optical Networks: A Practical Perspective, Elsevier Publication Elsevier India Pvt. Ltd, 3rd Edition, 2010.
2. Harry G. Parros, Communication Oriented Networks, Wiley
3. G. Agrwal, Fiber Optic Communication Systems, John Wiley and Sons, 3rd Edition, New York, 2014.

References:

1. C. Siva Ram Moorthy and Mohan Gurusamy, WDM Optical Networks: Concept, Design and Algorithms, Prentice Hall of India, 1st Edition, 2002.
2. Biswajit Mukherjee, Optical Communication Networks, TMG1998.
3. Jane M. Simoons, Optical Network Design and Planning, Second Edition, Springer
4. Ulysees Black, Optical Networks, Pearson education 2007.
5. Milorad Cvijetic, Ivan B. Djordjevic, Advanced Optical Communication Systems and Networks, Artech House Applied Photonics, 2012.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8042	Advanced Digital Signal Processing	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECCDLO 8042	Advanced Digital Signal Processing	20	20	20	80	--	--	--	100	

Prerequisites:

- Discrete Time Signal Processing

Course objectives:

The aim of this course is to provide in-depth treatment on methods and techniques on

- Multirate Signal Processing, Power Spectrum Estimation, Adaptive Filtering and Wavelet Transform.
- Application of signal processing to real world problems.

Course outcomes:

After successful completion of the course student will be able to

- Demonstrate an understanding of multirate sampling and its mechanism.
- Study and apply the techniques of power spectrum estimation and wavelet theory for various applications.
- Implement adaptive filters for given applications.
- Apply signal processing tools to Biomedical and Telecommunication Applications

Module No.	Unit No.	Topics	Hrs.
1.0		Multirate Digital Signal Processing	08
	1.1	Advantages of Multirate Signal Processing	
	1.2	Interpolation and Decimation	
	1.3	Sampling Rate Conversion by Non Integer Factor	
	1.4	Multistage Interpolation and Decimation	
	1.5	Polyphase Decomposition	
	1.6	Digital Filter Banks	
	1.7	Applications of Multirate Signal Processing	
2.0		Power Spectrum Estimation	10
	2.1	Non Parametric Method of Power Spectrum Estimation: Periodogram, Modified Periodogram, Barlett Method, Welch's Method, Blackman-Tukey Approach	
	2.2	Parametric Methods of Power Spectrum Estimation: Autoregressive Spectrum Estimation, Model Parameters-Yule-Walker Equation, Least Square Method and Linear Prediction, Moving Average Spectrum Estimation, Autoregressive Moving Average Spectrum Estimation	
	2.3	Eigen Analysis Algorithm for Spectrum Estimation	
3.0		Linear Prediction and Optimum Linear Filters	10
	3.1	Representation of Stationary Random Process	
	3.2	Forward and Backward Linear Prediction	
	3.3	Solution of Normal Equation(Levinson-Durbin and Schur Algorithm)	
	3.4	AR Lattice and ARMA Lattice Ladder Filters	
	3.5	Weiner Filters for Filtering and Prediction	
4.0		Adaptive Filters	10
	4.1	Applications of Adaptive Filters: System Identification, Adaptive Channel Equalization, Echo Cancellation, Adaptive Noise Cancellation, Suppression of Narrowband Interference in Wideband Signals, Adaptive Arrays.	
	4.2	Adaptive Algorithms: LMS Algorithm, RLS Algorithm, Lattice Ladder Algorithm	
5.0		Wavelet Transform	06
	5.1	Introduction to Time Frequency Analysis	
	5.2	Short Time Fourier Transform	
	5.3	Continuous Wavelet Transform	
	5.4	Discrete Wavelet Transform	
	5.5	Multiresolution Analysis	

	5.6	Applications	
6.0		Application Of Signal Processing	04
	6.1	Biomedical Applications	
	6.2	Audio Applications	
	6.3	Telecommunication Applications(Radar)	
		Total	48

Textbooks

1. John G. Proakis, Dimitris G. Monolakis “ Digital Signal Processing”, PHI 2007.
2. Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital Signal Processing A Practical Approach”, Pearson Education 2008.

Reference Books

1. Simon Haykin, “Adaptive Filter Theory”, Pearson Education 2013.
2. Tarun Kumar Rawat, “Digital Signal Processing”, Oxford University Press.
3. Raghuveer M. Rao and Ajit S. Bopardikar, “Wavelet Transforms”, “Introduction to Theory and Applications”, Pearson Education Asia 2000.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8043	Satellite Communication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCDLO 8043	Satellite Communication	20	20	20	80	--	--	--	100

Prerequisites:

- Analog Communication
- Digital Communication

Course objectives:

- To understand the basics of satellite communications and different satellite communication orbits
- Provide an in-depth understanding of satellite communication system operation, launching techniques, satellite link design and earth station technology
- To explain the tools necessary for the calculation of basic parameters in a satellite communication system.
- Review the state of the art in new research areas such as speech and video coding, satellite networking and satellite personal communications, mobile satellite communication, Laser satellite

Course outcomes:

After successful completion of the course student will be able to

- Explain basics of satellite communication, space segment and earth segment
- Understand different satellite orbits and orbital parameters
- Explain and analyze link budget of satellite signal for proper communication
- Understand various applications of satellite communications

Module No.	Unit No.	Topics	Hrs.
1.0		Overview of Satellite Systems, Orbits and Launching	09
	1.1	An overview of space and satellite, Frequency allocation for satellite communication, Polar orbiting satellites, Kepler's First, second and third law, orbital elements, apogee, perigee heights, orbital perturbations, effects of a non-spherical earth, atmospheric drag	
	1.2	Wave Propagation & Polarization, Atmospheric Losses, Ionospheric Effects, Rain Attenuation, Other impairments, Antenna Polarization, Polarization of Satellite signals, Cross polarization discrimination, Ionospheric depolarization, Rain depolarization, Ice depolarization	
	1.3	Sub-satellite Point, predicting satellite position, antenna look angles, polar mount antenna, limits of visibility, near geostationary orbits, earth eclipse of satellite, sun transit outage	
	1.4	Selection of launching site, launch window, zero and non-zero degree latitude launching, sea launch, launch vehicles; satellite launch vehicle (SLV), augmented satellite launch vehicle (ASLV), polar SLV, geostationary satellite launch vehicle (GSLV)	
2.0		Space Segment	06
	2.1	Satellite configuration, Transponder sub-system, Antenna sub-system, AOC Sub-system, TT&C Sub-system, power sub-system, Thermal sub-system, reliability and quality Assurance.	
3.0		Earth station	05
	3.1	Design consideration	
	3.2	General configuration- Block diagram, Receive only type earth, transmit-receive type earth station, Antenna system, Feed system, Tracking system, LNA, HPA	
4.0		Satellite Links	10
	4.1	Isotropic radiated power, transmission losses, free-space transmission, feeder losses, antenna misalignment losses, fixed atmospheric and ionospheric losses, link power budget	
	4.2	System noise, antenna noise, amplifier noise temperature, amplifiers in cascade, noise factor, noise temperature of absorptive networks, overall system noise temperature, carrier to noise ratio	
	4.3	Uplink: Saturation flux density, input back off, earth station HPA, Downlink: Output back off, satellite TWTA output	
	4.4	Effects of rain, uplink rain-fade margin, downlink rain-fade margin, combined uplink and downlink C/N ratio, inter-modulation noise	
5.0		The Space Segment Access and Utilization	08
	5.1	Space segment access methods, pre-assigned FDMA, demand assigned FDMA, SPADE system, bandwidth-limited and power-limited TWT amplifier operation	

	5.2	TDMA: Reference Burst; Preamble and Postamble, carrier recovery, network synchronization, unique word detection, traffic date, frame efficiency, channel capacity, preassigned TDMA, demand assigned TDMA, satellite switched TDMA	
	5.3	Code Division Multiple Access: Direct-sequence spread spectrum-acquisition and tracking, spectrum spreading and despreading – CDMA throughput	
6.0		Satellite Applications	10
	6.1	VSAT systems: Advantages, configurations, frequency bands, elements, Applications	
	6.2	Broadcast services: Television broadcast systems, DAB,	
	6.3	Mobile satellite communication: INMARSAT, LMSS, mobile satellite systems with non GEO satellites	
	6.4	Satellite navigation systems	
	6.5	Laser Satellite Communication: Link analysis, optical satellite link transmitter, optical satellite link receiver, satellite beam acquisition, tracking & positioning, deep space optical communication link	
	6.6	Recent applications	
	6.7	Modern development and future trends	
		Total	48

Text Books & References :

1. Dennis Roddy, “Satellite Communications”, 4th Ed., Mc. Graw-Hill International Ed. 2009.
2. M. Richharia, “Satellite Communication Systems Design Principles”, Macmillan Press Ltd. Second Edition 2003.
3. R. N. Mutangi, “ Satellite Communication”, Oxford university press, 2016.
4. Gerard Maral and Michel Bousquet, “Satellite Communication Systems”, 4th Edition Wiley Publication
5. Gerard Maral, “VSAT Networks”, John Willy & Sons
6. Timothy Pratt, Charles Bostian, and Jeremy Allmuti, “Satellite Communications”, John Willy & Sons (Asia) Pvt. Ltd. 2004
7. Wilbur L. Pritchard, Henri G. Suyderehoud, and Robert A. Nelson, “Satellite Communication systems Engineering”, Pearson Publication

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8044	Network Management in TeleCommunication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECCDLO 8044	Network Management in TeleCommunication	20	20	20	80	--	--	--	100	

Prerequisites:

- Computer Communication and Networks,
- Operating System
- Basic Programming skills

Course objectives:

- To understand the concept of Telecommunication, network management, architecture and protocol

Course outcomes:

After successful completion of the course student will be able to

- Explain the need for interoperable network management & analyze the trends and development of the Telecommunications Network Management.
- Demonstrate broad knowledge of fundamental principles and technical standards underlying.
- Describe the concepts and architecture behind standards based network management associated with SNMP and CMIP.
- Apply basic of telecommunication, networking and information technologies and architect and implement networked informative systems.
- Continuously improve their technology knowledge and communication skills.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction of Network Management	10
	1.1	Introducing Network Design Concepts: Network designers ensure that our communications networks can adjust and scale to the demands for new services. To support our network-based economy, designers must work to create networks that are available nearly 100 percent of the time. Challenges of IT managers.	
	1.2	Network Management: Goals, organization and functions	
	1.3	Network management architecture and organization network management perspectives	
2.0		OSI Network Management	04
	2.1	Network management standards	
	2.2	Network management models	
	2.3	Organization model	
	2.4	Information model	
	2.5	Communication model and functional model	
	2.6	Abstract syntax notation – encoding structure, macros functional model CMIP/CMISE	
3.0		Internet Management	12
	3.1	SNMP-organizational model-	
	3.2	System overview.	
	3.3	Information model, communication model, functional model	
	3.4	SNMP proxy server, Management information, Protocol	
	3.5	SNMPv1,v2 and V3	
	3.6	Remote monitoring. RMON	
4.0		Telecommunication Management Networks(TMN)	04
	4.1	Need for TMN , Conceptual TNM model	
	4.2	TMN Network Management Architecture	
	4.3	TMN management services architecture and TMN implementation	
5.0		Network Management Tools and Applications	12
	5.1	System Utilities for network management	
	5.2	Network statistics and measurements	
	5.3	NMS Design, NMS components, NMS Server Architecture	
	5.4	Network Management Systems and FCAPS	
	5.5	Automatic Fault Management and Event correlation Techniques	
	5.6	Security Management	
6.0		Broadband Network Management	06
	6.1	Broadband networks and services, ATM Technology – VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN	

	6.2	ATM Network Management – ATM network reference model, integrated local management interface. ATM management information base, role of SNMP and ILMI in ATM.	
	6.3	M1, M2, M3, M4 interface. ATM digital exchange interface management	
		Total	48

Text Books & References :

1. Mani Subramaniam, —Network Management Principles and Practise”, Addison Wisely, New York, 2000.
2. Designing and Supporting Computer Networks, CCNA Discovery Learning Guide By Kenneth Stewart, Aubrey Adams, Allan Reid, Jim Lorenz, Cisco Press
3. Network Management: Concepts and Practice, A Hands-On Approach by J. Richard Burke, Pearson Publications.
4. Network Management: Accounting and Performance Strategies by Benoit Claise - CCIE No. 2686; Ralf Wolter CISCO Press
5. Network Management Fundamentals, Alexander Clemm, Cisco Press, December 2006, ISBN-13: 978-158720137
6. Python for Software Design by Allen B. Downey, Cambridge University Press, March 2009, ISBN-13: 978-0521725965. A free manuscript is available at the author's website.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8021	Project Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 8021	Project Management	20	20	20	80	--	--	--	100	

Course objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course outcomes:

After successful completion of the course student will be able to

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Module No.	Unit No.	Topics	Hrs.
1.0		Project Management Foundation	05
	1.1	Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	
2.0		Initiating Projects	06
	2.1	How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	
3.0		Project Planning and Scheduling	08
	3.1	Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	
4.0		Planning Projects	06
	4.1	Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	
5.0			08
	5.1	Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings	
	5.2	Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit	
	5.3	Project Contracting Project procurement management, contracting and outsourcing,	
6.0			06
	6.1	6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects	

	6.2	Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	
		Total	39

References:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8022	Finance Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 8022	Finance Management	20	20	20	80	--	--	--	100	

Course objectives:

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Course outcomes:

After successful completion of the course student will be able to

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module No.	Unit No.	Topics	Hrs.
1.0			06
	1.1	<p>Overview of Indian Financial System Characteristics, Components and Functions of Financial System.</p> <p>Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p>Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p>Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	
2.0			06
	2.1	<p>Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.</p> <p>Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.</p>	
3.0			09
	3.1	<p>Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p>Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.</p>	
4.0			10
	4.1	<p>Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)</p> <p>Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity’s Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.</p>	

5.0			05
	5.1	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity’s Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	
6.0			03
	6.1	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity’s Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon’s Approach, Walter’s Approach, and Modigliani-Miller Approach	
		Total	39

References:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8023	Entrepreneurship Development and Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECCILO 8023	Entrepreneurship Development and Management	20	20	20	80	--	--	--	100

Course objectives:

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Course outcomes:

After successful completion of the course student will be able to

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

Module No.	Unit No.	Topics	Hrs.
1.0			04
	1.1	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	
2.0			09
	2.1	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	
3.0			05
	3.1	Women's Entrepreneurship Development, Social entrepreneurship- role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	
4.0			08
	4.1	Indian Environment for Entrepreneurship: key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
5.0			08
	5.1	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	
6.0			05
	6.1	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	
		Total	39

References:

1. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
2. T N Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
3. C N Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
4. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
5. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
6. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8024	Human Resource Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 8024	Human Resource Management	20	20	20	80	--	--	--	100	

Course objectives:

- To introduce the students with basic concepts, techniques and practices of the human resource management
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
- To familiarize the students about the latest developments, trends & different aspects of HRM
- To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Course outcomes:

After successful completion of the course student will be able to

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to HR	05
	1.1	Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions	
	1.2	Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	
2.0		Organizational Behaviour (OB)	07
	2.1	Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues	
	2.2	Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness	
	2.3	Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour	
	2.4	Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor)	
	2.5	Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team	
	2.6	Case study	
3.0		Organizational Structure & Design	06
	3.1	Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	
	3.2	Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.	
	3.3	Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
4.0		Human resource Planning	05
	4.1	Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale	
	4.2	Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning	
	4.3	Training & Development: Identification of Training Needs, Training Methods	
5.0		Emerging Trends in HR	06

	5.1	Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment	
	5.2	Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	
6.0			10
	6.1	HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries	
	6.2	Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals	
	6.3	Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	
		Total	39

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8025	Professional Ethics and Corporate Social Responsibility (CSR)	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 8025	Professional Ethics and Corporate Social Responsibility (CSR)	20	20	20	80	--	--	--	100	

Course objectives:

- To understand professional ethics in business
- To recognized corporate social responsibility

Course outcomes:

After successful completion of the course student will be able to

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module No.	Unit No.	Topics	Hrs.
1.0			04
	1.1	Professional Ethics and Business : The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	
2.0			08
	2.1	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	
3.0			06
	3.1	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	
4.0			05
	4.1	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	
5.0			08
	5.1	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
6.0			08
	6.1	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	
		Total	39

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.

2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8026	Research Methodology	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 8026	Research Methodology	20	20	20	80	--	--	--	100	

Course objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Course outcomes:

After successful completion of the course student will be able to

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction and Basic Research Concepts	09
	1.1	Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology	
	1.2	Need of Research in Business and Social Sciences	
	1.3	Objectives of Research	
	1.4	Issues and Problems in Research	
	1.5	Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	
2.0		Types of Research	07
	2.1	Basic Research	
	2.2	Applied Research	
	2.3	Descriptive Research	
	2.4	Analytical Research	
	2.5	Empirical Research	
	2.6	Qualitative & Quantitative Approaches	
3.0		Research Design and Sample Design	07
	3.1	Research Design – Meaning, Types and Significance	
	3.2	Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	
4.0		Research Methodology	08
	4.1	Meaning of Research Methodology	
	4.2	Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	
5.0		Formulating Research Problem	04
	5.1	Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	
6.0		Outcome of Research	04

	6.1	Preparation of the report on conclusion reached	
	6.2	Validity Testing & Ethical Issues	
	6.3	Suggestions and Recommendation	
		Total	39

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C. R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed.), Singapore, Pearson Education

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8027	IPR and Patenting	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECCILO 8027	IPR and Patenting	20	20	20	80	--	--	--	100	

Course objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Course outcomes:

After successful completion of the course student will be able to

- Understand Intellectual Property assets
- Assist individuals and organizations in capacity building
- Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module No.	Unit No.	Topics	Hrs.
1.0			05
	1.1	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	
2.0			07
	2.1	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	
3.0			05
	3.1	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	
4.0			07
	4.1	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	
5.0			08
	5.1	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	
6.0			07
	6.1	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	
		Total	39

References:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dufield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8028	Digital Business Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 8028	Digital Business Management	20	20	20	80	--	--	--	100	

Course objectives:

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Course outcomes:

After successful completion of the course student will be able to

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module No.	Unit No.	Topics	Hrs.
1.0			09
	1.1	Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	
2.0			06
	2.1	Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	
3.0			06
	3.1	Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure	
4.0			06
	4.1	Managing E-Business- Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	
5.0			04
	5.1	E-Business Strategy- E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	

6.0			08
	6.1	Materializing e-business: From Idea to Realization -Business plan preparation Case Studies and presentations	
		Total	39

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-en OECD Publishing

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (O.2 to O.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCILO 8029	Environmental Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECCILO 8029	Environmental Management	20	20	20	80	--	--	--	100	

Course objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Course outcomes:

After successful completion of the course student will be able to

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Module No.	Unit No.	Topics	Hrs.
1.0			10
	1.1	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	
2.0			06
	2.1	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	
3.0			05
	3.1	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	
4.0			10
	4.1	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	
5.0			05
	5.1	Total Quality Environmental Management, ISO-14000, EMS certification	
6.0			03
	6.1	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	
		Total	39

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management **V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC University of Mumbai, B. E. (Electronics & Telecommunication Engineering), Rev 2016 199

Press

7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL801	RF Design Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECL801	RF Design Laboratory	--	--	--	--	25	25	--	50	

Suggested List of experiments

- Calibration of Network analyser for measurements.
- Characterization of RF low pass filter.
- Characterization of RF high pass filter.
- Characterization of RF band pass filter.
- Design of passive matching networks.
- Stability circles for microwave transistor
- Gain and Noise circles for transistor amplifier design
- Measurement of radiated emission using EMI Probes for DOT.
- Measurement of conducted radiations.
- Grounding & shielding for EMC.
- Testing of various emission standards like MIL CESPARE.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL801	Wireless Networks Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL801	Wireless Networks Laboratory	--	--	--	--	25	25	--	50

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8041	Optical Networks Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECLDLO 8041	Optical Networks Laboratory	--	--	--	--	25	25	--	50	

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 05 Experiments, 02 tutorials and 1 mini project covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8042	Advanced Digital Signal Processing Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECLDLO 8042	Advanced Digital Signal Processing Laboratory	--	--	--	--	25	25	--	50	

Suggested List of Experiments

- Write a program to implement multirate sampling technique for Interpolation.
- Write a program to implement multirate sampling techniques for Decimation.
- Design Anti-aliasing and Anti-Imaging filters.
- Write a program to demonstrate LMS algorithm for noise cancellations.
- Write a program to demonstrate RLS algorithm to calculate it's error function.
- Demonstrate application of Wavelet Transform for denoising.
- Analyse the frequency contents in EEG record.
- Write a program to generate ECG signal and isolate the QRS complex.

Instructions:

1. Minimum 4 experiments and 4 assignments must be submitted by each student.
2. Assignments can be designed on problem based learning from the content of the syllabus.
3. Simulation tools like Matlab/Scilab can be used.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8043	Satellite Communication Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECLDLO 8043	Satellite Communication Laboratory	--	--	--	--	25	25	--	50

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECLDLO 8044	Network Management in TeleCommunication Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam					
		Test 1	Test2	Avg. Of Test 1 and Test 2						
ECLDLO 8044	Network Management in TeleCommunication Laboratory	--	--	--	--	25	25	--	50	

Suggested List of Experiments

- Network Monitoring tools
 - a) Status b)Route c)Traffic Tools
- Network Audit using NMAP Gui
- Monitoring and management network using SNMP
 - a) Basic SNMP b) Advanced SNMP v3 Authentication/Encryption and ACL
 - c) SNMP Trap Daemon Implementation
- Configuration SNMP Protocol on Cisco Router using Packet Tracer
- Install and configure SNMP MIB browser
 - a) qtmib b)snmpB c) OpManager MIB browser
- Configuration manageable Switch: Dlink DES 3026 24 Port L2 Switch
- Network Statistics and measurement

a] LAN Traffic Monitoring b) Protocol statistics

- LAN Troubleshooting using Wireshark
- Monitoring of services and Servers using Observium\
- Monitoring of services and Servers using Cacti
- Install and configure NAGIOS and monitor server
- Installation and Configuration of OpenNMS as a NMS.
- Implementation of Centralized Log Management System: Syslog-ng
- Study of commercial network management tools: HPOpenView, OpManager, GFILanguard and IBM NMS.

Note: Small Project can be considered as a part of term-work.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the “**Laboratory session batch wise**”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL803	Project Stage-II	--	12	--	--	6	--	6

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				End Sem. Exam	Term Work	Practical & Oral	Oral	Total
		Internal assessment			Avg. Of Test 1 and Test 2					
		Test 1	Test2							
ECL803	Project Stage-II	--	--	--	--	100	50	--	150	

Objective: The primary objective is to meet the milestones formed in the overall project plan decided in Project - I. The idea presented in Project -I should be implemented in Project -II with results, conclusion and future work. The project will culminate in the production of a thesis by each individual student.

Guidelines:

Project Report Format:

At the end of the semester the student needs to prepare a project report which should be prepared as per the guidelines issued by the University of Mumbai. Along with the project report a CD containing: project documentation, Implementation code, required utilities, Software's and user Manuals need to be attached.

Term Work:

Student has to submit weekly progress report to the internal guide and the internal guide has to keep a track on the progress of the project and also has to maintain the attendance report. This progress report can be used for awarding the term work marks. In case of industry projects, visit by internal guide will be preferred to get the status of project. Distribution of marks for term work shall be as follows:

- a) Weekly Attendance on Project Day
- b) Project work contributions as per objective
- c) Project Report (Hard Bound)
- d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

Oral & Practical:

Oral & Practical examination of Project- II should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project-II.

Chemical Engineering

Sr. No.	Subject Code	Subject Name	Count
1	CHL301	Engineering Chemistry-I Lab	1
2	CHL302	Chemical Engineering Lab I (FFO)	1
3	CHL303	Chemical Engineering Lab II (Synthesis)	1
4	CHL401	Engineering Chemistry-II Lab	1
5	CHL402	Chemical Engineering Lab III (SFMO)	1
6	CHL403	MED Lab	1
7	CHL501	Computer programming and Numerical Methods Lab	1
8	CHL502	Chemical Engineering Lab IV (MTO-I)	1
9	CHL503	Chemical Engineering Lab V (HTO)	1
10	CHL504	Chemical Engineering Lab VI (CRE-I)	1
11	CHL601	Chemical Engineering Lab VII (EE)	1
12	CHL602	Chemical Engineering Lab VIII (MTO-II)	1
13	CHL603	Chemical Engineering LabIX CRE-II)	1
14	CHL701	PED Lab	1
15	CHL702	Chemical Engineering Lab X (PDC)	1
16	CHL801	Chemical Engineering Lab XI (MSO)	1
		Total	16

UNIVERSITY OF MUMBAI



Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Chemical Engineering

Second Year with Effect from **AY 2017-18**

Third Year with Effect from **AY 2018-19**

Final Year with Effect from **AY 2019-20**

Under

FACULTY OF TECHNOLOGY

As per **Choice Based Credit and Grading System**

With effect from the AY 2016-17

From Coordinator's Desk

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Credit grading based system was implemented for Second Year of B.E. in Chemical Engineering from the academic year 2017-2018. This system is carried forward for Third Year of B.E. in Chemical Engineering in the academic year 2018-2019 and will be implemented for Fourth Year B.E. in the year 2019-2020 respectively.

Dr. S. K. Ukarande

Co-ordinator,

Faculty of Technology,

Member - Academic Council

University of Mumbai, Mumbai

Preamble to the Revision of Syllabus in Chemical Engineering

To match the increasing pace of development in all fields including Chemical Engineering and Biotechnology along with use of softwares for process plant and process engineering, there is demand on academicians to upgrade the curriculum in Education. The availability of free software such as Scilab, DW SIM expand the boundaries of learning. Hence, the Undergraduate Curriculum in Chemical Engineering must provide the necessary foundation for a Chemical Engineer to be able to specialize in any area as and when the need and opportunity arise. The Curriculum must integrate knowledge of the basic and advanced sciences with problem solving abilities and inclusion of technological development. The Curriculum must be broad enough to cover all areas from design to operation of Process plants. It should be deep enough to enable the learners to carry out research and develop products to meet rapidly changing needs and demands. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program.

With these objectives, a meeting was organized at Thadomal Shahani Engineering College Bandra on 17th November 2016 which was attended by Industries experts, heads of the departments and subject faculty of affiliating Institutes. The program objectives and outcomes were thoroughly discussed in this meeting and the core structure of the syllabus was formulated keeping in mind choice based credit and grading system curriculum to be introduced in this revised syllabus for B.E. (Chemical Engineering) for all semesters. Views from experts and UG teachers were taken into consideration and final Academic and Exam scheme was prepared with the consent of all the members involved. Subject wise meetings were held to finalize the detail syllabus in Bharati Vidyapeeth College of Engineering on 13th Jan 2017, SS Jondhale College of Engineering on 27th Jan 2017, Datta Meghe College of Engineering Airoli on 20th February 2017 and 13th April 2017 and in D. J. Sanghavi College of Engineering on 17th April 2017.

The Program Educational Objectives finalized for the undergraduate program in Chemical Engineering are:

1. To prepare the student for mathematical, scientific and engineering fundamentals
2. To motivate the student to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities.
4. To prepare the student in achieving excellence in their career in Indian and Global Market.

Dr. Kalpana S. Deshmukh,

Chairman, Board of Studies in Chemical Engineering (Adhoc),

University of Mumbai

General Guidelines

Tutorials

- The number of tutorial batches can be decided based on facilities available in the institution.
- Tutorials can be creative assignments in the form of models, charts, projects, etc.

Term Work

- Term work will be an evaluation of the tutorial/practical done over the entire semester.
- It is suggested that each tutorial/practical be graded immediately and an average be taken at the end.
- A minimum of eight tutorials/ten practical will form the basis for final evaluation.
- The total 25 marks for term work (except project and seminar) will be awarded as follows:

Tutorial / Practical Journal – 20 marks

Overall Attendance – 05

Further, while calculating marks for attendance, the following guidelines shall be adhered to:

75 % to 80%. – 03 marks

81% to 90% - 04 marks

91% onwards – 05 marks

Theory Examination

- In general all theory examinations will be of 3 hours duration.
- Question paper will comprise of total six questions, each of 20 Marks.
- Only four questions need to be solved.
- Question one will be compulsory and based on maximum part of the syllabus.

Note:

In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus as far as possible.

Practical Examination:

- Duration for practical examination would be the same as assigned to the respective Lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Project and Seminar Guidelines

- Project Groups: Students can form groups with minimum 2 (Two) and not more than 3 (Three)
- The load for projects may be calculated proportional to the number of groups, not exceeding two hours per week.
- The load for projects may be calculated as:
Sem VII: ½ hr for teacher per group.
Sem VIII: 1 hr for teacher per group.
- Each teacher should have ideally a maximum of three groups and only in exceptional cases four groups can be allotted to the faculty.
- Seminar topics will be the consensus of the project guide and the students. Each student will work on a unique topic.
- The load for seminar will be calculated as one hour per week irrespective of the number of students
- Students should spend considerable time in applying all the concepts studied, into the project. Hence, eight hours each were allotted in Project A, B and three hours for Seminar to the students.

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
S.E. Semester III (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC301	Applied Mathematics-III	3	-	1	3	-	1	4
CHC302	Engineering Chemistry I	4	-	-	4	-	-	4
CHC303	Fluid Flow Operations (FFO)	4	-	-	4	-	-	4
CHC304	Chemical Engineering Thermodynamics I	3	-	1	3	-	1	4
CHC305	Process Calculations	3	-	1	3	-	1	4
CHC306	Chemical Technology	4	-	-	4	-	-	4
CHL301	Engineering Chemistry-I Lab	-	3	-	-	1.5	-	1.5
CHL302	Chemical Engineering Lab I (FFO)	-	3	-	-	1.5	-	1.5
CHL303	Chemical Engineering Lab II (Synthesis)	-	2	-	-	1	-	1
Total		21	8	3	21	4	3	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC301	Applied Mathematics-III	20	20	20	80	3	25	-	-	125
CHC302	Engineering Chemistry I	20	20	20	80	3	-	-	-	100
CHC303	Fluid Flow (FF)	20	20	20	80	3	-	-	-	100
CHC304	Chemical Engineering Thermodynamics I	20	20	20	80	3	25	-	-	125
CHC305	Process Calculations	20	20	20	80	3	25	-	-	125
CHC306	Chemical Technology	20	20	20	80	3	-	-	-	100
CHL301	Engineering Chemistry-I Lab	-	-	-	-	3	-	25	-	25
CHL302	Chemical Engineering Lab I (FFO)	-	-	-	-	3	25	25	-	50
CHL303	Chemical Engineering Lab II (Synthesis)	-	-	-	-	-	25	-	25	50
Total				120	480	-	125	50	25	800

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
S.E. Semester IV (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC401	Applied Mathematics-IV	3	-	1	3	-	1	4
CHC402	Engineering Chemistry II	4	-	-	4	-	-	4
CHC403	Chemical Engineering Thermodynamics II	3	-	1	3	-	1	4
CHC404	Solid Fluid Mechanical Operations (SFMO)	4	-	-	4	-	-	4
CHC405	Mechanical Equipment Design (MED)	4	-	-	4	-	-	4
CHC406	Chemical Engineering Economics	3	-	1	3	-	1	4
CHL401	Engineering Chemistry-II Lab	-	3	-	-	1.5	-	1.5
CHL402	Chemical Engineering Lab III (SFMO)	-	3	-	-	1.5	-	1.5
CHL403	MED Lab	-	2	-	-	1	-	1
	Total	21	8	2	21	4	3	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC401	Applied Mathematics-IV	20	20	20	80	3	25	-	-	125
CHC402	Engineering Chemistry II	20	20	20	80	3	-	-	-	100
CHC403	Chemical Engineering Thermodynamics II	20	20	20	80	3	25	-	-	125
CHC404	Solid Fluid Mechanical Operations (SFMO)	20	20	20	80	3	-	-	-	100
CHC405	Mechanical Equipment Design (MED)	20	20	20	80	3	-	-	-	100
CHC406	Chemical Engineering Economics	20	20	20	80	3	25	-	-	125
CHL401	Engineering Chemistry-II Lab	-	-	-	-	3	-	25	-	25
CHL402	Chemical Engineering Lab III (SFMO)	-	-	-	-	3	25	25	-	50
CHL403	MED Lab	-	-	-	-	-	25	-	25	50
	Total			120	480	-	125	50	25	800

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
T.E. Semester V (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC501	Computer programming and Numerical Methods	4	-	-	4	-	-	4
CHC502	Mass transfer Operations-I (MTO- I)	4	-	-	4	-	-	4
CHC503	Heat transfer Operations (HTO)	4	-	-	4	-	-	4
CHC504	Chemical Reaction Engineering-I (CRE I)	4	-	-	4	-	-	4
CHC505	Business Communication & Ethics	2	-	2	-	-	2	2
CHDE501X	Department Elective I	4	-	-	4	-	-	4
CHL501	Computer programming and Numerical Methods lab	-	2	-	-	1	-	1
CHL502	Chemical Engineering Lab IV (MTO-I)	-	3	-	-	1.5	-	1.5
CHL503	Chemical Engineering Lab V (HTO)	-	3	-	-	1.5	-	1.5
CHL504	Chemical Engineering Lab VI (CRE-I)	-	2	-	-	1	-	1
Total		20	14	-	20	5	2	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC501	Computer programming and Numerical Methods	20	20	20	80	3	-	-	-	100
CHC502	Mass transfer Operations-I (MTO- I)	20	20	20	80	3	-	-	-	100
CHC503	Heat transfer Operations (HTO)	20	20	20	80	3	-	-	-	100
CHC504	Chemical Reaction Engineering-I (CRE I)	20	20	20	80	3	-	-	-	100
CHC505	Business Communication & Ethics	-	-	-	-	-	50	-	-	50
CHDE501X	Department Elective I	20	20	20	80	3	-	-	-	100
CHL501	Computer programming and Numerical Methods Lab	-	-	-	-	2	25	25	-	50
CHL502	Chemical Engineering Lab IV (MTO-I)	-	-	-	-	3	25	25	-	50
CHL503	Chemical Engineering Lab V (HTO)	-	-	-	-	3	25	25	-	50
CHL504	Chemical Engineering Lab VI (CRE-I)	-	-	-	-	2	25	25	-	50
Total				100	400	-	150	100	-	750

Department Elective I (Sem V)		
Engineering Stream (Elective Code)	Advanced Sciences Stream (Elective code)	Technology Stream (Elective Code)
1. Piping Engineering (CHDE5011) 2. Instrumentation (CHDE5014)	1. Colloids and Interfaces (CHDE5012)	1. Advanced Material Sciences (CHDE5013)

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
T.E. Semester VI (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC601	Environmental Engineering (EE)	4	-	-	4	-	-	4
CHC602	Mass transfer Operations –II (MTO-II)	4	-	-	4	-	-	4
CHC603	Transport Phenomenon	3	-	1	3	-	1	4
CHC604	Chemical Reaction Engineering –II (CRE- II)	4	-	-	4	-	-	4
CHC605	Plant Engineering & Industrial Safety	3	-	1	3	-	1	4
CHDE602X	Department Elective II	4	-	-	4	-	-	4
CHL601	Chemical Engineering Lab VII (EE)	-	3	-	-	1.5	-	1.5
CHL602	Chemical Engineering Lab VIII (MTO-II)	-	3	-	-	1.5	-	1.5
CHL603	Chemical Engineering Lab IX (CRE-II)	-	2	-	-	1	-	1
Total		22	8	2	22	4	2	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC601	Environmental Engineering (EE)	20	20	20	80	3	-	-	-	100
CHC602	Mass transfer Operations –II (MTO-II)	20	20	20	80	3	-	-	-	100
CHC603	Transport Phenomenon	20	20	20	80	3	25	-	-	125
CHC604	Chemical Reaction Engineering –II (CRE- II)	20	20	20	80	3	-	-	-	100
CHC605	Plant Engineering & Industrial Safety	20	20	20	80	3	25	-	-	125
CHDE602X	Department Elective II	20	20	20	80	3	-	-	-	100
CHL601	Chemical Engineering Lab VII (EE)	-	-	-	-	3	25	25	-	50
CHL602	Chemical Engineering Lab VIII (MTO-II)	-	-	-	-	3	25	25	-	50
CHL603	Chemical Engineering Lab IX (CRE-II)	-	-	-	-	2	25	25	-	50
Total				120	480	-	125	75	--	800

Department Elective II (Sem VI)		
Engineering Stream (Elective Code)	Management Stream (Elective Code)	Technology Stream (Elective Code)
1. Computational Fluid Dynamics (CHDE6021)	1. Operation Research (CHDE6022)	1. Biotechnology (CHDE6023)

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
B.E. Semester VII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC701	Process Equipment Design. (PED)	4	-	-	4	-	-	4
CHC702	Process Engineering	3	-	1	3	-	1	4
CHC703	Process Dynamics and Control (PDC)	4	-	-	4	-	-	4
CHDE703X	Department Elective III	4	-	-	4	-	-	4
ILO701X	Institute Elective I	3	-	-	3	-	-	3
CHP701	Project A	-	-	8	-	-	3	3
CHS701	Seminar	-	-	3	-	-	3	3
CHL701	PED Lab	-	3	-	-	1.5	-	1.5
CHL702	Chemical Engineering Lab X (PDC)	-	3	-	-	1.5	-	1.5
Total		18	6	12	18	3	7	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC701	Process Equipment Design. (PED)	20	20	20	80	3	-	-	-	100
CHC702	Process Engineering	20	20	20	80	3	25	-	-	125
CHC703	Process Dynamics and Control (PDC)	20	20	20	80	3	-	-	-	100
CHDE703X	Department Elective III	20	20	20	80	3	-	-	-	100
ILO701X	Institute Elective I	20	20	20	80	3	-	-	-	100
CHP701	Project A	-	-	-	-	-	100	-	25	125
CHS701	Seminar	-	-	-	-	-	50	-	-	50
CHL701	PED Lab	-	-	-	-	-	25	-	25	50
CHL702	Chemical Engineering Lab X (PDC)	-	-	-	-	3	25	25	-	50
Total				100	400	-	225	25	50	800

Department Elective III (Sem VII)		
Engineering Stream (Elective Code)	Management Stream (Elective Code)	Technology Stream (Elective Code)
1. Corrosion Engineering (CHDE7031)	2. Industrial organization and Management. (CHDE7032)	1. Petroleum Refining Technology (CHDE7033) 3. Food Technology (CHDE7034)

Institute Level Optional Subject I (Sem VII)		
1. Product Lifecycle Management (ILO7011)	4. Design of Experiments (ILO7014)	7. Disaster Management and Mitigation Measures (ILO7017)
2. Reliability Engineering (ILO7012)	5. Operation Research (ILO7015)	8. Energy Audit and Management (ILO7018)
3. Management Information System (ILO7013)	6. Cyber Security and Laws (ILO7016)	9. Development Engineering (ILO7019)

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
B.E. Semester VIII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC801	Modeling, Simulation & Optimization (MSO)	4	-	-	4	-	-	4
CHC802	Project Engineering & Entrepreneurship Management	3	-	1	3	-	1	4
CHC803	Energy System Design	3	-	1	3	-	1	4
CHDE804X	Department Elective IV	4	-	-	4	-	-	4
ILO802X	Institute Elective II	3	-	-	3	-	-	3
CHP801	Project B	-	-	8	-	-	6	6
CHL801	Chemical Engineering Lab XI (MSO)	-	2	-	-	1	-	1
Total		17	2	10	17	1	8	26

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC801	Modeling, Simulation & Optimization (MSO)	20	20	20	80	3	-	-	-	100
CHC802	Project Engineering & Entrepreneurship Management	20	20	20	80	3	25	-	-	125
CHC803	Energy System Design	20	20	20	80	3	25	-	-	125
CHDE804X	Department Elective IV	20	20	20	80	3	-	-	-	100
ILO802X	Institute Elective II	20	20	20	80	3	-	-	-	100
CHP801	Project B	-	-	-	-	-	100	-	50	150
CHL801	Chemical Engineering Lab XI (MSO)	-	-	-	-	2	25	25	-	50
Total				100	400	-	175	25	50	750

Department Elective IV (Sem VIII)		
Engineering Stream (Course Code)	Management Stream (Course Code)	Technology Stream (Course Code)
1. Advanced Process Control (CHDE8041)	1. Total Quality Management (CHDE8042)	1. Advanced Separation Technology (CHDE8043) 2. Polymer Technology(CHDE8044)

Institute Level Optional Subject II (Sem VIII)		
1. Project Management (ILO8021)	4. Human Resource Management (ILO8024)	7. IPR and Patenting (ILO8027)
2. Finance Management (ILO8022)	5. Professional Ethics and CSR (ILO8025)	8. Digital Business Management (ILO8028)
3. Entrepreneurship Development and Management (ILO8023)	6. Research Methodology(ILO8026)	9. Environmental Management (ILO8029)

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
S.E. Semester III (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC301	Applied Mathematics-III	3	-	1	3	-	1	4
CHC302	Engineering Chemistry I	4	-	-	4	-	-	4
CHC303	Fluid Flow Operations (FFO)	4	-	-	4	-	-	4
CHC304	Chemical Engineering Thermodynamics I	3	-	1	3	-	1	4
CHC305	Process Calculations	3	-	1	3	-	1	4
CHC306	Chemical Technology	4	-	-	4	-	-	4
CHL301	Engineering Chemistry-I Lab	-	3	-	-	1.5	-	1.5
CHL302	Chemical Engineering Lab I (FFO)	-	3	-	-	1.5	-	1.5
CHL303	Chemical Engineering Lab II (Synthesis)	-	2	-	-	1	-	1
Total		21	8	3	21	4	3	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC301	Applied Mathematics-III	20	20	20	80	3	25	-	-	125
CHC302	Engineering Chemistry I	20	20	20	80	3	-	-	-	100
CHC303	Fluid Flow (FF)	20	20	20	80	3	-	-	-	100
CHC304	Chemical Engineering Thermodynamics I	20	20	20	80	3	25	-	-	125
CHC305	Process Calculations	20	20	20	80	3	25	-	-	125
CHC306	Chemical Technology	20	20	20	80	3	-	-	-	100
CHL301	Engineering Chemistry-I Lab	-	-	-	-	3	-	25	-	25
CHL302	Chemical Engineering Lab I (FFO)	-	-	-	-	3	25	25	-	50
CHL303	Chemical Engineering Lab II (Synthesis)	-	-	-	-	-	25	-	25	50
Total				120	480	-	125	50	25	800

Course Code	Course/Subject Name	Credits
CHC301	Applied Mathematics III	4

Pre-requisites:

- Basics of Complex numbers, Modulus, Argument, Equation of circle, Roots of unity, Euler's formula, Hyperbolic functions, Matrices, Symmetric, Orthogonal and Unitary matrices, Rank, Normal form, Solution of system of linear equations, L. I. & L. D. vectors, Basics of Probability.

Course Objectives:

- To enable students to solve initial value ODE problems using L-transforms.
- To strengthen the knowledge of students in Linear Algebra.
- To study the basics of statistics and Probability.
- To study the basics of Complex Variable.

Course outcomes:

- The student will be able to apply Laplace Transform techniques for solving initial value problems.
- Identify the Analytic function and Harmonic function and to apply Bilinear Transformation.
- Understanding and apply the concept of Probability distribution and Sampling theory to engineering problems.

Module	Topics	Contact hours
1	<p>Laplace transform:</p> <p>1.1 Introduction, Definition of Laplace transform, Laplace transform of constant, trigonometrical, exponential functions.</p> <p>1.2 Important properties of Laplace transform: First shifting theorem, Laplace transform of $L\{f(at)\}$, $L\{t^n f(t)\}$, $L\left\{\frac{f(t)}{t}\right\}$, $L\left\{\frac{d^n f(t)}{dt^n}\right\}$, $L\left\{\int_0^t f(u)du\right\}$, without proof.</p> <p>1.3 Unit step function, Heavi side function, Second shifting theorem, Dirac-delta function, Periodic function and their Laplace transforms without proof.</p> <p>1.4 Inverse Laplace transform with Partial fraction and Convolution theorem. (without proof)</p> <p>1.5 Application to solve initial and boundary value problem involving ordinary differential equations with one dependent variable and constant coefficients.</p>	10
2	<p>Matrices:</p> <p>2.1 Eigen values and eigen spaces of 2x2 and 3x3 matrices; existence of a basis and finding the dimension of the eigen space (no proofs); diagonalisable matrices.</p> <p>2.2 Cayley - Hamilton theorem. (without proof)</p>	08

	2.3 Quadratic forms; orthogonal and congruent reduction of a quadratic form in 2 or 3 variables; rank, index, signature; definite and indefinite forms.	
3	Probability: 3.1 Random Variables:- discrete & continuous random variables, expectation, Variance, Probability Density Function & Cumulative Density Function. 3.2 Moments, Moment Generating Function. 3.3 Probability distribution: binomial distribution, Poisson & normal distribution.	07
4	Sampling Theory: 4.1 Test of Hypothesis, Level of significance, Critical region, One Tailed and two Tailed test, Test of significant for Large Samples:-Means of the samples and test of significant of means of two large samples. 4.2 Test of significant of small samples:- Students t- distribution for dependent and independent samples. 4.3 Chi square test:- Test of goodness of fit and independence of attributes, Contingency table. Correlation: 4.4 Karl Pearson's coefficient of correlation, covariance, Spearman's Rank correlation. 4.5 Regression Lines.	07
5	Complex Variable: 5.1 Functions of a complex variable, Analytic functions, Cauchy-Riemann equations in Cartesian co-ordinates, Polar co-ordinates. (without proof) 5.2 Harmonic functions, Analytic method and Milne Thomson methods to find f(z), Orthogonal trajectories. (without proof) Mapping 5.3 Conformal Mapping, Linear, Bilinear transformations, Cross ratio, fixed points and standard transformation such as rotation and magnification, inversion, translation.	07

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Reference Books

1. Higher Engineering Mathematics by Dr. B. S. Grewal 42th edition, Khanna Publication.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
3. A Text Book of Applied Mathematics Vol. II by P.N.Wartilar & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.
4. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
5. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
6. Laplace Transforms by Murry R. Spieget, Schaun'sout line series-McGraw Hill Publication.
7. Theory And Problems of Statistics by Murry R. Spieget, Schaun'sout line series-McGraw Hill Publication.
8. Fundamentals Of Mathematical Statistics by S. C. Gupta, V. K. Kapoor, Sultan Chand & Sons -2003

Course Code	Course/Subject Name	Credits
CHC302	Engineering Chemistry– I	4

Prerequisites:

- Knowledge of Vander-Waal's forces, various bonds, Octet rule, Resonance theory, Hybridization.
- Knowledge of variable valency, ligands.
- Knowledge of properties of transition metals.
- Knowledge of intermediate steps involved in conversion of reactants to products.
- Basic concept of quantum chemistry & wave theory approach.

Course Objectives:

- To understand chemical bonding.
- To study chelation and its advantages.
- To understand structures of different bio-molecules and their chemistry.
- To study importance of iron compounds for life.
- To understand different concepts of organic reactions.
- To study the effect of temperature and time on chemical reactions.
- To become aware of industrially important reactions.
- To understand mechanism of aromatic substitution and elimination reactions.

Course Outcomes:

- Students will understand different theories of chemical bonding, organometallic chemistry, mechanism and application of Photochemical processes.
- Students will also be capable of defining Stability of Coordination compounds, Kinetics and energy profile diagrams of reactions.
- Students will have knowledge of metal carbonyls and their properties.
- Students will be able to express role of metalloproteins in biological processes.
- Students will be able to carry out organic estimations, gravimetric analysis and handle different instruments in the laboratory.

Module	Content	Contact Hours
1	Basic Concepts of Chemistry and Molecular Structures- Hydrogen bonding, Valence bond theory (application for H ₂ molecule). Molecular orbital theory, Bonding, Non-bonding and anti-bonding orbitals, LCAO method, VSEPR theory .Structure of BrF ₃ , SF ₄ , XeF ₄ , and IF ₇ . Molecular orbital diagrams of homonuclear and heteronuclear molecules H ₂ , Be ₂ , B ₂ , C ₂ , N ₂ , O ₂ , F ₂ , HF, CO, NO and NO ⁺ types etc, metallic bond.	08

2	<p>Co-ordination chemistry Definitions- Co-ordination number or ligancy, Ligand, Complex ion, Co-ordination or dative bond. Nomenclature and isomerism (Only Geometrical and Structural) in co-ordination compounds with respect to co-ordination number 4 and 6. Theories of coordination compounds- Werner's Co-ordination theory, Valence bond theory, Crystal field theory (CFT), Ligand field theory. Effective Atomic Number (EAN), Application of CFT to tetrahedral and octahedral complexes, drawbacks of CFT. Measurement of CFSE (10Dq), and Numericals based on EAN and 10Dq measurement.</p>	08
3	<p>Organometallic compounds and Bio-inorganic chemistry Chemistry of Fe-Carbonyls –Fe(CO)₅,Fe₂(CO)₉w.r.t preparation, properties, structure and bonding. Biochemistry of proteins containing Fe and Zn. O₂ atom transfer reactions of bio molecules containing Fe.</p>	06
4	<p>Reaction Mechanism & Reactive Intermediates Transition state (T.S.), Intermediate, Difference between T.S. & intermediate. Equilibrium (Thermodynamically) controlled & rate (Kinetically) controlled reactions. Explain w.r.t. Nitration of chlorobenzene, methylation of toluene by Friedel-Craft's reaction, sulphonation of naphthalene.</p>	07
5	<p>Reactive intermediates Definition, carbocation, carbanion, carbon free radicals and carbenes – their formation, structure & stability. Reactive intermediate formation with mechanism and applications- Carbocation – Pinacol - Pinacolone reaction. Carbanion – Michael reaction. Free radical - Wohl-Ziegler bromination reaction. Carbene - Reimer-Tiemann reaction.</p>	08
6	<p>Photochemistry Introduction, difference between Photochemical and thermochemical reaction, laws of Photochemistry i) Grothus Draper Law ii) Stark Einstein Law. Fluorescence and phosphorescence. Jablonskii diagram, Quantum yield, reasons for high quantum yield. Photochemical reactions of carbonyl compounds-(i) Norrish type- I cleavage (ii) Norrish type-II cleavage with mechanism.</p>	08

Assessment

Internal:

Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.

- Total 4 questions need to be solved.
- Question No.1 should be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Principles of Inorganic Chemistry- Puri, Sharma, Kalia – Milestone/Vishal Publishers
2. Advanced Inorganic Chemistry – J. D. Lee
3. Organic Chemistry - I L Finar volume I and II.
4. Advanced Organic Chemistry – Jerry March, John Wiley & Sons (Wiley India)
5. Organic Chemistry – J. Clayden, Greeves, Warren, Wothers. Oxford
6. Organic reaction Mechanisms- V.K. Ahluwalia , Rakesh Parashar, Narosa Publication
7. A textbook of Physical Chemistry - Glasston Samuel, Macmillan India Ltd. (1991)
8. Inorganic Chemistry: Huheey.
9. Principles of Physical Chemistry- B. R. Puri, L. R. Sharma, M.S. Pathania.
10. Photochemistry and Pericyclic Reactions- Jagdamba Singh, Jaya Singh
11. Organic reaction mechanism – Peter sykes
12. Vogel's Textbook of Practical organic chemistry.

Course Code	Course/Subject Name	Credits
CHC303	Fluid Flow Operation	4

Prerequisites:

- Students are assumed to have adequate background in physics, units and dimensions and thermodynamics.

Course Objectives:

- Students should be able to understand the scope of the subject in chemical industry.
- They should be comfortable with measurement of pressure or pressure drop.
- They should be able to calculate pressure drop and flow rates in conduits for incompressible as well as compressible fluids.
- They should be able to determine viscosity using different methods such as Stokes Law, Capillary viscometer.
- They should be able to calculate power requirement in agitation and to be able to select and calculate power requirement for pumps.
- They should be able to select proper valves.

Course Outcomes:

- After studying this subject, students would be able to measure pressure drop, flow rates etc.
- Students will able to understand basic concepts and pressure measurement.
- Students will able to understand kinetics and rheological behavior of fluid flow.
- Students will able to understand flow equations for compressible and incompressible flow.
- Students will able to select pumps and valves and would be able to calculate power requirement for pumping as well as agitation operations.

Module	Contents	Contact Hours
1	<p>Introduction and Basic Concepts: Scope and Applications of fluid flow, Properties of fluids such as Density, viscosity, surface tension, capillarity effect, vapour pressure.</p> <p>Pressure and Fluid Statics:</p> <ul style="list-style-type: none"> • Fluid Pressure at a Point, Pascal's Law, Pressure Variation in a fluid at rest. Hydrostatic Equilibrium. • Measurement of Pressure, Manometers – Peizometers, U-Tube, Single Column manometer, U – Tube differential manometer, Inverted Differential U – tube manometer, inclined manometer. 	7
2	Fluid Kinematics:	2

	<ul style="list-style-type: none"> Types of fluid flow namely steady and unsteady, Uniform and non- uniform, laminar and turbulent, compressible and incompressible internal and external, one, two dimensional flow. Newton's Law of Viscosity, Rheological behavior of fluid, capillary viscometer. 	
3	<p>Basic Equations of Fluid Flow:</p> <ul style="list-style-type: none"> Bernoulli's equation Euler's Equation, Modified Bernoulli's equation. Major and Minor losses, Equivalent length, flow through pipe in series, parallel, pipe network. <p>Practical Application of Bernoulli's Equation:</p> <ul style="list-style-type: none"> Venturimeter: Horizontal and inclined, Orificemeter, Pitot tube Notches and Weirs: Introduction, classification, Derivation for V – notch, Rectangular notch. 	10
4	<p>Flow through Pipes:</p> <p>A] Incompressible flow: Shear stress distribution and velocity distribution. Relationship between Skin friction and wall shear, friction factor, Darcy-Weisbach equation. Reynolds experiment and Reynolds no., Formation of Boundary.</p> <p>Laminar Flow: Shear stress, velocity distribution, Derivation of local velocity, maximum velocity, average velocity, Kinetic Energy Correction factor, Hagen – Poiseuille equation.</p> <p>Turbulent Flow: Velocity distribution equations, Average velocity, local velocity, maximum velocity, kinetic energy correction factor (No Numericals on universal velocity). Von Carman equation and friction factors, Moody diagram. Equivalent diameter for circular and non-circular ducts. Pipes in series and parallel. Frictional Losses in different pipe fittings.</p> <p>B] Compressible Fluids: Introduction, Mach no, Sonic, supersonic and subsonic flow, continuity equation and Bernoulli's equation, stagnation properties, Acoustic velocity. Adiabatic Flow. Isothermal Flow. Isentropic Flow.</p>	12
5	<p>Flow past immersed bodies: Drag forces, Coefficient of drag, Terminal settling velocity, Stoke's law.</p>	2
6	<p>Pumps, Valves and Agitators: Classification and types, Centrifugal pumps – Construction and working, Power required, Definitions of heads and efficiency, NPSH, Priming, Cavitations, characteristic curves. Specific speed, minimum speed.</p>	12

	<p>Reciprocating Pump: Classifications and working.</p> <p>Power Consumption in Agitation: Power curves, Power No., types of impellers.</p> <p>Introduction to Compressors, Fans and Blowers.</p> <p>Types of Valves: Globe valves, Gate valves, butterfly valves and non – Return valves.</p>	
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Assessment

Internal:

Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Warren L. McCabe, Julian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, McGraw Hill International Edition.
2. Okiishi, Huebsch, Rothmayer Munson, Fluid Mechanics - SI Version, Wiley, 7th edition, 2015.
3. Coulson J. M., Richardson J. F., Backhurst J. R. and J. H. Harker, Chemical Engineering, Vol. 1 and 2.
4. Suresh Ukarande, Fluid Mechanics and Hydraulics, Ane Books, 2012.
5. Robbert W. Fox, Philip J. Pritchard, Alan T. McDonald, Introduction to Fluid Mechanics, 7th edition, WILEY, India Edition.
6. Yunus A. Cengel, John M. Cimbala, Adapted by S. Bhattacharya, Fluid Mechanics Fundamentals and Applications, The McGraw Hill Companies.
7. Dr. R. K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications Pvt. Ltd.
8. Fluid Mechanics for Chemical Engineers by Noel de Nevers, McGraw Hill Education

Course Code	Course/Subject Name	Credits
CHC304	Chemical Engineering Thermodynamics I	04

Prerequisites:

- Basic thermodynamic properties, laws and equations.
- Engineering Mathematics: Differential Equations, Linear Algebraic Equations.

Course Objectives:

- To make students understand the Laws of Thermodynamics and Basics of Chemical Engineering Thermodynamics
- To make students learn to apply the concepts of Chemical Engineering Thermodynamics to various Chemical Engineering Processes

Course Outcomes:

- The students will be able to apply thermodynamic laws and equations to various Chemical Engineering processes.

Module	Contents	Contact Hours
01	<ul style="list-style-type: none"> • First Law of Thermodynamics for flow and non-flow processes • Calculation of heat and work for various types of processes 	08
02	<ul style="list-style-type: none"> • Second Law of Thermodynamics • Concepts of heat engine, heat pump and refrigerator • Carnot Cycle and Carnot Principle • Clausius Inequality • Concept of Entropy and estimation of Entropy change of various processes • Third Law of Thermodynamics 	08
03	<ul style="list-style-type: none"> • Concept of Exergy, Exergy Balance • Steady flow Exergy equation and its application 	06
04	<ul style="list-style-type: none"> • Equations of State for non-ideal gases: Virial equation of state, van der Waals equation of state, Redlich-Kwong, Redlich-Kwong-Soave and Peng-Robinson equation of state 	06
05	<ul style="list-style-type: none"> • Maxwell Equation, Joule Thomson effect • Enthalpy and Entropy departure functions (vander Waals and RedlichKwong EOS) • Thermodynamic Charts, Diagrams and their applications • Fugacity and fugacity coefficient(vander Waals and RedlichKwong EOS) 	08

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Reference

1. Introduction to Chemical Engineering Thermodynamic by J.M. Smith, H.C. Van Ness, M.M. Abbott, Latest Edition, McGraw Hill Publishing Company Limited
2. A textbook of Chemical Engineering Thermodynamics by K.V. Narayanan, Latest Edition, Prentice Hall of India Private Limited
3. Chemical Engineering Thermodynamics by Y.V.C. Rao, Latest Edition, University Press
4. Fundamentals of Engineering Thermodynamics by Micheal J Moran , Howard N Shaprio, Latest Edition, Wiley publication.
5. Introduction to Chemical Engineering Thermodynamics by Gopinath Halder, PHI learning Pvt. Ltd

Course Code	Course/Subject Name	Credits
CHC305	Process Calculations	4

Prerequisites:

- Linear algebra.
- Differential equations

Course Objectives:

- Students will learn to write mass balances on various process equipments with and without recycle.
- Students will learn to write energy balances on various process equipments with and without recycle.
- Students will learn to write mass and energy balances for chemical reactions with and without recycle.
- Students will learn to flow sheeting calculations.

Course Outcomes:

- Students will learn to calculate mass and energy flow rates into and out of various process equipments.
- Students will learn to calculate conversion, selectivity etc for various reactions with and without recycle.
- Students will learn to carry out degrees of freedom analysis for various units.

Module	Contents	Contact Hours
1	Introduction. Basic Chemical Calculations .Units And Dimensions Various systems of units, conversion of units. Density, specific volume, specific gravity, Concentration & composition of mixtures and solutions. Ideal Gas law, Dalton's law, Amagat,s law, Raoult's law, Henry's law	06
2	Material Balance without chemical reactions. General material balance equation, degree of freedom analysis for individual units, solving material balance problems for various unit operations using steady state equation, Material Balance for Unsteady Processes. Recycle, Bypass and Purge Calculations.	07
3	Material Balance with chemical reactions. Concept of limiting and excess reactants, conversion and yield, selectivity and degree of completion of reaction, material balance problems related to chemical reactions including recycle, bypass and purge Calculations.	07
4	Energy Balance. Heat capacity, sensible heat, latent heat, calculation of enthalpy changes. General energy balance equation. Energy balances for process involving chemical reaction including adiabatic reactions & combustion processes (Orsat Analysis & Net, Gross Calorific Value determination).	10

5	Combined Material and Energy balance. Material and Energy balance for binary distillation, combustion and evaporation.	08
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Tutorials

1. Basic chemical calculations.
2. Material balance without chemical reaction.
3. Material balance without chemical reaction for unsteady. Bypass, recycle and purge operations
4. Material balance without chemical reaction for unsteady. Bypass, recycle and purge operations.
5. Energy balance based on heat capacity, enthalpy change.
6. Energy balance based on Hess's law, temperature of reaction.
7. Energy balance based on orsat analysis, NCV and GCV.
8. Combined material and energy balance.

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Text Books

1. Narayan, K. V. and Lakshmikutty, B. "Stoichiometry and Process Calculations", 1st edition, Prentice Hall of India Pvt. Ltd., New Delhi (2006)
2. Bhatt, B. I. and Thakore, S. B., "Stoichimetry, 5th edition Tata McGraw Hill Education Private Limited, New Delhi
3. Ch. Durga Prasad Rao and D. V. S. Murthy, "Process Calculations for Chemical Engineers", McMilan India Ltd. (2010)
4. O. A. Hougen, K. M. Watson, and R. A. Ragatz., "Chemical process principles-part 1, Material and Energy Balances". Second Edition. John Wiley & Sons, Inc., New York (1954). 525 pages.

Reference books

1. Himmelblau, D. M. and Riggs, J. B., “Basic Principles and Calculations in Chemical Engineering, 7th edition, Prentice Hall of India Pvt. Ltd., New Delhi (2009)
2. Stoichiometry and Process calculations by K.V. Narayanan and B. Lakshmikutty, PHI learning Pvt. Ltd

Course Code	Course/Subject Name	Credits
CHC306	Chemical Technology	4

Prerequisites

- Knowledge of Inorganic, Organic and Physical Chemistry, Physics and Mathematics.

Course Objectives

- To give students an insight of different chemical processes.
- To understand the development of a process from its chemistry.
- To understand different engineering problems in process industries.

Course Outcomes

At the end of the course the student will be able to:

- Describe various manufacturing processes used in the chemical process industries.
- Explain industrial processing and overall performance of any chemical process including the major engineering problems encountered in the process.
- Determine the overall process aspects including yield, formation of by-products and generation of waste, etc.
- Draw and illustrate the process flow diagram for a given process.

Module	Contents	Contact Hours
1	<p>Introduction : Concept and brief description of the Unit Operations and Unit Processes used in Chemical Industries.</p> <p>Overview of Industrially Important Products in the Chemical Process Industries: Soaps and Detergents Dyes and Intermediates Agrochemicals</p>	05
2	<p>Manufacture of Acids : Sulphuric Acid (DCDA Process), Nitric Acid, Phosphoric Acid (Wet Process) and Acetic Acid (by reaction of carbon monoxide with methanol).</p> <p>Manufacture of Fertilizers : Ammonia, Urea and Superphosphate (SSP and TSP).</p>	12
3	<p>Natural Product Industries : Hydrogenation of Vegetable Oils Manufacture of Sugar from Sugarcane, By-products obtained in manufacture of sugar, Inversion of sugar Manufacture of ethanol by fermentation of molasses</p> <p>Introduction to Biodiesel Processing : Biodiesel production by base- catalysed transesterification process</p> <p>Chloro-Alkali Industries :</p>	12

	Manufacture of Caustic Soda Manufacture of Hydrochloric Acid by combustion of chlorine and hydrogen Manufacture of Soda Ash (Solvay and Dual Processes)	
4	Synthesis of Important Heavy Organic Chemicals and Intermediates : Manufacture of Styrene by dehydrogenation of ethylbenzene Manufacture of Cumene from benzene and propylene Manufacture of Phenol from cumene by peroxidation-hydrolysis process Manufacture of Purified Terephthalic Acid (PTA) by oxidation of p-xylene	05
5	Synthesis of Polymers : Manufacture of Polyethylene : LDPE and HDPE Manufacture of Nylon 66	03
6	Basic Building Blocks of Petrochemical Industry : Introduction to Petroleum Refining Catalytic Cracking by Fluidized Catalytic Cracking Unit (FCCU) Naphtha Cracking for manufacture of ethylene and propylene Naphtha Reforming Separation of BTX (Benzene-Toluene-Xylene) Isomerization of Xylenes Separation of Xylene isomers	08

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Reference

1. Austin G.T., Shreve's Chemical Process Industries, 5th Edition, McGraw Hill International Edition.
2. Pandey, G.N., A Textbook of Chemical Technology, Vol.I and II, Vikas Publications, 1984.
3. Rao, G.N. and Sittig M., Dryden's Outlines of Chemical Technology for 21st Century, East West Press, 3rd Edition.
4. B.K. Bhaskara Rao, Modern Petroleum Refining Processes.
5. B.K. Bhaskara Rao, A Textbook of Petrochemicals.

6. Heaton, C.A., An Introduction to Industrial Chemistry, Leonard Hill, 1984.
7. Thomson, R., Modern Inorganic Chemical Industries, Royal Society of Chemistry, 2nd. Edition, 1994.
8. Kirk-Othmer's Encyclopedia of Chemical Technology, John Wiley and Sons, Inc., 4th Edition, 1990.
9. Ullmann's Encyclopedia of Industrial Chemistry, VCH, 1985.
10. McKetta's Encyclopedia of Chemical Processing and Design, Marcel Dekker, 1999.
11. Pletcher D. and Walsh, F.C., Industrial Electrochemistry, Chapman and Hall, 1990.
12. Alok Adholeya and Pradeepkumar Dadhich, Production and Technology of Biodiesel: Seeding a Change, TERI Publication, New Delhi, 2008.
13. NIIR Board of Consultants and Engineers, The complete book on Jatropha (Biodiesel) with Ashwagandha, Stevia, Brahmi and Jatamansi Herbs (Cultivation, Processing and Uses), Asia Pacific Business Press Inc.

Course Code	Course/Subject Name	Credits
CHL301	Engineering Chemistry Lab– I	1.5

List of Experiments Suggested:

Volumetric analysis-[Any 2]

Preparation of standard solutions and to find normality and deviation factor.

Titrimetric analysis- [Any 3]

- Analysis of talcum powder for Mg content by EDTA method
- Analysis of Aspirin as per I.P. or USP
- Determination of Strength of KMnO_4
- Determination of fluoride content in the toothpaste spectrophotometrically
- Estimation of CaO in cement
- Estimation of Vitamin C using Ceric ammonium sulphate
- Estimation of Glycine by non aqueous titration using perchloric acid

Organic estimations - [Any 2]

- Estimation of aniline
- Estimation of phenol
- Estimation of Acetamide

Gravimetric estimation - [Any 2]

- Barium as BaCl_2
- Tin as SnCl_2
- Nickel as Ni D.M.G.
- Zinc as ZnSO_4

Preparation.

- Preparation of Methyl Salicylate

Students have to perform any 10 practicals from the above during the semester.

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
CHL302	Chemical Engineering Lab (FFO)	1.5

List of Experiments Suggested

Minimum Ten experiments must be performed

- Viscosity by Efflux time
- Reynolds Apparatus
- Bernoulli's apparatus
- Venturimeter
- Orificemeter
- Pitot tube
- V – Notch/ Rectangular notch
- Friction through Circular pipe
- Flow through Annulus.
- Flow through Helical coil
- Pipe Fitting (Minor Losses)
- Pumps
- Power Consumption in agitated vessel
- Viscosity by Stoke's Law

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
CHL303	Chemical Engineering Lab II (Synthesis)	1

s.n	Preparation	Chemicals required	Apparatus/ glassware required
1	Soap	Sodium hydroxide (20% solution), ethanol saturated solution of sodium chloride ,calcium chloride (5% solution), magnesium chloride (5% solution), ferric chloride (5% solution), cooking oil, phenolphthalein indicator solution.	250-mL beaker, 100- mL beaker; wire gauze; laboratory burner; glass stirring rod; test tubes; filter flask and Buchner funnel; filter paper; graduated cylinder
2	Alum from Aluminum	Aluminum can or aluminum metal, Crushed ice, 9M H ₂ SO ₄ , 1.5M KOH solution, Methanol, NaHCO ₃ (sodium bicarbonate)	Glass filter funnel, Buchner filter funnel, filter paper, steel wool, two 150 mL and two 150 ml beakers, 500 ml beaker, thermometer, ruler, stirring rod
3	Asprin	2 gm salicylic acid, 5.0 ml of acetic anhydride, ve drops of 85% phosphoric acid, distilled water	burette clamp, burner, stand with iron ring, wire gauze, ice bath,50 ml ask beaker, Buchner funnel aspirator
4	Methyl orange	0.29 g of anhydrous sodium carbonate, 1.0 g of sulfanilic acid monohydrate, 0.375 g of sodium nitrite, 0.7 ml of dimethylaniline and 0.5 mL of glacial acetic acid, 10% aqueous sodium hydroxide, 1.25 ml of concentrated hydrochloric acid	50 ml Erlenmeyer ask, lter,100 ml beaker, test tube
5	Thiokol rubber	Sodium hydroxide solution, 1M Sulfur 1,2-dichloroethane distilled or deionized water	Copper wire, approximately 6 inches long (15 cm); two 10 ml vials with teflon cap liners, two 400 ml beakers ,10 ml graduated cylinder ,glass pipette (dropper), hot plate, chemical resistant gloves
6	RUBBER BALL FROM RUBBER LATEX	15 ml rubber latex, 15 ml vinegar, 15 ml wate	Two paper cups (5 ounce), stir- ring rod (popsicle stick or equiv-

			alent), small bucket or large beaker (1000 ml or larger)
7	p-BROMO-NITROBENEZENE FROM BRO-MOBENEZENE	Conc. H ₂ SO ₄ , conc. HNO ₃ , bromobenzene, ethyl alcohol, conical ask, funnel, lter paper, water Bath	Conical flask, funnel, filter paper, water bath.
8	DETERGENT	Dodecanol (dodecyl alcohol), sulphuric acid, concentrated sodium hydroxide, 6M phenolphthalein solution, 1% sodium chloride	Erlenmeyer ask, 125 ml beakers, 400 ml, 150 ml, 100 ml graduated cylinders, 10 ml, 25 ml, 125 ml funnel, spatula, stirring rod, Cheese cloth, watch glass, scissors

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
S.E. Semester IV (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC401	Applied Mathematics-IV	3	-	1	3	-	1	4
CHC402	Engineering Chemistry II	4	-	-	4	-	-	4
CHC403	Chemical Engineering Thermodynamics II	3	-	1	3	-	1	4
CHC404	Solid Fluid Mechanical Operations (SFMO)	4	-	-	4	-	-	4
CHC405	Mechanical Equipment Design (MED)	4	-	-	4	-	-	4
CHC406	Chemical Engineering Economics	3	-	1	3	-	1	4
CHL401	Engineering Chemistry-II Lab	-	3	-	-	1.5	-	1.5
CHL402	Chemical Engineering Lab III (SFMO)	-	3	-	-	1.5	-	1.5
CHL403	MED Lab	-	2	-	-	1	-	1
	Total	21	8	2	21	4	3	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC401	Applied Mathematics-IV	20	20	20	80	3	25	-	-	125
CHC402	Engineering Chemistry II	20	20	20	80	3	-	-	-	100
CHC403	Chemical Engineering Thermodynamics II	20	20	20	80	3	25	-	-	125
CHC404	Solid Fluid Mechanical Operations (SFMO)	20	20	20	80	3	-	-	-	100
CHC405	Mechanical Equipment Design (MED)	20	20	20	80	3	-	-	-	100
CHC406	Chemical Engineering Economics	20	20	20	80	3	25	-	-	125
CHL401	Engineering Chemistry-II Lab	-	-	-	-	3	-	25	-	25
CHL402	Chemical Engineering Lab III (SFMO)	-	-	-	-	3	25	25	-	50
CHL403	MED Lab	-	-	-	-	-	25	-	25	50
	Total			120	480	-	125	50	25	800

Course Code	Course/Subject Name	Credits
CHC401	Applied Mathematics- IV	4

Prerequisites:

- The concepts of basic Mathematics as well as a few concepts of higher mathematics.
- The concepts of basic chemistry, basic civil engineering, basic mechanical engineering, etc. in order to understand the concepts like, corrosion, corrosion allowance, construction costs, equipment costs, etc.

Course Objectives:

- The Fourier Series, Fourier Transform and Partial Differential Equation
- Module does the Ground work for the techniques required to solve and find the answer for various physiochemical problems.
- To study the basics of Finite Differences.
- To study the basics of Complex Integration.
- To introduce the basics of NLPP.

Course outcomes:

- Demonstrate the ability of using Fourier Series and Fourier Transform in solving PDE.
- Enable the students to solve boundary value Problem using Finite Differences Approximations.
- Identify the applicability of theorems and evaluate the Contour Integral.
- The students will be ready for any further course on Optimization.

Module	Topics	Contact Hours
01	Fourier Series: 1.1 Orthogonal and Ortho-normal functions 1.2 Dirichlet's conditions, Fourier series of periodic functions with period 2π and $2L$. Parseval's identities (without proof). 1.3 Fourier series for even and odd functions. 1.4 Half range sine and cosine Fourier series, 1.5 Complex form of Fourier series. 1.6 Fourier Integral Representation, sine & cosine Integrals 1.7 Fourier Transform sine & cosine transforms, complex transforms. NO PROOFS REQUIRED.	10
02	Partial Differential Equations: 2.1 Solutions of linear partial differential Equation by method of separation of variables 2.2 Partial differential equations governing transverse vibrations of elastic string its solution using Fourier series. 2.3 Heat equation, steady-state configuration for heat flow. 2.4 Two dimensional Laplace equations.	08

	(ONLY NUMERICAL PROBLEMS. NO PROOFS REQUIRED).	
	<p>Finite Differences and Interpolation</p> <p>3.1 Forward difference operator Δ, backward difference operator ∇, shift operator E, properties of operators Δ, ∇ and E, relation between E and D where $D = \frac{d}{dx}$.</p> <p>3.2 Missing terms (equal Intervals), Factorial Notation</p> <p>3.3 Assumption of interpolation, Gregory Newton's Forward Interpolation formula for equal Intervals, Gregory Newton's Backward Interpolation formula for equal Intervals</p> <p>3.4 Interpolation with arguments at unequal Intervals-Divided Difference table Newton's Divided Difference Formula,</p> <p>3.5 Lagrange's Interpolation Formula.</p>	07
04	<p>Complex Integration</p> <p>4.1 Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula (without proof)</p> <p>4.2 Taylor's and Laurent's series (without proof)</p> <p>4.3 Zeros, poles of $f(z)$, Residues, Cauchy's Residue theorem</p> <p>4.4 Applications of Residue theorem to evaluate Integrals of the type $\int_0^{2\pi} f(\sin\theta, \cos\theta) d\theta$, $\int_{-\infty}^{\infty} f(x) dx$,</p>	07
05	<p>Optimization (No theory)</p> <p>5.1 Non-linear programming: Lagrange multiplier method for one and two equality constraints for 2 and 3 variables, conditions on the Hessian matrix (no proof);</p> <p>5.2 Non-linear programming: Kuhn-Tucker conditions with at most 2 constraints with two variables.</p>	07

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.

- Weightage of marks should be proportional to number of hours assigned to each Module.

Reference Books

1. Higher Engineering Mathematics by Dr. B. S. Grewal 42th edition, Khanna Publication 2005.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
3. A Text Book of Applied Mathematics Vol. II by P.N.Wartilar & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.
4. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
5. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
6. Laplace Treansforms by Murry R. Spieget, Schaun'sout line series-McGraw Hill Publication.
7. Operation Research by S. D. Sharma.
8. Operation Research by ER.Prem Kumar Gupta & Dr. D. S. Hira.

Course Code	Course/Subject Name	Credits
CHC402	Engineering Chemistry– II	4

Prerequisites:

- Knowledge of electronic structure of atom and electrolytic properties and their laws.
- Basic concept of quantum chemistry & wave theory approach.
- Knowledge of intermediate steps involved in conversion of reactants to products.
- Knowledge of properties of solutions.

Course Objectives:

- To understand applications of EMF measurement.
- To understand the principles of different instrumental and chromatographic techniques.
- To state and understand Nernst distribution law in extraction.
- To be able to solve numerical on solvent extraction and ion exchange.
- To understand colloidal phenomenon and its applications.
- To be able to predict the significance of active methylene group.
- To state and understand the Huckel's rule of aromaticity and its application to aromatic hydrocarbons and heterocyclic compounds.

Course Outcomes:

- They should be able to understand the role of different conductivity cells and different titrimetric methods and solvent extractions.
- Students will be able to detect the organic and inorganic biological compound by the use of spectrophotometer.
- Students will know the colloidal phenomenon applied in food industry and pesticides.
- Students will be able to identify the significance of rearrangement reactions, active methylene group.
- Students will be able to predict and synthesize different products by learning reaction mechanism.
- Students will have deep knowledge of Qualitative (Analysis) and Quantitative (estimations) methods.

Module	Content	Contact Hours
1	Electrochemistry Conductance, specific conductance, equivalent conductance, molar conductance. Effect of dilution and temperature on conductance. Transport number (Numerical on moving boundary method). Debye Huckel theory of strong electrolytes. Hydrogen ion concentration by glass electrode/Quinhydrone electrode. Concentration cells with and without transference w.r.t. cations. Weston Standard cells. Application of emf measurement for	08

	determination of solubility product (K_{sp}) of sparingly soluble salt.	
2	<p>Instrumental methods of Analysis Conductometry -Principle and types of titrations - Acid-base and precipitation. Potentiometry- Principle and types of titrations –precipitation only.</p> <p>Chromatography Adsorption and partition. Study of Paper Chromatography, Thin Layer Chromatography, High Performance Liquid Chromatography (HPLC), Gas (Liquid and solid) Chromatography –Principle and their applications.</p> <p>Optical Methods (Principle, Instrumentation and applications) UV, IR, NMR spectroscopy, flame photometry.</p>	10
3	<p>Ion exchange and solvent extraction techniques Ion exchange resins, cation and anion exchangers. Desalination by ion exchange and separation of lanthanides. Solvent extraction. Nernst distribution law. Distribution ratio. Batch, continuous and counter current extraction. Numericals based on solvent extraction.</p>	06
4	<p>Colloids and surfactants Origin of charge on colloidal particles. Concept of electrical double layer-Helmholtz and stern model. Electro-kinetic Phenomenon- Electrophoresis, electro-osmosis, streaming potential and Dorn effect (Sedimentation potential). Colloidal electrolytes, Donnan Membrane equilibrium and its significance.</p> <p>Catalysis- Definition. Criteria of catalysis. Types (Homogeneous and Heterogeneous).Catalytic promoters, poisons. Negative catalysis and inhibition. Autocatalysis and Induced catalysis. Activation energy. Intermediate compound formation theory. Adsorption theory. Acid Base catalysis and mechanism. Enzyme catalysis- Characteristics and mechanism.</p>	10
5	<p>Industrially important esters and Aromaticity Synthesis and properties of malonic ester and acetate acetic ester. Huckel’s rule of aromaticity, Aromatic character and reactions of Benzene, Naphthalene, Pyrrole, Furan, Thiophene, Pyridine.</p>	06
6	<p>Name reactions. Definition, mechanism and application of -Beckman rearrangement, Fischer-Indole synthesis, Favorskii reaction, Reformatsky reaction, Paal-Knorr synthesis of pyrrole, Benzil-Benzilic acid rearrangement.</p>	05

**Assessment
Internal:**

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Principles of Physical Chemistry- B. R. Puri, L. R. Sharma, M.S. Pathania.
2. A textbook of Physical Chemistry - Glasston Samuel, Macmillan India Ltd. (1991).
3. Physical chemistry - Castellan G.W. Addison Wesley-Haroda Student Edition (1994).
4. Instrumental methods of Analysis - Willard, Merritt, CBS publishers and Distributor.
5. Instrumental Methods of Chemical Analysis - S.M.Khopkar
6. Principle of instrumental analysis - Douglas A. Skoog
7. Organic Chemistry - I L Finar volume I and II.
8. Advanced Organic Chemistry – Jerry March, John Wiley & Sons(Wiley India)
9. Organic Chemistry – J. Clayden, Greeves, Warren, Wothers. Oxford
10. Organic reaction Mechanisms- V.K. Ahluwalia , Rakesh Parashar, Narosa Publication
11. Spectroscopy – P.S. Kalsi
12. Introduction to Spectroscopy – Pavia, Lampman, Krutz.
13. Engineering Chemistry- Jain & Jain Dhanapat Rai publication.
14. Vogel's Textbook of Practical organic chemistry.

Course Code	Course/Subject Name	Credits
CHC403	Chemical Engineering Thermodynamics II	04

Prerequisites:

- Engineering Mathematics, Chemical Engineering Thermodynamics-I

Course Objectives:

- To make students understand the concepts of equilibrium in phases and in chemical reactions
- To make students learn to calculate conditions and compositions of ideal and non-ideal vapor liquid equilibrium systems and of various chemical reactions at equilibria.
- To make students understand the concept of refrigerator and learn to calculate COP, power required etc. for a given duty of refrigeration

Course Outcomes

- Students learn the application of First law and second law to the problem of phase equilibrium and reaction equilibrium.
- Students learn to calculate the refrigerant flow rate for a given duty of refrigeration.
- Students learn to calculate the compressor sizes and loads for refrigeration.
- The calculation of phase equilibria and the understanding of it is a fundamental concept to design of mass transfer

Module	Contents	Contact hrs
01	<ul style="list-style-type: none"> • Properties of ideal mixtures and solutions • Non idealities of solutions and mixtures • Chemical potential • Activity and activity coefficients • Gibbs Duhem equations 	04
02	<ul style="list-style-type: none"> • Partial molar properties • Properties changes of mixing • Excess properties 	06
03	<ul style="list-style-type: none"> • Concept of equilibrium between phases • Review of Raoult's law and Henry's law • Phase diagrams for binary solutions • Vapor liquid equilibria in ideal and non-ideal solutions • Estimation of activity coefficients using van Laar equation, Margules equation, Wilson equation 	10
04	<ul style="list-style-type: none"> • Representation of reaction stoichiometry • Concept of reaction equilibrium in single and multiple reactions <ul style="list-style-type: none"> • Estimation of standard enthalpy change of a reaction • Heat of reaction in a batch and continuous reactor 	10

	<ul style="list-style-type: none"> • Estimation of standard Gibbs free change and equilibrium constant of a reaction • Estimation of degree of conversion and composition of reactor effluents • Degree of freedom for single and multiple reactions 	
05	<ul style="list-style-type: none"> • Theory of Refrigeration • Vapor compression refrigeration system • Vapor absorption refrigeration system • Refrigeration cycle diagrams (P-V, T-S, H-S, H-X) • Estimation of COP, power of compression, refrigerant flow rate etc. 	06

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Reference

1. Introduction to Chemical Engineering Thermodynamic by J.M. Smith, H.C. Van Ness, M.M. Abbott, Latest Edition, McGraw Hill Publishing Company Limited
2. A textbook of Chemical Engineering Thermodynamics by K.V. Narayanan, Latest Edition, Prentice Hall of India Private Limited
3. Chemical Engineering Thermodynamics by Y.V.C. Rao, Latest Edition, University Press
4. Elementary Principle of Chemical Processes by Felder and Rousseau Latest Edition.
5. Introduction to Chemical Engineering Thermodynamics by Gopinath Halder, PHI learning Pvt. Ltd

Course Code	Course/Subject Name	Credits
CHC404	Solid Fluid Mechanical Operations	4

Prerequisites:

- Fluid Flow Operations
- Engineering Mechanics
- Differential Equations

Course Objectives:

- understanding basic concept of particle size analysis and size reduction
- Understanding concept of flow through packed bed fluidization and filtration
- Understanding concept of sedimentation & gas solid separation
- Understanding concept of size enlargement, solid mixing and solid storage & conveying.

Course outcomes:

- The students would understand the concept of particle size analysis and size reduction.
- The students would understand the concept of flow through packed bed, fluidization and filtration
- The students would understand the concept of sedimentation and gas- solid separation.
- The students would understand the concept of solid mixing, solid storage & conveying, size enlargement.

Module	Contents	Contact Hours
1	Introduction- scope & application of solid fluid operation <ul style="list-style-type: none"> • Particle size analysis, particle size measurement and distribution • Sieve analysis • Capacity and effectiveness of screen • Screening Equipment: Vibrating screens; Grizzlies; Trommels • Size reduction of solids • Mechanism of size reduction and method of operation • Energy of size reduction • Size reduction Equipments: Jaw Crusher; Hammer Mill; Ball Mill; Roll Crusher 	12
2	<ul style="list-style-type: none"> • Flow through packed bed • Types of packing • Flow of a single fluid through a packed bed, Ergun's equipment • Fluidization: Conditions for fluidization; Minimum 	12

	fluidization velocity; Types of fluidization; Application of Fluidization; Numerical on Fluidization <ul style="list-style-type: none"> • Filtration: Mechanism of Filtration; Types of Filtration – constant rate & constant pressure; Filtration; Filter aids, washing of filter cake; Flow of filtrate through the cloth & cake combine; Numerical on constant pressure & constant cloth rate & combine cake. • Filters: Rotary drum vacuum filter, Plate & frame filter press 	
3	<ul style="list-style-type: none"> • Economics of production and Growth • Sedimentation: Batch sedimentation; Kynch Theory of sedimentation; Area and Depth of thickener • Particle separation by Flotation and Elutriation • Gas solid separation Equipments: Cyclone separator- theory and derivation for minimum particle separated in cyclone separator. Fabric filter, Electrostatic precipitator 	10
4	<ul style="list-style-type: none"> • Size enlargement of particles: Agglomeration & granulation Growth mechanism; Size enlargement processes • Storage of solids: Properties of particulate masses; Pressures in Bins & Silos; Jansen's equation • Conveying of solids: Belt conveyer, bucket conveyer, screw conveyer, pneumatic conveyer • Solid mixing: Introduction to solid mixing, degree of mixing, mixing Index & rate of mixing; Mixing Equipments: 1) Mixers for cohesive solids: Muller Mixer; Kneaders . 2) Mixers for free flowing solids: Ribben Blender; Internal Screw mixer 	10

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Unit operations of Chemical engineering, WC McCabe & J C Smith, McGraw Hill
2. Chemical Engineering, Vol II J M Coulson & J F Richardson, pergamon Press
3. Unit operations by foust
4. Perry's Handbook for chemical Engineers, Robert H. Perry & Don W. Green, 8th edition, McGraw Hill

Course Code	Course/Subject Name	Credits
CHC405	Mechanical Equipment Design (MED)	4

Prerequisites:

- Fundamentals of units
- Elementary theory of engineering mechanics
- Engineering drawing

Course Objectives:

- To understand the basics for design as per the codes & standards for the mechanical design of equipments used in the process industry.
- Selection of material of construction and stress analysis by determining values of stresses arising out of different loading conditions.

Course Outcomes:

- Students will demonstrate ability to design various components of process equipment as heads, shell, flanges and supports and complete design of chemical equipment
- Students will demonstrate understanding of design of storage vessel
- Students will demonstrate general understanding of fabrication techniques and equipment testing as a designer.

Module	Contents	Contact Hours
1	Introduction to Chemical process equipment design. Nature of process equipment, General design procedure. Basic consideration in process equipment design, Standards, codes & their significance, equipment classification & selection. Fundamentals of various stresses due to compression, tension, bending, torsion & thermal stresses. Fundamental of bending moment and shear stress. Concept of moment of inertia. Calculating moment of inertia for I, T, circle and solid bar. Calculation of bending moment of cantilever and simply supported beam and uniform distributed load. Principal stress and theories of failure. Concept of hook's law, material behavior and poisson's ratio, material of construction for chemical process equipment, Design pressure, Design temperature, design stress & design loads, Significance of factor of safety and economic considerations.	6
2	Design of Unfired Pressure Vessels Type of pressure vessels, code & standard for pressure vessels (IS: 2825:1969). Material of Construction, Selection of corrosion Allowance & weld joint efficiency. Thin cylinder theory for internal pressure. PART A: Pressure Vessel Subjected to Internal Pressure. Complete design of cylindrical pressure vessel as per IS: 2825: 1969. Study, selection & design of various heads such	10

	as flat, hemispherical, torispherical, elliptical & conical openings/nozzles & manholes etc. Flanged joints. Gasket: Types, selection & design. Bolt design & selection. Flange dimensions & optimization for bolt spacing. PART B: Pressure Vessel Subjected to External Pressure. Design of shell, heads nozzles, flanged joints & stiffening rings as per IS 2825: 1969 equation. Appendix F by use of charts. Analytical approach by elastic bucking & plastic deformation.	
3	Study of Various types of storage vessels and application. Atmospheric vessels, vessels for storing volatile & non-volatile liquids. Storage of gases, Losses in storage vessel. Various types of roofs used for storage vessels. Manholes, Nozzles and mounting. Design of cylindrical storage vessels as per IS: 803 should include base plates, shell plates ,roof plate and wind girders.	5
4	Study of various types of agitators & their application. Baffling. Power requirement of agitators & their applications, system which includes design of shaft based on equivalent bending moment and critical speed. Design of blades & Blade assembly, key & key ways. Study of seals. Design of stuffing box and gland.	6
5	Introduction, Classification of reaction vessels, Material of Construction, Heating system. Material of Construction, Heating system. Design of vessel. Study & design of various types of jackets like plain and half coil.	4
6	Introduction & classification of support. Design of skirt Support considering stresses due to dead weight, wind load, Seismic load & period of vibration. Design of base plates, skirt bearing plate, anchor bolt and bolting chair. Introduction to bracket support. Design of saddle supports.	5
7	Fundamentals of pipeline design. Optimum diameter of pipelines. Supporting structure for pipelines. Pipeline design for liquids and gases, steam and thermic fluids. Material of construction for pipelines.	4
8	Equipment fabrication and inspection Metal forming techniques (bending, Rolling, Forming). Metal Joining techniques – welding (Gas of Arc & Electric) for various types such as Butt, Lap, fillet, corner. Inspection of vessel by radiography.	4

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.

- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Text Books

1. Process Equipment Design, 4th Edition, V.V. Mahajani, Umarji, Macmillan Publishers
2. Process Design of Equipments, 4th Edition, S.D. Dawande, Central Techno publications
3. Introduction to Chemical Equipment Design, B.C. Bhattacharya, CBS publications
4. Design of machine elements, V.B. Bhandari, McGraw Hill publications
5. Machine Drawing, N.D. Bhatt and V.M. Panchal, Charotar publication
6. Process Equipment Design and Drawing by Kiran Ghadyalji, Nandu publication.
Kiran Ghadyalji, Nandu publication

Reference books

1. RC's Chemical Engineering, Fourth edition, R. K. Sinnott, Pergamon Press publications
2. Chemical Engineering Design, Fifth edition, Ray Sinnott and Cavin Towler, Elsevier, Butterworth-Heinemann publications
3. Equipment design handbook for refineries and chemical plants, volume 1 & 2, Evans F.L, Gulf publications
4. Process equipment design-vessel design, Brownell L.E., Edwin Young, John Wiley publications

Course Code	Course/Subject Name	Credits
CHC406	Chemical Engineering Economics	4

Prerequisites:

- The concepts of basic Mathematics as well as a few concepts of higher mathematics.
- The concepts of basic chemistry, basic civil engineering, basic mechanical engineering, etc. in order to understand the concepts like, corrosion, corrosion allowance, construction costs, equipment costs, etc.

Course Objectives:

- To understand various economical terms and economics related activities which can be helpful to them during economical evaluation of any chemical engineering related problem.
- To learn about various basic economic aspects like need, demand, supply, price, cost and market.
- To make familiar to calculate the interest amount on investments as well as loans by different methods
- To understand the concepts of present and future worth of property.
- To understand existing rules and regulations as well as types related to taxes and insurance.
- To understand the methodology of cost estimation including fixed and variable costs by considering the concept of cost indices.
- To have the knowledge about evaluation of depreciation cost as well as salvage value, scrap value, book value of property
- To understand the concept of profitability evaluation of project and select best process alternative based on its economic evaluation.
- To understand the concept of balance sheet, profit and loss accounting and income statement

Course Outcomes:

- Students should will be expose to market And demand driven economics in chemical industry.
- Get an idea on the growth and development of futuristic planning.
- Students will be able to calculate the profitability, rate of return on investments and cost estimation.
- After acquiring the knowledge in this subject, students become familiar with various aspects related to economics and can apply them for economic evaluation of chemical process and decide its economical feasibility.
- The knowledge in this subject will make the students well aware about economic evaluation of dissertation work that they will undertake in final year of their curriculum.
- Students will learn to prepare realistic cost estimation to prepare plan and offer.

Module	Contents	Contact hours
1	Introduction to Basic Principles of Economics: <ul style="list-style-type: none"> • Economics-various definitions • Concept of Need – hierarchy • Market - Concept of Price determination under particular market conditions – perfect competition market & monopoly market, causes • Price Discrimination-concept, types • Concept of Cost-total cost, fixed and variable cost, direct and indirect cost • Cost index – definition, types 	02
2	Demand and Supply analysis: <ul style="list-style-type: none"> • Law of demand-assumptions and exceptions • Demand schedule and demand curve • Determinants of demand • Changes and variations in demand • Demand elasticity-definition, types, methods of measurement of elasticity, Income elasticity of demand, types. • Law of Supply-assumptions and exceptions • Supply schedule and supply curve • Determinants of supply, changes and variations in supply • Supply elasticity-definition, types, determinants • Methods of measurement of supply 	02
3	<ul style="list-style-type: none"> • Economics of production and Growth: • Production function-types of production economies • Diseconomies of scale • Features of growth • Growth v/s Development • Determinants of growth (economic and non-economic) • Stages of growth & futuristic planning • Growth strategy- steady state and big – push growth strategy; balanced and unbalanced growth 	02
4	<ul style="list-style-type: none"> • Cost Accounting: • Outline of Accounting Procedure • Basic Relationship in Accounting • Balance Sheet- types of Asset; Current and Cash Ratio • Income Statement; Debits and Credits; General format of Journal and Ledger • Methods of cost accounting 03 • Accumulation, inventory and cost-of-sales account • Material cost – Different Methods: current average, fifo, lifo 	03
5	<ul style="list-style-type: none"> • Interests and Investment Costs: • Importance of time value of money- Interest and Interest 	06

	<p>rate;</p> <ul style="list-style-type: none"> • Types of Interest – Simple interest (ordinary and exact), Compound interest, Nominal and Effective interest rates, Continuous interest • Present worth and Discount • Annuities, Perpetuities and Capitalized costs • Cash Flow in Chemical Project 	
6	<ul style="list-style-type: none"> • Taxes and Insurance: • Concept of taxes and insurance • Types of Taxes - property tax, excise tax, income tax Capital gain tax, surtax, normal tax • Insurance types, Legal responsibilities, Self insurance • Effect of taxes and depreciation on annual income • Depreciation , types of depreciation, Methods of depreciation & Numericals 	03
7	<ul style="list-style-type: none"> • Cost Estimation: • Cash flow to Industrial operation – Tree diagram; Cumulative Cash position • Factors affecting cost estimation; • Total, fixed, working capital investment • Breakdown of Fixed capital investment- Direct costs; Indirect costs; • Types of Capital Cost Estimates • Grass Root plant; Battery limit; • Estimation of equipment cost by scaling; Components of costs in FCI; • Methods of Cost Estimation • Estimation of Total Product Cost; • Break even Analysis • Cost estimation to prepare offer. 	10
8	<ul style="list-style-type: none"> • Profitability, Alternative Investments & Replacements: • Introduction; Profitability Standards; • Mathematical methods for profitability evaluation- Rate of Return on investment method , Discounted cash flow method , Net present worth method, Capitalized Cost method , Pay out period method; Advantages & Disadvantages of Different Profitability Analysis Methods and their comparison • Alternative investments • Replacement analysis • Practical factors affecting investment and replacement decisions 	11

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Peters, M. S. and Timmerhaus, K. D. , “Plant design and economics for chemical engineers”, latest edition, Mcgraw Hill, New York
2. Pravin Kumar “Fundamentals of Engineering Economics” Wiley India.
3. Kharbanda, O. P. and Stallworthy, E. A. “Capital cost estimating for process industries”, Butterworths, London
4. K. K Dewett and Adarshchand, “ Modern Economic Theory”, latest edition, S Chand and Company
5. O. P Khanna, “Industrial Engineering and Management” DhanpatRai Publications (P) Ltd.
6. AtulSathe, ShubhadaKanchan, “Chemical Engineering Economics”, VipulPrakashan, Mumbai
7. Indrajit N. Yadav, “Chemical Engineering Economics” Sai- publication,Pune 2nd edition, 2017

Course Code	Course/Subject Name	Credits
CHL401	Engineering Chemistry Lab– II	1.5

List of Experiments Suggested:

- **Organic spotting-** Identification of organic compounds [**at least 05**].
- **Potentiometric Titrations**
- Titration of strong acid and strong base potentiometrically.
- Determination of solubility and solubility product of AgCl.
- **pH-metry.**
- Determination of dissociation constant of dibasic organic acids such as malonic acid, succinic acid.
- **Conductometric Titrations.**
- Titration of strong acid with strong base.
- Weak acid against strong base.
- Titration of mixture of weak acid and strong acid against strong base.
- **Flame photometry.**
- Determination of Na / K / Ca present in the given sample.
- **Chromatography.**
- Estimation of Sodium by Ion Exchange chromatography.
- Paper Chromatography and TLC [Demonstration of techniques].
- **Organic Estimations.**
- Estimation of Glucose Iodometrically.
- Estimation of Ester by Hydrolysis.
- Volume strength and amount of H₂O₂.
- **Organic preparations**
- Nitration of benzene
- Nitration of Salicylic Acid
- Sulphonation of Benzene

Students have to perform any 10 practicals from the above during the semester.

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
CHL402	Chemical Engineering Lab III (SFMO)	1.5

List of Experiments Suggested

Minimum Ten Experiments must be performed

1. Sieve Analysis
2. Effectiveness Of Screen
3. Size reduction by Jaw Crusher
4. Size reduction by Hammer Mill
5. Size reduction by Ball Mill
6. Batch Sedimentation
7. Flow through Packed Bed
8. Flow through Fluidized Bed
9. Filtration
10. Mixing
11. Cyclone Separator
12. Roll Crusher
13. Elutriation
14. Froth Flootation

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
CHL403	MED Lab	1

Drawing sheets based on (Minimum of 8 sheets):

1. Design of Unfired Pressure Vessel with internal pressure.
2. Design of Unfired Pressure Vessel with external pressure.
3. Storage Vessel.
4. Agitator.
5. Reaction Vessel.
6. Vessel Supports.

Term work

Term work shall be evaluated based on performance in Lab.

Drawing Sheets: 20 marks
Attendance: 05 marks
Total: 25 marks

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
T.E. Semester V (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC501	Computer programming and Numerical Methods	4	-	-	4	-	-	4
CHC502	Mass transfer Operations-I (MTO- I)	4	-	-	4	-	-	4
CHC503	Heat transfer Operations (HTO)	4	-	-	4	-	-	4
CHC504	Chemical Reaction Engineering-I (CRE I)	4	-	-	4	-	-	4
CHC505	Business Communication & Ethics	2	-	2	-	-	2	2
CHDE501X	Department Elective I	4	-	-	4	-	-	4
CHL501	Computer programming and Numerical Methods lab	-	2	-	-	1	-	1
CHL502	Chemical Engineering Lab IV (MTO-I)	-	3	-	-	1.5	-	1.5
CHL503	Chemical Engineering Lab V (HTO)	-	3	-	-	1.5	-	1.5
CHL504	Chemical Engineering Lab VI (CRE-I)	-	2	-	-	1	-	1
Total		20	14	-	20	5	2	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC501	Computer programming and Numerical Methods	20	20	20	80	3	-	-	-	100
CHC502	Mass transfer Operations-I (MTO- I)	20	20	20	80	3	-	-	-	100
CHC503	Heat transfer Operations (HTO)	20	20	20	80	3	-	-	-	100
CHC504	Chemical Reaction Engineering-I (CRE I)	20	20	20	80	3	-	-	-	100
CHC505	Business Communication & Ethics	-	-	-	-	-	50	-	-	50
CHDE501X	Department Elective I	20	20	20	80	3	-	-	-	100
CHL501	Computer programming and Numerical Methods Lab	-	-	-	-	2	25	25	-	50
CHL502	Chemical Engineering Lab IV (MTO-I)	-	-	-	-	3	25	25	-	50
CHL503	Chemical Engineering Lab V (HTO)	-	-	-	-	3	25	25	-	50
CHL504	Chemical Engineering Lab VI (CRE-I)	-	-	-	-	2	25	25	-	50
Total				100	400	-	150	100	-	750

Department Elective I (Sem V)		
Engineering Stream (Elective Code)	Advanced Sciences Stream (Elective code)	Technology Stream (Elective Code)
1. Piping Engineering (CHDE5011) 2. Instrumentation (CHDE5014)	1. Colloids and Interfaces (CHDE5012)	1. Advanced Material Sciences (CHDE5013)

Course Code	Course/ Subject Name	Credits
CHC501	Computer Programming & Numerical Methods	4

Prerequisites:

- Differential Calculus.
- Integral Calculus.
- Differential Equations.
- Linear Algebraic Equations.

Course Objectives:

- To familiarize students with the use of software in solving numerical problems.
- To develop analytical thinking in designing programs.
- To learn to interpret results of computer programs and debug the same.
- To learn to present results in graphical form.

Course Outcomes:

- The students will be able to solve linear algebraic equations.
- The students will be able to solve non-linear algebraic equations.
- The students will be able to solve differential equations.
- The students will be able to solve partial differential equations.

Module	Contents	Contact Hours
1	<ul style="list-style-type: none"> • Fundamentals of Python • Variables • Expressions and Arithmetic • Conditional Execution • Functions • Lists and Objects 	8
2	<ul style="list-style-type: none"> • Solution of algebraic and transcendental equations. • Bisection Method • RegulaFalsi Method. • Successive substitution. • Secant Method. • Newtons Method for one and two simultaneous equations • Applications in Chemical Engineering 	8
3	<ul style="list-style-type: none"> • Systems of linear equations. • Gaussian Elimination • Gauss Jordan Method • LU Decomposition • Jacobi Iteration Method • Gauss-Seidel Method. • Applications in Chemical Engineering 	8

4	<ul style="list-style-type: none"> • Ordinary differential equations. • Euler's explicit and implicit methods. • Runge-Kutta second and fourth order methods. • Adams-Bashforth formulas. Predictor and Corrector Formulas <ul style="list-style-type: none"> • Gear's Method • Applications in Chemical Engineering 	10
5	<ul style="list-style-type: none"> • Difference Equations • Linear and Non-linear equations • Applications to Absorption, Adsorption , Extraction etc. 	6
6	<ul style="list-style-type: none"> • Partial differential equations. • One-dimensional diffusion equation: Transient and Steady-state problems using explicit and implicit methods. • Two-dimensional diffusion: steady-state problems. 	8

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Books

1. Numerical Methods for Engineers. By Santosh K. Gupta New Age Publishers, Second Edition, 2010
2. Introduction to Chemical Engineering Computing by Bruce A. Finlayson Wiley-International, 2005.
3. Numerical Methods by Chapra and Canale, 4th Ed.

References

1. Learning Python
Mark Lutz and David Ascher
2. Numerical Methods
John Mathews

Course Code	Course/ Subject Name	Credits
CHC502	Mass Transfer Operation I	4

Prerequisites:

- Knowledge of chemistry, physics, physical chemistry, mathematics, process calculations and unit operations.

Course Objectives:

- To give insight of mass transfer basic principle and mass transfer mechanisms.

Course Outcomes:

At the end of the course students will be able to:

- Demonstrate the knowledge of mass transfer by applying principles of diffusion, mass transfer coefficients, and interphase mass transfer.
- Understand the concept and operation of various types of gas-liquid contacts equipments.
- Determine NTU, HTU, HETP and height of packed bed used for Absorption and Humidification operations.
- Find time required for drying and design of drying equipments.

Module	Contents	Contact Hours
1	<p>Molecular Diffusion in Gases and Liquid: Basics of Molecular Diffusion, Fick's First Law of Molecular Diffusion, Various fluxes and relations between them, Molecular Diffusion in binary gas mixtures- Steady state diffusion of one component in non-diffusing second component, Equimolar counter diffusion of two components. Molecular Diffusion in binary liquid solutions- Steady state diffusion of one component in non-diffusing second component, Steady State Equimolar counter diffusion of two components. Diffusivity of gases. Theoretical and experimental determination of diffusivities, Diffusivities of liquids - Theoretical Determination. Diffusion in Solids: Ficks law of diffusion in solids, Types of Solid Diffusion, Diffusion through Polymers, Diffusion through Crystalline Solids, Diffusion in Porous Solids</p>	10
2	<p>Mass Transfer Coefficients: Definition of Mass Transfer Coefficient, F-Type and K-Type Mass Transfer Coefficients and relations between them, Mass Transfer Coefficients in Laminar and Turbulent Flow. Heat, Mass and Momentum Transfer Analogies and dimensionless numbers, Interphase Mass Transfer- Individual and Overall Mass Transfer Coefficients and relation between them. Methods of contacting two insoluble phases- Continuous Contact, Stage-wise Contact. Cocurrent, counter current and cross current operations, Equilibrium stage definition and concepts, equilibrium stage</p>	12

	operations: material balance, concepts of operating line and equilibrium line, theoretical stage, point and stage efficiency, overall efficiency. Continuous contacting, concepts of HTU,NTU,HETP etc.	
3	Equipments for Gas-Liquid Contacting: Classification of equipments for gas-liquid contacting <ul style="list-style-type: none"> • Gas dispersed and liquid continuous phase-Sparged Vessels (Bubble Columns), Mechanically Agitated Vessels, Tray Towers. • Liquid dispersed phase and gas continuous phase -Venturi Scrubbers, Wetted Wall Towers, Spray Towers and Spray Chambers, Packed Towers. Comparison of Packed Towers with Tray Towers.	06
4	Gas Absorption: Solubility of gases in liquids, Effect of temperature and pressure on solubility, Ideal and Non-ideal solutions, Choice of solvent for gas absorption, Single component gas absorption- Cross Current, Co-current, Countercurrent, Multistage Counter current Operation. Absorption with Chemical Reactions.	07
5	Drying: Introduction to drying, Equilibrium, Different types of moisture contents, Rate of Drying and drying curve, Batch Drying and calculation of time of drying, Continuous drying. Equipments for drying.	06
6	Humidification and Dehumidification: Introduction, Vapor Pressure Curve, Properties of Vapor-Gas mixtures [Understanding various terms], Theory of wet bulb temperature, Adiabatic Saturation Curves, Humidity Charts, Adiabatic operation : (Air water systems) water coolers, cooling towers	07

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Book

1. Treybal R.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.
2. McCabe W.L. and Smith J.C., Unit operation in chemical engineering, 5 Ed., McGraw Hill, NewYork,1993.

3. Geankoplis C.J., Transport processes and unit operations, Prentice Hall, New Delhi 1997.

References

1. Coulson J.M. Richardson J.F., Backhurst J.R. and Harker J.H., Coulson and Richardson chemical Engineering, vol 1 & 2, Butterworth Heinman, New Delhi, 2000.
2. Dutta B.K., Mass Transfer and separation processes, Eastern economy edition, PHI learning private ltd, New Delhi, 2009.

Course Code	Course/ Subject Name	Credits
CHC 503	Heat Transfer Operations	4

Prerequisites:

- Units and Dimensions, Fluid Flow Principles, Laws of Thermodynamics, Solution Technique of ODEs and PDEs.

Course Objectives:

- Students should be able to calculate heat transfer rates by various modes of heat transfer, for various geometry of equipment and should get introduced to Unsteady Heat Transfer.
- Students should be able to design Double Pipe Heat Exchanger and also be able to do preliminary design of Shell and Tube Heat Exchanger. Should be familiar with Extended Surfaces, Evaporators, and Agitated Vessels etc.

Course Outcomes:

Upon Completion of this course students would be able to

- Analyze Steady and Unsteady State Conduction systems.
- Analyze Convective Heat transfer Systems.
- Analyze Radiative Heat Transfer Systems.
- Analyze Extended Surfaces, Evaporators and Agitated Vessels.
- Basic design of DPHE and STHE.

Module	Contents	Contact Hours
1	<p>Introduction to Heat Transfer Operations and Heat Transfer by Conduction Fundamentals of heat transfer, basic modes of heat transfer. Concept of driving force and heat transfer coefficients, rate expressions for three modes i. e. conduction, convection, radiation. Steady State Conduction:-Fourier's Law, thermal conductivity, conduction through a flat slab, composite slab, conduction through a cylinder wall, composite cylinder, Conduction through hollow sphere, composite sphere. Thermal resistance network. Critical radius of insulation. Unsteady state conduction: -Lumped Parameter Analysis - systems with negligible internal resistance (Heat transfer by convection and radiation). Biot number, Fourier number, Heating a body under conditions of negligible surface resistance, heating a body with finite surface and internal resistance.</p>	10
2	<p>Heat Transfer by Convection Forced and Natural Convection:-Fundamental considerations in convective heat transfer, significant parameters in convective heat transfer such as momentum diffusivity, thermal diffusivity, Prandtl number, Nusselt number, dimensional analysis of convective heat transfer-Natural and Forced convection, convective heat transfer</p>	8

	correlations for internal and external flows, equivalent diameter for heat transfer, estimation of wall temperature, Reynold's Analogy, Prandtl' Analogy, Coulburn's Analogy. Correlations for heat transfer by natural convection from hot surfaces of different geometries and inclination.	
3	Boiling and Condensation: -Introduction, types of condensation, Nusselt's theory of condensation, correlations for vertical and horizontal tube, plate, for stack of tubes etc. Heat transfer to boiling liquids, regimes of pool boiling of saturated liquid, correlations for estimating the boiling heat transfer coefficients.	6
4	Heat Transfer by Radiation Emissivity, absorptivity, black body, grey body, opaque body, Stephan Boltzmann law, Kirchhoff's law. Calculations for rate of heat transfer by radiation (Steady State) for various cases. Construction and working of various types of Box and Cylindrical types of Furnaces.	8
5	Heat Exchangers Extended Surfaces: -longitudinal, transverse and radial fins, calculations with different boundary conditions, efficiency and effectiveness of fin, calculation of rate of heat transfer.	5
6	DPHE and STHE: -Overall Heat Transfer Coefficients (U), Resistance form of U, LMTD, and Wilson plot; fouling factors.Process design of Double Pipe Heat Exchanger. Preliminary process design and Kern's method of Design for Shell and Tube Heat Exchanger. Effectiveness-NTU method.	5
7	Heat Transfer to Vessels: - Jacketed Vessels, Internal Coils and Agitated Vessels- heat transfer correlations and calculations. Evaporators:- Types of Tubular Evaporators, Performance Capacity and Economy, Boiling Point Elevation, Mass and Enthalpy Balances For Single Effect Evaporators, Multieffect Evaporators:- Methods of Feeding; Mass and Energy balance.	6

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Books

1. B. K. Datta, Heat Transfer: Principles and applications, PHI learning.
2. Yunus A. Cengel and A. J. Ghajar, Heat and Mass Transfer.
3. Welty, Wicks, Wilson and Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 5th Edition, Wiley India.
4. D. Q. Kern, Process Heat Transfer, McGraw hill, 1997.

References

1. McCabe W. L., Smith J. C., Harriot P., Unit Operations of Chemical Engineering, 5th edition, McGraw Hill, 1993.
2. Holman J. P., Heat Transfer, 9th Edition, McGraw Hill, 2008.
3. R. K. Sinnott, Coulson & Richardsons Chemical Engineering Design, Vol 1 & 6, Elsevier Science & Technology Books.

Course Code	Course Name	Credits
CHC504	Chemical Reaction Engineering-I	4

Prerequisites:

- Students should know basic chemistry pertaining to chemical reactions, chemical formula etc. They are required to be aware of chemical process and unit operations used for the manufacturing of chemical products. Simple to complex numerical methods of solving one and two dimensional Mathematical equations.

Course Objectives:

- To understand the different types of reactions and formulation of their reaction rate.
- Development of Kinetic model for homogeneous reactions giving emphasis on various types of reactions.
- Development of design strategy for homogeneous reactions considering different types of reactors.
- To understand the effect of temperature on reactor performance for adiabatic and non adiabatic operation

Course Outcomes:

- Students will be able to identify and analyze different types of homogeneous reactions.
- Students will be able to apply the knowledge they have gained to develop kinetic models for different types of Homogeneous reactions
- Students will be able to find the model equation and use this model to design the reactors used for Homogeneous reactions.
- Students will be able to understand the effect of temperature on reactor performance for adiabatic and non adiabatic operation and develop kinetic model to design the reactors for adiabatic and non-isothermal operations.

Module	Topics	Contact Hours
1	Introduction to Reaction Engineering: Classification of reactions, definitions of reactions rate, variables affecting reaction rate, speed of chemical reactions. Kinetics of homogenous reactions: Simple reactor types, the rate equation, concentration dependent term of rate equation. Molecularity and order of reaction. Rate constant k, representation of an elementary and non elementary reaction. Kinetic models for non elementary reactions. Testing kinetic models. Temperature dependant term of rate equations from Arrhenius theory and comparison with collision and transition state theory. Activation energy and temperature dependency. Predictability of reaction rate from theory.	10
2	Methods of analysis of experimental data	12

	For constant volume and Variable Volume Batch Reactor-Integral Method of analysis of experimental data. Differential Method of analysis of experimental data. Concept of Half Life/Fractional Life. Overall order of irreversible reaction. Analysis of total pressure data. Reversible and irreversible reaction in parallel and in series. Homogeneous catalyzed reactions, Auto catalytic reactions, Shifting Order reactions.	
3	Design of Reactors: Ideal batch reactor and concept of batch time. Flow reactor and concept of space time / space velocity and holding time/residence time. Ideal Mixed Flow reactor(MFR) and Plug Flow Reactor (PFR). Design for single reactions: Single reactor performance of reversible and irreversible first order, pseudo first order, second order reactions for MFR, PFR. Graphical and analytical techniques. Combination of reactors: PFR in series/ parallel, unequal size MFR in series, performance of the above for the first order and second order reactions. Semi batch reactor and Recycle Reactor. Design for complex reactions: Irreversible and Reversible reactions in series and parallel with same or different order in various combinations.	12
4	Heat and pressure effects: Single Reactions: Calculations of heats of reaction and equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure. Optimum temperature progression, Energy balances equations in adiabatic and non-adiabatic case. Exothermic reaction in mixed flow, Rules for choice of reactors and optimum operation of reactors.	10

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Levenspiel O., Chemical Reaction Engineering, John Wiley&Sons,3ed.,1999.
2. Smith J.M., Chemical Reaction Engineering, 3ed.,TataMcGrawHill,1980.
3. Fogler,H.S.Elements of Chemical Reaction Engineering, 4ed.,PHI, 2008

4. Hill C.G., Chemical Reaction Engineering.
5. Walas, Reaction Kinetics for Chemical Engineers, McGraw Hill, 1959.

Course Code	Course/Subject Name	Credits
CHC505	Business Communication and Ethics	2

Prerequisites:

- Students should have basic knowledge of English and general engineering.

Course Objectives

- To inculcate in students professional and ethical attitude, effective communication skills, teamwork, multidisciplinary approach, and an ability to understand Engineers' social responsibilities
- To provide students with an academic environment where they will be aware of the excellence, leadership and lifelong learning needed for a successful professional career
- To inculcate professional ethics and codes of professional practice
- To prepare students for successful careers that meets the global Industrial and Corporate requirement

Course Outcomes:

Students will be able to

- Communicate effectively in both oral and written form and equip to demonstrate knowledge of professional and ethical responsibilities.
- participate and succeed in campus placements and competitive examinations like GATE, TOFEL
- Possess entrepreneurial approach and ability for life-long learning
- Have education necessary for understanding the impact of Engineering solutions on Society, and demonstrate awareness of contemporary issues Detailed Syllabus.
- Design a technical document using precise language, suitable vocabulary and apt style.
- Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
- Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
- Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
- Deliver formal presentations effectively implementing the verbal and non-verbal skills.

Module	Contents	Contact Hours
1	Report Writing Objectives of Report Writing Language and Style in a report Types : Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports (Memo, Letter, Short and Long	05

	Report)	
2	Technical Writing Technical Paper Writing (IEEE Format) Proposal Writing	03
3	Introduction to Interpersonal Skills Emotional Intelligence Leadership and Motivation Team Building Assertiveness Conflict Resolution and Negotiation Skills Time Management Decision Making	09
4	Meetings and Documentation Strategies for conducting effective meetings Notice, Agenda and Minutes of a meeting Business meeting etiquettes	02
5	Introduction to Corporate Ethics Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.) Introduction to Intellectual Property Rights Ethical codes of conduct in business and corporate activities(Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	02
6	Employment Skills Group Discussion Resume Writing Interview Skills Presentation Skills Statement of Purpose	07

Term Work

The term work shall be comprised of the neatly written Journal comprising below mentioned assignments.

Assignment 1- Interpersonal Skills (Group activity Role play)

Assignment 2- Interpersonal Skills (Documentation in the form of soft copy or hard copy)

Assignment 3- Cover Letter Resume

Assignment 4- Report Writing

Assignment 5- Technical Proposal (document of the proposal)

Assignment 6- Technical Paper Writing

Assignment 7 -Meetings Documentation (Notice, Agenda, Minutes of Mock Meetings)

Assignment 6- Corporate Ethics (Case study, Role play)

Assignment 8- Printout of the PowerPoint presentation

Term-work Marks: 50 Marks

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of Term work warrants the satisfactory the appropriate completion of the assignments, presentation, book report, group discussion and internal oral the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

- Attendance : 05 Marks
- Assignments : 20 Marks
- Internal Oral: 25 Marks. Comprising of:
 - Presentation of the Project Report: 10 Marks
 - Book Report (one copy per group): 05 Marks
 - Group discussion: 10 Marks

References

1. Fred Luthans, "*Organizational Behavior*", McGraw Hill, edition
2. Lesiker and Petit, "*Report Writing for Business*", McGraw Hill, edition
3. Huckin and Olsen, "*Technical Writing and Professional Communication*", McGraw Hill
4. Wallace and Masters, "*Personal Development for Life and Work*", Thomson Learning, 12th edition
5. Heta Murphy, "*Effective Business Communication*", McGraw Hill, edition
6. Sharma R.C. and Krishna Mohan, "*Business Correspondence and Report Writing*", Tata McGraw-Hill Education
7. Ghosh, B. N., "*Managing Soft Skills for Personality Development*", Tata McGraw Hill. Lehman,
8. Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
9. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
10. Dr. Alex, K., "Soft Skills", S Chand and Company
11. Subramaniam, R., "Professional Ethics" Oxford University Press.
12. Robbins Stephens P., "Organizational Behavior", Pearson Education
13. <https://grad.ucla.edu/asis/agep/adv SOPstem.pdf>

Course Code	Course Name	Credits
CHDE5011	Department Elective I-Piping Engineering	4.0

Prerequisites:

- Basics of various Chemical Process.

Course Objectives:

- To introduce students to the crucial role of piping engineer in turn key projects
- To make students understand the approval drawings and execute the work adhering to procedures and standards
- To understand the layout and manage the work with adequate safety and reliability

Course Outcomes:

By the end of the course students should be able

- understand the piping fundamentals, codes and standards
- understand pipe fittings, selections, drawings and dimensioning
- understand Pipe Material specifications
- understand pressure design of pipe systems

Module	Content	Contact Hours
1	Introduction to Piping 1.1 Introduction to piping 1.2 Piping 1.3 Pipe classification 1.4 General definitions 1.5 Length, area, surface & volume acronyms and abbreviation. Color coding of piping as per types fluid passing through piping (IS 2379:1990) 1.6 Concept of high point vent and low point drain. 1.7 Duties & responsibilities of piping field engineer	06
2	Materials of Piping 2.1 Selection of material for piping, 2.2 Desirable properties of piping materials 2.3 Iron Carbide Diagram 2.4 Materials for various temperature and pressure conditions, 2.5 Materials for corrosion resistance. 2.6 Pipe coating and insulation	08

3	Piping Components 3.1 Pipe & tube product 3.2 Pipe sizes & materials, Mitre Joint. 3.3 Pipes joints & bending (Cold & Hot Bending), Welding defect (NDT) 3.4 Valves: Types of valves and selection 3.5 Strainers & traps 3.6 Expansion joints 3.7 Threaded joints 3.8 Types of piping support	10
4	Piping Codes and Standards 4.1 Introduction of ASME codes 4.2 Code cases interpretation 4.3 Introduction of ASME B 31.1, 31.2, 31.3 4.4 Introduction of ANSI 4.5 Introduction of ASTM 4.6 Introduction of API 4.7 Introduction of AWS	06
5	Piping System Design 5.1 Flows through Pipes. 5.2 Loss of energy / head in pipes Loss of head due to friction. 5.3 Minor energy losses, 5.4 Water hammer in pipes Unit. 5.5 Design Principles and Line Sizing 5.6. Mitre Joint Calculation. 5.7 Various stresses in piping 5.8 Bending stress calculation	10
6	Piping Drawing 6.1 Piping drawing symbols and abbreviations 6.2 Classification/Types of drawing 6.3 Introduction to simple piping drawings 6.3.1 Plot Plan 6.3.2 G.A. Drawing 6.3.3 Process flow diagram (P.F.D) 6.3.4 Piping and instrumentation diagram (P&ID) / Engineering flow diagram.	08

Assessment

Internal

- Assessment consists of average of two tests which should be conducted at proper interval

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions to be solved
- Question no.1 will be compulsory and based on entire syllabus where in sub questions can be asked.

- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. Handbook of piping design- S.K. Sahu Elsevier Publishers
2. Piping/mechanical hand book- Mohinder L. Nayyar. Peter H. O. Fischer, Manager, Pipeline Operations, Bechtel
3. Piping Design Handbook by John J. Mcketta, by Marcel Dekker, Inc, New York.

Recommended:

- i. Arrange visit to a process industry and discuss different features of process piping in use.
- ii. Arrange expert lecture by some experienced process piping engineer.

Course Code	Course/Subject Name	Credits
CHDE5012	Department Elective I- Colloids and Interfaces	4

Prerequisites:

- Basic knowledge of Chemical Engineering, basic concept of electron, atom, ions, molecules & molecular rearrangements, Basic knowledge of fluid flow, thermodynamics and heat transfer, Various types of material and metals, Basic knowledge of particle size measurement.

Course Objectives:

- To understand the fundamental knowledge of the Colloids, interfaces and explain their applications
- To understanding of basic nomenclature, concepts and tools of colloid and interface science and engineering; multi-phase nano-systems; mechanics and thermodynamics on small scales.
- To impart the interdisciplinary subject in which chemical engineers, chemists and biotechnologists are involved
- Understand the engineering aspects of fluid-fluid and fluid-solid interfaces and Surface energy.

Course Outcomes:

Upon completion of the course, the student should be able to

- Describe the colloidal state, including colloids and their preparation and properties as well as fundamental concepts in colloid and interface engineering.
- Discuss factors that affect colloidal systems and important factors on solid/liquid interactions as well as apply knowledge in colloid and surface science and analyze and solve problems calculations concerning the practical problems
- Explain experimental techniques used to determine colloidal properties; interfacial phenomena
- To facilitate skills transfer from another relevant area of engineering or science and technology to the study of Interfacial engineering.
- Students should understand, know how to interpret and apply the following topics in colloid and interface engineering to wettability, solubility, surface tension, diffusion, sedimentation, colloid stability and aggregation, adsorption, electrical interfacial layer and surface equilibrium and experimental methods for surface characterization
- Gain knowledge of fabrication methods in nanotechnology and characterization methods in nanotechnology.

Module	Contents	Contact hrs
01	Introduction of Colloids, The colloidal state and classification, Importance of colloids, Properties and application of colloid systems, interaction between particles, colloid stability and aggregation	06
02	Surface tension and interfacial tension surfaces, Experimental	08

	method for measurement of Surface Tension, dynamic surface tension & Contact Angle, Vander Waals forces between colloidal particles	
03	Surfactants: classification, properties, applications Surfactants in solution: micelles, vesicles, Micro emulsions Electrical phenomena at interfaces: Electric double layer, zeta potential, DLVO theory	08
04	Surface free energy, films on liquid substrates (mono-molecular films, Langmuir-Blodgett layers), Adsorption-Langmuir and Gibbs adsorption isotherm, Types of Interface (Solid-Gas, Solid-liquid, liquid –gas, liquid-liquid) and its features	08
05	Top-down and bottom-up approach for nanostructure Methods: Vacuum Synthesis, Gas Evaporation Tech, Condensed Phase, Synthesis, Sol Gel Processing, Polymer Thin Film	07
06	Interaction between Biomolecules & Nanoparticle Surface, Influence of Electrostatic Interactions in the binding of Proteins with Nanoparticles, The Electronic effects of bimolecule - Nanoparticle Interaction, Different Types of Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies, Application.	07
07	Particle Size, Surface area, Volume, Equivalent Diameter and Aerodynamic Diameter Measurement Methods – Microscopy, Optical Counter, Electrical Aerosol Analyzer, Bacho Microparticle classifier, Particle Size analyzer Particle mass, Volumetric flow rate and average particle concentration calculation	08

Assessment

Internal:

- Assessment consists of an average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.

Textbook/References Book

1. J. C. Berg, An Introduction to Interfaces and Colloids: The Bridge to Nanoscience, World Scientific, Singapore
2. P. Ghosh, Colloid and Interface Science, PHI Learning, New Delhi
3. R. J. Hunter, Foundations of Colloid Science, Oxford University Press, New York

4. D.J. Shaw, Colloid and Surface Chemistry, 4th Edition, Butterworth-Heinemann, Oxford
5. Myers, D. Surfaces, Interfaces, and Colloids: Principles and Applications. New York
6. Robert J. Stokes, D Fennell Evans, "Fundamentals of Interfacial Engineering", Wiley-VCH
7. P. C. Hiemenz and R. Rajagopalan, Principles of Colloid and Surface Chemistry, Marcel Dekker, New York
8. Louis Theodore, A John, Nanotechnology: Basic Calculations for Engineers and Scientists - Willy & Sons
9. T. Pradeep, Nano-The Essentials, Understanding Nanoscience and Nanotechnology,
10. Kal Ranganathan Sharma, Nanostructuring Operations in NanoScale Science and Engineering, McGraw-Hill

Course Code	Course/ Subject Name	Credits
CHDE5013	Department Elective I- Advanced Material Science	4

Prerequisites

- Mechanical, Electrical, Magnetic and Optical Properties of Materials, Commonly used Materials of Construction and their Selection, Corrosion in Materials.

Course Objectives

- To understand various advanced materials such as conducting polymers, high temperature polymers, stainless steels, composites, ceramics, etc.
- To understand the properties and engineering applications of the above materials.
- To understand the fabrication methods of the above materials.

Course Outcomes

At the end of the course the student will:

- Identify various types of advanced materials such as polymers, ceramics and composites.
- Understand the properties of various advanced polymeric, ceramic and metallic materials and their applications in various fields.
- Have knowledge of different types of composite materials and their properties and applications.
- Understand the fabrication of various composite materials.
- Have knowledge of types of nanotubes and nanosensors and their applications.
- Understand the different thin film coating methods and their applications in various fields.

Module	Contents	Contact Hours
1	Advanced Metallic Materials: Stainless Steels: Types, properties of stainless steels, corrosion resistance and selection of stainless steels, failure of stainless steels. High Temperature Alloys: Properties and types. Titanium Alloys and Cobalt-Chromium Alloys: Composition, properties and applications. Nitinol as Shape Memory Alloy and its applications.	08
2	Advanced Polymeric Materials: Structure, preparation, and application of various conducting polymers, high temperature polymers and liquid crystal polymers. Biomedical applications of polymers such as hydrogels, polyethylene, polyurethanes, polyamides and silicone rubber.	06
3	Ceramic Materials: Properties of ceramic materials, classification of ceramic materials, ceramic crystal structures. Behaviour of ceramic materials: dielectric, semiconductor,	08

	ferroelectric, magnetic, and mechanical behaviour. Preparation and application of ceramic materials: Alumina, Partially Stabilized Zirconia, Sialon, Silicon Nitride, Silicon Carbide. Processing of Ceramics.	
4	Composite Materials: Necessity of composite materials, classification of composite materials, types of matrix materials and reinforcements, reinforcement mechanism, choosing material for matrix and reinforcement. Fiber Reinforced Plastic Processing: Open Moulding Processes : Filament Winding Process Closed Moulding Processes : Pultrusion and Pulforming, Sheet Moulding Compound Process Carbon-Carbon Composites : Fabrication and Properties	08
5	Metal Composites: Advantage of metal composite over metal, types of reinforcement and matrix fabrication types, various fabrication processes: diffusion bonding process, in-situ process, mechanical behaviour and properties. Ceramic Composites: Matrices and reinforcements, mechanical properties, fabrication methods: Slurry infiltration processes, chemical vapour infiltration process.	08
6	Carbon Nanotubes: Synthesis, properties and applications. Nanoshells: Types, properties and applications. Nanosensors: Assembly methods, nanosensors based on optical, quantum size, electrochemical and physical properties. Thin Film Coatings: Physical and chemical vapour deposition coatings, hard facing, thermal spraying, diffusion process, useful material for appearance, corrosion and wear.	07

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No. 1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Text Books and Reference Books

1. B.K. Agrawal, Introduction to Engineering Materials, Tata McGraw Hill Education Pvt. Ltd., 2012.
2. A.K. Bhargava, Engineering Material: Polymers, Ceramics and Composites, PHI Learning Pvt. Ltd., Second Edition 2012.
3. Dr. H.K. Shivanand and B.V. Babu Kiran, Composite Material, Asian Books Private Limited, 2010.
4. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill Education Pvt. Ltd., 2010.
5. William Smith, Structure and Properties of Engineering Alloys, Second Edition, McGraw Hill International Book Co.
6. William Smith, JavedHasemi, Ravi Prakash, Material Science and Engineering, Tata McGraw Hill Education Company Ltd., 2006.
7. Kenneth G. Budinski, Michael K. Budinski, Engineering Materials Properties and Selection, 8th Edition, Prentice Hall.
8. Bowden M.J. and Tumber S.R., Polymer of High Technology, Electronics and Photonics, ACS Symposium Series, ACS, 1987.
9. Dyson, R.W., Engineering Polymers, Chapman and Hall, First Edition, 1990.
10. Chawala K.K., Composite Materials, Science and Engineering, 3rd Edition.
11. Sujata V. Bhat, Biomaterials, Narosa Publication Pvt. Ltd., Second Edition, 2005.
12. V. Raghavan, PHI Learning Private Ltd, Sixth Edition.

Course Code	Course/ Subject Name	Credits
CHDE5014	Department Elective I- Instrumentation	4

Prerequisites

- Process Calculations

Course Objectives

- To understand the primary mechanisms of sensors
- To understand how measured quantities are processed for transmission and control
- To understand how alarms and interlocks are incorporated into over-all instrumentation and control
- To understand basic control configurations of typical process units

Course Outcomes

- The student will be able to calculate the output of various measuring schemes
- The student will be able to select a DAQ card for any given application
- The student will be able to select the appropriate type of instrument for any application
- The student will be able to prepare a basic control scheme for process units
- The student will be able to write programs for a PLC.

Module	Contents	Contact Hours
1	Fundamentals of Measuring Instruments: Introduction Standards and Calibration, Elements of Measuring Systems, Classification of Instruments, Performance Characteristics, Errors in Measurement.	04
2	Primary Sensing Mechanisms: Introduction, Resistive Sensing Elements, Capacitive Sensing Elements, Inductive Sensing Elements, Thermo-electric Sensing Elements, Piezo-electric Sensing Elements, Elastic Sensing Elements, Pneumatic Sensing Elements, Deferential Pressure Sensing Elements, Expansion Sensing Elements..	04
3	Signal Conversion: Signal Conditioning , Wheatstone Bridge, Potentiometer Measurement System, Signal Processing, Mechanical Amplifier, Electronic Amplifier, A/D and D/A conversion, Signal Transmission, Selection of DAQ cards.	04
4	Measuring Instruments: Flow Measurement, Temperature Measurement, Level Measurement, Pressure Measurement.	10
5	Valves and Drives: Introduction, Control Valve Characteristics, Sizing and Selection of Valves, Variable Drives.	04

6	Programmable Logic Controllers: Introduction, Ladder Logic, Applications of PLCs to typical processes.	04
7	Introduction to Safety Relief Systems: Introduction, Types of Relieving Devices, Relief Valves, Rupture Discs, Over-pressurization, Emergency Depressurization, Introduction to SIL Classification, LOPA Methods, Basic Process Control Schemes.	10

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No. 1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. K. Krishnaswamy and S. Vijayachitra, Industrial Instrumentation, second Edition, New Age International.
2. B. E. Noltingk, Jones Instrument Technology, Vol. 4 and 5, Fourth Edition, Butterworth-Heinemann.
3. W. Bolton, Instrumentation and Control Systems, First Edition, Newnes, Elsevier, 2004.
4. Stephanopoulos, Chemical Process Control, Prentice Hall of India.
5. John P. Bentley, Principles of Measurement Systems, Third edition, Addison Wesley Longman Ltd., UK, 2000.
6. Doebelin E.O, Measurement Systems - Application and Design, Fourth edition, McGraw-Hill International Edition, New York, 1992.
7. Noltingk B.E., Instrumentation Reference Book, 2nd Edition, Butterworth Heinemann, 1995

Course Code	Course/ Subject Name	Credits
CHL501	Computer Programming and Numerical Methods Lab	1

Minimum Ten practicals should be performed from the modules of Theory course of Computer Programming and Numerical Methods (CHC501)

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments

Course Code	Course/ Subject Name	Credits
CHL502	Chemical Engineering Lab IV (MTO-I)	1.5

Concept for Experiments

Minimum of ten experiments are to be conducted.

- To determine the diffusivity of given liquid sample.
- To study diffusion through porous solids and determine effective diffusivity.
- To determine Mass Transfer Coefficient in a packed extraction column
- To determine Mass Transfer Coefficient in a spray extraction column
- To determine Mass Transfer Coefficient in a spray extraction column
- To estimate the mass transfer coefficient in flow process system (eg. benzoic acid + water).
- To determine mass transfer co-efficient in gas liquid system by evaporation.
- To study absorption in packed tower.
- To determine the efficiency of cooling and tower study of Humidification and water cooling operations.
- To study the operation of a fluidized bed drier and analyze drying curve.
- To determine rate of absorption and study absorption in spray tower.
- To study batch drying and plot drying curve.
- To study hydrodynamics of packed bed and study variation in pressure drop with velocity.
- Experiments demonstrating determination of mass transfer coefficient/diffusivity/ number of transfer units, HTU, HETP are envisaged.

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments

Course Code	Course/ Subject Name	Credits
CHL503	Chemical Engineering Lab IV (HTO)	1.5

Concept for Experiments

Minimum of ten experiments are to be conducted.

1. Thermal conductivity of a metal rod.
2. Heat transfer through composite wall.
3. Newtonian heating/cooling.
4. Heat transfer by forced convection.
5. Heat transfer by natural convection.
6. Heat transfer by condensation.
7. Stefan Boltzmann's apparatus
8. Kirchoff's law
9. Double pipe heat exchanger
10. Shell & Tube heat exchanger
11. Finned tube heat exchanger
12. Heat transfer in agitated vessel.

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/ Subject Name	Credits
CHL504	Chemical Engineering Lab VI (CRE-I)	1

Concept for Experiments

Minimum 10 experiments need to be performed by the students on following concepts

1. Differential and Integral Analysis (Order of Reaction at Room Temperature)
2. Arrhenius Constants (Verification of Laws)
3. Order and rate constant using Half Life Method
4. Study of Pseudo Order Reaction
5. Acidic Hydrolysis
6. Batch Reactor
7. Plug Flow Reactor (PFR)
8. Continuous Stirred Tank Reactor (CSTR)
9. Continuous Stirred Tank Reactors Series (Three CSTRs In Series)
10. PFR – CSTR In Series Combination

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
T.E. Semester VI (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC601	Environmental Engineering (EE)	4	-	-	4	-	-	4
CHC602	Mass transfer Operations –II (MTO-II)	4	-	-	4	-	-	4
CHC603	Transport Phenomenon	3	-	1	3	-	1	4
CHC604	Chemical Reaction Engineering –II (CRE- II)	4	-	-	4	-	-	4
CHC605	Plant Engineering & Industrial Safety	3	-	1	3	-	1	4
CHDE602X	Department Elective II	4	-	-	4	-	-	4
CHL601	Chemical Engineering Lab VII (EE)	-	3	-	-	1.5	-	1.5
CHL602	Chemical Engineering Lab VIII (MTO-II)	-	3	-	-	1.5	-	1.5
CHL603	Chemical Engineering Lab IX (CRE-II)	-	2	-	-	1	-	1
Total		22	8	2	22	4	2	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC601	Environmental Engineering (EE)	20	20	20	80	3	-	-	-	100
CHC602	Mass transfer Operations –II (MTO-II)	20	20	20	80	3	-	-	-	100
CHC603	Transport Phenomenon	20	20	20	80	3	25	-	-	125
CHC604	Chemical Reaction Engineering –II (CRE- II)	20	20	20	80	3	-	-	-	100
CHC605	Plant Engineering & Industrial Safety	20	20	20	80	3	25	-	-	125
CHDE602X	Department Elective II	20	20	20	80	3	-	-	-	100
CHL601	Chemical Engineering Lab VII (EE)	-	-	-	-	3	25	25	-	50
CHL602	Chemical Engineering Lab VIII (MTO-II)	-	-	-	-	3	25	25	-	50
CHL603	Chemical Engineering Lab IX (CRE-II)	-	-	-	-	2	25	25	-	50
Total				120	480	-	125	75	--	800

Department Elective II (Sem VI)		
Engineering Stream (Elective Code)	Management Stream (Elective Code)	Technology Stream (Elective Code)
1. Computational Fluid Dynamics (CHDE6021)	1. Operation Research (CHDE6022)	1. Biotechnology (CHDE6023)

Course Code	Course/ Subject Name	Credits
CHC601	Environmental Engineering	4

Prerequisites:

- Basic concepts of Fluid Flow Operations, Solid Fluid Mechanical Operations, Mass Transfer Operations and Chemical Reaction Engineering.

Course Objectives:

- Students should be able to understand the scope of subjects in Chemical Industry.
- Students should learn to apply the Environmental Engineering concepts to control management of various types of pollutants.

Course Outcomes:

- To understand Importance of environmental pollution, such as air, water, solid, noise. Various pollutants sources, adverse effects, Environmental Legislation
- To understand meteorological aspects air pollutant dispersion. Sampling and measurement, Control Methods and Equipment:
- To understand Sampling, measurement of various water pollutants.
- To understand and design various Waste Water Treatments,

Module	Contents	Contact Hours
1	Environmental pollution, Importance of environmental pollution control, Concept of ecological balance, Role of environmental engineer, Environmental Legislation & Regulations, Industrial pollution emissions & Indian standards, Water (prevention & control of pollution) act, Air (prevention & control of pollution) act.	2
2	Water Pollution: Classification of sources and effect of water pollutant on human being and ecology, Sampling, measurement and standards of water quality, Determination of organic matters: DO, BOD, COD, and TOC. Determination of inorganic substances: nitrogen, phosphorus, trace elements, alkalinity. Physical characteristics: suspended solids, dissolved solids, colour and odour, Bacteriological measurements.	8
3	Waste Water Treatment: Primary treatment: pre-treatment, settling tanks and their sizing. Secondary treatment: micro-organisms growth kinetics, aerobic biological treatment, activated sludge process, evaluation of bio-kinetic parameters, trickling filters, sludge treatment and disposal. Tertiary treatment: advanced methods for removal of nutrients, suspended and dissolved solids, Advanced biological systems, Chemical oxidation, Recovery of materials from process effluents.	12
4	Air Pollution:	14

	Air pollutants, sources and effect on man and environment, behaviour and fate of air pollutants, photochemical smog, Meteorological aspects of Air pollutants: Temperature lapse rate and stability, inversion, wind velocity and turbulence, Plume behaviour, Dispersion of air pollutants, Gaussian plume model, Estimation of plume rise, Air pollution sampling and measurement, Analysis of air pollutants	
5	Air Pollution Control Methods and Equipment: Source correction methods for air pollution control, Cleaning of gaseous effluents, Particulate emission control, Equipment, system and processes for. ----Particulate pollutants: gravity settler, cyclones, filters, ESP, scrubbers etc. ----Gaseous pollutants: scrubbing, absorption, adsorption, catalytic conversion.	8
6	Solid Waste Management: Solid waste including plastic, nuclear and hazardous waste management, E waste management	3
7	Noise Pollution: Noise pollution: measurement and control, effect on man and environment.	1

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Books

1. Rao, C.S., Environmental Pollution Control Engineering, New Age International (P) Ltd.
2. Peavy, H. S., Rowe, D.R., Tchobanoglous, G., Environmental Engineering, McGraw-Hill Book Company Limited
3. Metcalf et al., Waste Water Treatment, Disposal & Reuse, Tata McGraw Hill Publishing Company Limited.
4. Mahajan, S.P., Pollution Control in Process Industries, Tata McGraw Hill Publishing Company Limited.

References

1. Industrial and Pollution Engineering, Cavaseno, VinCene N.T.

2. Sewage Disposal and Air Pollution Engineering, S.K. Garg
3. Chemistry for Environmental Engineering, C.N. Sawyer
4. Wastewater Engineering, B.C Punmia

Course Code	Course/ Subject Name	Credits
CHC602	Mass Transfer Operations II	4

Prerequisites:

- Knowledge of chemistry, physics, physical chemistry and mathematics.
- Knowledge of process calculations.
- Knowledge of diffusion, mass transfer coefficients, modes of contact of two immiscible phases.

Course Objectives:

- To understand design methods for distillation columns.
- To understand design of extractor and leaching equipments.
- To understand membrane separation.
- To understand crystallisation process and to design crystallization equipments

Course Outcomes

At the end of the course student will be able to:

- understand equilibrium in all separation process
- design the mass transfer equipments for extraction, leaching and crystallization processes
- design distillation column
- choose the separation operation which will be economical for the process
- optimize the process parameters
- understand membrane separation processes principle and working

Module	Contents	Contact Hours
1	Distillation: Introduction to Distillation, Vapor-liquid Equilibrium-At constant Pressure and At constant temperature, Minimum and maximum boiling Azeotropes. Methods of distillation [binary mixtures] – Flash Distillation, Differential distillation, Rectification. Calculations of number of ideal stages in multistage countercurrent rectification. McCabe Thiele Method. Ponchon-Savarit Method, Lewis-Sorel Method, Concepts of [Brief Discussion], Steam Distillation, Azeotropic Distillation, Extractive Distillation, Reactive Distillation, Molecular Distillation, Introduction to Multicomponent Distillation.	12
2	Liquid-Liquid Extraction: Introduction to Liquid-Liquid Extraction, Choice of Solvent for Liquid-Liquid Extraction, Triangular coordinate system, Ternary Equilibria [Binodal Solubility Curve with effect of temperature and pressure on it], Single Stage Operation, Multistage Cross Current Operation, Multistage Counter Current Operation [with	10

	and without reflux, Equipments for liquid-liquid extraction.	
3	Leaching: Representation of Equilibria, Single stage leaching, Multistage Cross Current Leaching, Multistage Counter Current Leaching, Equipments for Leaching.	06
4	Adsorption and Ion Exchange: Introduction to Adsorption, Types of Adsorption, Adsorption Isotherms, Single Stage Adsorption, Multistage Cross Current Adsorption, Multistage Counter Current adsorption, Equipments for Adsorption, Break through curve, Ion Exchange Equilibria, Ion Exchange Equipments	12
5	Crystallization: Solubility curve, Super saturation, Method of obtaining super saturation, Effect of heat of size and growth of crystal, Rate of Crystal growth and ΔL law of crystal growth, Material and energy balance for crystallizers, Crystallization equipment-description.	4
6	Membrane separation Technique: Need of membrane separation, and its advantages, classification of membrane separation process, Various membrane configurations. Various membrane and their applications, Ultrafiltration, Nanofiltration. Reverse osmosis, Pervaporation, Membrane distillation.	4

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Treybal R.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.
2. McCabe W.L. and Smith J.C., Unit operation in chemical engineering, 5 Ed., McGraw Hill NewYork 1993.
3. Geankoplis C.J., Transport processed and unit operations, Prentice Hall, New Delhi 1997.
4. Coulson J.M. Richardson J.F., Backhurst J.R. and Harker J.H., Coulson and Richardson chemical engineering, vol 1 & 2, Butterworth Heinman, New Delhi, 2000.
5. R.K.Sinnott (Ed) Coulson and Richardson chemical engineering, vol 6, Butterworth Heinman, NewDelhi, 2000.

6. Kiran D. Patil, Principals and Fundamentals of mass transfer operation II, Nirali Prakashan Pune.
7. Dutta B.K., Mass Transfer and separation processes, Eastern economy edition, PHI learning private ltd, New Delhi, 2009.

Course Code	Course/Subject Name	Credits
CHC603	Transport Phenomena	4.0

Prerequisites:

- Continuity equation, equation motion covered in Fluid Mechanics, Diffusion and absorption from Mass Transfer and Conduction, convection and radiation from Heat Transfer.
- Numerical methods to solve ordinary differential equations.

Course Objectives:

- Students will be able to get depth knowledge of momentum, energy and mass transport.
- Applications of fundamental subjects learned, towards chemical engineering problems.
- Ability to analyze industry oriented problems.

Course Outcomes:

- Understanding of transport processes.
- Student will learn to establish and simplify appropriate conservation statements for momentum, energy and mass transfer processes.
- Ability to do momentum, energy and mass transfer analysis.
- To apply conservation principles, along with appropriate boundary conditions for any chemical engineering problem.

Module	Contents	Contact Hours
1	Introduction: Importance of transport phenomena, Introduction to analogies between momentum, heat and mass transfer and defining of dimensionless number, Eulerian and Lagrangian approach, introduction of molecular and convective flux, equation of continuity, motion and energy.	06
2	Momentum Transport: Introduction of viscosity and mechanism of momentum transport: Newton's law of viscosity, Newtonian & Non-Newtonian fluids, Pressure and temperature dependence of viscosity, theory of viscosity of gases and liquids. Velocity distribution in laminar flow: Shell momentum balances and boundary conditions a) Flow of falling film b) Flow through the circular tube c) Flow through an annulus d) Flow in a narrow slit e) Adjacent flow of two immiscible fluids	10
3	Energy Transport: The introduction of thermal conductivity and mechanism of energy transport: Fourier's law of heat conduction, temperature and pressure dependence of thermal conductivity in gases and liquids. Temperature distribution in solids and in laminar flow, shell energy balance and boundary conditions a) Heat conduction with electrical heat source b) Heat conduction with a nuclear heat source c) Heat conduction with a viscous heat	10

	source d) Heat conduction with a chemical heat source e) Heat conduction with variable thermal conductivity f) Heat conduction in composite wall and cylinder g) Heat conduction in a cooling fin	
4	Mass Transport: Introduction of diffusivity and mechanism of mass transport: Definitions of concentrations, velocities and mass fluxes, Fick's law of diffusion, temperature and pressure dependence of mass diffusivity. Concentration distribution in solids and in laminar flow, Shell mass balances and boundary conditions a) Diffusion through stagnant gas film b) Diffusion with heterogeneous chemical reaction c) Diffusion with homogeneous chemical reaction d) Diffusion into a falling liquid film (Gas absorption)	10

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: **25 Marks**

Assessment

Internal

- Assessment consists of average of two tests which should be conducted at proper interval

End Semester Theory Examination:

- Question paper will be comprises of six questions, each carrying 20 Marks.
- Total 4 questions need to be solved.
- Question no. 1 will be compulsory and based on entire syllabus wherein sub-questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. Bird, R.B., W.E. Stewart and E.N. Lightfoot, Transport Phenomena, Wiley, New York, 2nd ed., 2002.
2. Christie J. Geankoplis, Transport Processes and Separation Process Principles, 4th Edition, 2004
3. Slattery, J.C., Advanced Transport Phenomena, Cambridge University Press, Cambridge, 1999.
4. Brodkey, R.S. and H.C. Hershey, 1988, Transport Phenomena: A Unied Approach, McGraw-Hill, New York.
5. Bodh Raj, Introduction to Transport Phenomena (Momentum, Heat and Mas), PHI Learning Pvt. Ltd, Eastern Economy Edition.

Course Code	Course/Subject Name	Credits
CHC604	Chemical Reaction Engineering II	4.0

Prerequisites:

- Students should know basic chemistry pertaining to chemical reactions, chemical formula etc. They are required to be aware of chemical process and unit operations used for the manufacturing of chemical products. Simple to complex numerical methods of solving one and two dimensional Mathematical equations.

Course Objectives:

- To understand the concept of Residence Time Distribution (RTD) in various reactors and obtain the actual design parameters to design Real Reactor.
- To find the model equation and use this model to design the reactors used for heterogeneous non catalytic reactions.
- To apply the knowledge they have gained to develop kinetic model and Design strategy for heterogeneous catalytic reactions.
- To apply the knowledge they have gained to develop kinetic model and use this model to design the reactors used for Fluid-Fluid reactions.

Course Outcomes:

- Students will be able to understand the concept of Residence Time Distribution (RTD) in various reactors and obtain the actual design parameters to design Real Reactor.
- Students will be able to find the model equation and use this model to design the reactors used for heterogeneous non catalytic reactions.
- Students will be able to apply the knowledge they have gained to develop kinetic model and Design strategy for heterogeneous catalytic reactions.
- Students will be able to apply the knowledge they have gained to develop kinetic model and use this model to design the reactors used for Fluid-Fluid reactions.

Module	Content	Contact Hours
1	Non Ideal flow reactors: Concept of residence time distribution (RTD), Measurement and characteristics of RTD, RTD in Ideal batch reactors, Plug Flow Reactor and CSTR. Zero Parameter Model – Segregation and Maximum mixedness model. One parameter model–Tanks in series model and Dispersion Model. Effect of dispersion on conversion for general irreversible reaction case, Diagnostic methods of analysis of flow patterns in reactors, Role of micro and macro mixing and segregation in ideal (MFR, PFR) and non ideal reaction cases.	12
2	Non Catalytic heterogeneous Reactions: Kinetics: General mechanism of reaction. Various models.	10

	<p>Specific cases with respect: (a) Film diffusion controlling. (b) Ash diffusion controlling. (c) Chemical reaction controlling.</p> <p>Design of reactors for non-catalytic reactions: Experimental reactors for heterogeneous Reactions, Non-Catalytic Fluid Solid Reactions in Flow Reactor. Application to design of continuous solid flow reactors; various design considerations, Application of fluid bed reactors and their design consideration.</p>	
3	<p>Kinetics and mechanism of various Heterogeneous reactions and design consideration of reactors used during different operating conditions.</p> <p>Catalytic heterogeneous reactions: Properties of solid catalysts, Physical adsorption and Chemisorption, Surface area and pore size distribution, Langmuir-Hinshelwood model, and General mechanism of solid catalyzed fluid phase reactions. Special cases when (a) Film resistance controls. (b) Surface phenomenon controls. (c) Surface reaction controls (d) Pore diffusion controls. Concept of effectiveness factor of catalyst and its dependence on catalyst properties and kinetic parameters. Numericals based on physical properties of catalyst, Derivations for LHHW model mechanism-various cases, Effectiveness factor. Numericals based on kinetics</p> <p>Introduction to Catalytic Reactors: Packed Bed Reactor Fluidized Bed, Trickle Bed and Slurry Reactor. Numericals based on Design of Packed Bed Reactor (Calculation of weight/volume of catalyst).</p>	12
4	<p>Kinetics of fluid-fluid reactions: Reaction with mass transfer, the rate equation pertaining to fast to very slow reactions.</p> <p>Applications to design: Design of gas-liquid, liquid-liquid and gas liquid-solid reactors- Heterogeneous reactors, Bubble heterogeneous reactors, co-current and counter-current flow packed bed reactors.</p>	10

Assessment

Internal

- Assessment consists of average of two tests which should be conducted at proper interval

End Semester Theory Examination:

- Question paper will be comprises of six questions, each carrying 20 Marks.
- Total 4 questions need to be solved.
- Question no. 1 will be compulsory and based on entire syllabus wherein sub-questions can be asked.
- Remaining questions will be randomly selected from all the modules.

- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. Levenspiel O., Chemical Reaction Engineering, John Wiley & Sons, 3rd ed., 1999.
2. Smith J.M., Chemical Reaction Engineering, 3rd ed., Tata McGraw Hill, 1980.
3. Fogler, H.S. Elements of Chemical Reaction Engineering, 4th ed., PHI, 2008
4. Hill C.G., Chemical Reaction Engineering.
5. Walas, Reaction Kinetics for Chemical Engineers, McGraw Hill, 1959.

Course Code	Course/Subject Name	Credits
CHC605	Plant Engineering and Industrial Safety	4

Prerequisites:

- Knowledge of Process Calculations, Thermodynamics and Fluidflow.

Course Objectives:

- At the end of the course the students should understand the knowledge of industrial safety, plant utilities.
- They should be able to understand industrial accidents and hygiene, hazards and risk analysis.
- They should be able to understand various types of steam generators, its performance.
- They should be able to understand various properties of compressed air, air drying methods, study different types of compressors and calculate the power required by compressors.
- They should understand how to select vacuum system.

Course Outcomes

- Students should be able to identify the causative and initiating factors of accidents. They should be able to make quantitative assessment of vapour release and noise impact.
- Students should be able to understand and evaluate situations causing industrial fire and evaluate risk. .
- Students should learn and understand type of boilers and be able to calculate its efficiency.
- Students should be able to calculate work requirements for compressors and draw schematic of instrument air, plant air and venting system.

Module	Contents	Contact Hours
1	Industrial Accidents: Causative and initiating factors of accidents. Identifying the causative and initiating factors of Industrial accidents, case studies.	3
	Industrial Hygiene. Definition and evaluation of toxicity and noise	5
	Ventilation. Local Ventilation, Dilution Ventilation. Problems on Ventilation airflow.	1
2	Fire. Fire triangle, Flammability characteristics of liquids and gases, Limiting oxygen concentration, ignition energy, auto ignition, auto oxidation, adiabatic compression. Ignition sources, spray and mist.	2
	Explosion: Detonation, Deflagration, Confined explosion, unconfined explosion, VCE, BLEVE, Problems on energy of chemical explosion.	5
	Types of relief systems	2
	HAZOP, How to do a HAZOP. HAZOP Checklist.	2
	Risk assessment: Event tree analysis, Fault tree analysis.	2

3	<p>Steam generators: Properties of steam, Use of steam tables, Steam generators, Classification of boilers, Study of high pressure boilers, boiler mountings and accessories. Performance of steam generators. Distribution of steam in plant; Efficient use of steam, steam traps.</p>	8
4	<p>Air: Reciprocating compressors, work calculations, PV Diagrams, Two stage compression system with intercooler, problems of work and volumetric efficiency. Instrument Air System, Process Air System, Vacuum producing devices</p>	6

Term Work

Term work shall consist of minimum eight tutorials (two from each module) from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: **25 Marks**

Assessment

Internal:

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Crowl, D. A. and Louvar, J. P.; Chemical Process Safety: Fundamentals with Applications; Prentice Hall, Englewood
2. Khurmi, R. S. and Gupta, J. K. A textbook of thermal Engineering, S. Chand.
3. Rajput, R.K .A textbook of Power Plant Engineering. Laxmi Publications (P) Ltd., Navi Mumbai.
4. K. S. N. Raju, Chemical Process Industry Safety, McGraw Hill Education.

Course Code	Course/ Subject Name	Credits
CHDE6021	Department Elective II -Computational Fluid Dynamics	04

Prerequisites:

- Linear Algebra
- Partial Differential Equations
- Scilab or Python

Course Objectives:

- To understand the formulation of CFD problems
- To discretize the problems
- To solve the set of equations in simple cases using Scilab routines.
- To understand and use software in CFD

Course Outcomes:

- The student will be able to obtain flow profiles for some simple applications using Scilab.
- The student will be able to use appropriate software for solving realistic problems.

Module	Contents	Contact Hours
1	Module: Introduction Contents: Advantages of Computational Fluid Dynamics Typical Practical Applications Equation Structure Overview of CFD	02
2	Module: Preliminary Computational Techniques Contents: Discretisation Approximation to Derivatives Accuracy of the Discretisation Process Wave Representation Finite Difference Method	04
3	Module: Theoretical Background Contents: Convergence Consistency Stability Solution Accuracy Computational Efficiency	06
4	Module: Weighted Residual Methods Contents: General Formulation Least Squares, Galerkin and Subdomain Formulations. Weak form of Galerkin Method	08
5	Module: Finite Element Method Contents: Piece-wise Continuous Trial Functions One Dimensional Linear and Quadratic Elements	08

	One Dimensional Heat Transfer Tri-diagonal Matrix Algorithm	
6	Module: Two Dimensional Elements Quadrilateral Elements Steady State Heat Transfer in Two Dimensions Alternating Direction Implicit Method Potential Flow in Two Dimensions	08
7	Module: Finite Volume Method One Dimensional Diffusion Two Dimensional Diffusion Diffusion With Convection and The Upwind Scheme	06
8	Module: Pressure Velocity Coupling in Steady Flows The Staggered Grid The Momentum Equation The Simple Algorithm	06

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Books

1. C.A.J. Fletcher; Computational Techniques for Fluid Dynamics 1; Springer-Verlag Berlin Heidelberg GmbH
2. P. Seshu; Textbook of Finite Element Analysis; PHI Learning Private Limited, New Delhi
3. H.K. Versteeg and W. Malalasekera; An Introduction To Computational Fluid Dynamics; Longman Scientific & Technical

References

1. John D. Anderson; Computational Fluid Dynamics; McGraw Hill Education Private Limited

Course Code	Course/ Subject Name	Credits
CHDE6022	Department Elective II -Operations Research	4

Prerequisites:

- Linear Algebra
- Computer Programming

Course Objectives:

- To understand Linear Programming and its applications to OR models.
- To understand and solve network models in OR.
- To understand Game theory and its applications.
- To study and design Queuing systems.

Course Outcomes:

- The student will be able to solve typical OR models using linear integer and dynamic programming techniques.
- The student will be able to model and solve network flow problems in OR.
- The student will be able to make decisions under various scenarios.
- The student will be able to design Queuing Systems.

Module	Contents	Contact Hours
1	Module: Linear Programming Contents: Introduction Graphical Method of Solution Simplex Method Two-Phase Method Duality Dual Simplex Revised Simplex	10
2	Module: Transportation Models Contents: Examples of Transportation Models The Transportation Algorithm The Assignment Model The Transshipment Model	06
3	Module: Network Models Contents: Scope and Definition of Network Models Minimal Spanning Tree Algorithm Shortest Route Problem Maximal Flow Model	06
4	Module: Integer and Dynamic Programming Contents: Branch and Bound Method Travelling Salesman Problem Introduction to Dynamic Programming Forward and Backward Recursion Selected Applications	06

5	Module: Deterministic Inventory Models Contents: Classic EOQ Model EOQ with Price Breaks Dynamic EOQ Models No-Setup Model Setup Model	06
6	Module: Decision Analysis and Game Theory Contents: Decision Making under Certainty Decision Making under Risk Decision Under Uncertainty Game Theory	06
7	Module: Queuing Systems Contents: Elements of a Queuing Model Role of Exponential Distribution Pure Birth and Death Models Generalized Poisson Queuing Model Measures of Performance	08

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Books

1. Operations Research; Hamdy A. Taha; Eighth Edition; Prentice Hall India

References

1. Hillier and Lieberman; Introduction to Operations Research

Course Code	Course/ Subject Name	Credits
CHDE6023	Department Elective II -Biotechnology	04

Prerequisites

- Knowledge of biology, chemistry, chemical engineering

Course Objectives

- At the end of the course the students should understand the basic concept of biotechnology. They should be able to classify micro-organisms, understand cell structure and basic metabolism.
- They should be able to understand basic knowledge about biological polymers.
- They should be able to understand basic knowledge about enzyme technology.
- They should understand role of biotechnology in medical field and industrial genetics.
- They should know importance of biotechnology in agricultural, food and beverage industries, environment, energy and chemical industries.
- They should understand to how to recover biological products.

Course Outcomes

- Students will demonstrate the knowledge of biotechnology in various fields.
- Students will know cell and metabolism.
- Students will have deep knowledge of biological polymers.
- Students will have deep knowledge of enzymes.
- Students will able to know about other uses of biotechnology in medical/pharmaceutical field and industrial genetics.
- Students will be able to understand how biotechnology helps in agricultural, food and beverage industry, chemical industries, environment and energy sectors.
- Students will be able to understand how biological products are recovered.

Module	Contents	Contact Hours
1	Introduction: Traditional and modern applications of biotechnology. Classification of micro-organisms. Structure of cells, types of cells. Basic metabolism of cells. Growth media. Microbial growth kinetics.	7
2	Biological polymers: Lipids, Proteins, Amino acids, Nucleic acids, Carbohydrates, Macronutrients and micronutrients.	6
3	Enzyme Technology: Nomenclature and classification of enzymes. Enzyme kinetics. Michaels Menten Kinetics, Immobilized enzyme kinetics, Immobilization of enzymes. Industrial applications of enzymes. The technology of enzyme production	7
4	Biotechnology in health care and genetics: Pharmaceuticals and bio-pharmaceuticals, antibiotics, vaccines and monoclonal antibodies, gene therapy. Industrial genetics, protoplast and cell fusion technologies, genetic engineering& protein engineering, Introduction to Bio-informatics. Potential lab biohazards of genetic engineering. Bioethics.	10
5	Applications of biotechnology: Biotechnology in agriculture, food and beverage industries, chemical industries, environment and energy sectors.	8
6	Product recovery operations: Dialysis, Reverse osmosis,	10

	ultrafiltration, microfiltration, chromatography, electrophoresis, elecrodialysis, crystallization and drying.	
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Assessment

Internal

- Assessment consists of average of two tests which should be conducted at proper interval

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions to be solved
- Question no.1 will be compulsory and based on entire syllabus where in sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Reference Books

1. Shuller M.L. and F. Kargi. 1992. Bioprocess Engineering, Prentice-Hall, Englewood Cliffs,NJ.
2. Bailey. J.E. and Ollis D.F. 1986, Biochemical Engineering Fundamentals, 2 nd Edition, McGraw Hill, NewYork.
3. Kumar H.D., Modern Concepts of Biotechnology, Vikas Publishing House Pvt. Ltd.
4. Gupta P.K., Elements of Biotechnology, Rastogi Publications
5. Inamdar, Biochemical Engineering, Prentice Hall of India.

Course Code	Course/ Subject Name	Credits
CHL601	Chemical Engineering Lab VII (EE)	1.5

Concept for Experiments

Students should be able to apply the Environmental Engineering concepts to control and management of various types of pollutants. A minimum of TEN experiments must be performed on following concepts:

- Physical characterization (TDS /turbidity measurement) of waste water.
- Chemical characterization (chloride ion, sulphate ion etc.) of waste water.
- Determination of organic matters (dissolved oxygen) in waste water.
- Sampling measurement and standard of water quality (determination of BOD).
- Sampling measurement and standard of water quality (determination of COD).
- Determination of toxic matters (phenol, chromium etc.) in waste water.
- Determination of inorganic matters (heavy metal) in waste water.
- Measurement of particulate matter in air.
- Measurement of gaseous pollutant (any one) in air.
- Measurement of various types of residues or solids in the given sample.
- Measurement of sound level.

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.

Course Code	Course/ Subject Name	Credits
CHL602	Chemical Engineering Lab VIII (MTO II)	1.5

Concept for Experiments

A minimum of TEN experiments must be performed on following concepts:

- Verification of Rayleigh Equation.
- To determine the percentage recovery of solute by solid liquid leaching operation (multistage crosscurrent).
- To determine the vapour-liquid equilibrium curve.
- To find out distribution coefficient. [eg. acetic acid between water and toluene]
- To verify Freundlich adsorption isotherm
- To find the yield of crystals in batch crystallizer.
- To prepare the ternary phase diagram of Binodal solubility curve and tie line relationship for ternary system
- To study distillation at total reflux in a packed column.
- To determine the efficiency of steam distillation
- To study the performance of Swenson Walker crystallizer and also to determine the yield.
- To carry out multistage cross current operation in liquid liquid extraction and compare with single stage operation
- To carry out multistage cross current adsorption and compare with single stage operation.

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.

Course Code	Course/ Subject Name	Credits
CHL603	Chemical Engineering Lab IX (CRE II)	1

Concept for Experiments

Minimum 10 experiments need to be performed by the students on following concepts:

1. Residence Time Distribution (RTD) In Continuous Stirred Tank Reactor (CSTR)- Pulse Input
2. Residence Time Distribution (RTD) In Plug Flow Reactor (PFR) – Pulse Input
3. Residence Time Distribution (RTD) In Packed Bed Reactor (PBR) – Pulse Input
4. Residence Time Distribution (RTD) In Continuous Stirred Tank Reactor (CSTR) – Step Input
5. Residence Time Distribution (RTD) In Plug Flow Reactor (PFR) – Step Input
6. Void volume, Porosity and solid density of catalyst
7. Semibatch reactor
8. Solid fluid heterogeneous non – catalytic reaction
9. Soli fluid Heterogeneous catalytic reaction.
10. Study of adsorption isotherm
11. Adiabatic batch reactor

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
B.E. Semester VII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC701	Process Equipment Design. (PED)	4	-	-	4	-	-	4
CHC702	Process Engineering	3	-	1	3	-	1	4
CHC703	Process Dynamics and Control (PDC)	4	-	-	4	-	-	4
CHDE703X	Department Elective III	4	-	-	4	-	-	4
ILO701X	Institute Elective I	3	-	-	3	-	-	3
CHP701	Project A	-	-	8	-	-	3	3
CHS701	Seminar	-	-	3	-	-	3	3
CHL701	PED Lab	-	3	-	-	1.5	-	1.5
CHL702	Chemical Engineering Lab X (PDC)	-	3	-	-	1.5	-	1.5
Total		18	6	12	18	3	7	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC701	Process Equipment Design. (PED)	20	20	20	80	3	-	-	-	100
CHC702	Process Engineering	20	20	20	80	3	25	-	-	125
CHC703	Process Dynamics and Control (PDC)	20	20	20	80	3	-	-	-	100
CHDE703X	Department Elective III	20	20	20	80	3	-	-	-	100
ILO701X	Institute Elective I	20	20	20	80	3	-	-	-	100
CHP701	Project A	-	-	-	-	-	100	-	25	125
CHS701	Seminar	-	-	-	-	-	50	-	-	50
CHL701	PED Lab	-	-	-	-	-	25	-	25	50
CHL702	Chemical Engineering Lab X (PDC)	-	-	-	-	3	25	25	-	50
Total				100	400	-	225	25	50	800

Department Elective III (Sem VII)		
Engineering Stream (Elective Code)	Management Stream (Elective Code)	Technology Stream (Elective Code)
1. Corrosion Engineering (CHDE7031)	1. Industrial organization and Management. (CHDE7032)	1. Petroleum Refining Technology (CHDE7033) 2. Food Technology (CHDE7034)

Institute Level Optional Subject I (Sem VII)		
1. Product Lifecycle Management (ILO7011)	4. Design of Experiments (ILO7014)	7. Disaster Management and Mitigation Measures (ILO7017)
2. Reliability Engineering (ILO7012)	5. Operation Research (ILO7015)	8. Energy Audit and Management (ILO7018)
3. Management Information System (ILO7013)	6. Cyber Security and Laws (ILO7016)	9. Development Engineering (ILO7019)

Course Code	Course/ Subject Name	Credits
CHC701	Process Equipment Design	4

Prerequisites:

- Fundamentals of units
- Elementary theory of engineering mechanics,
- Engineering drawing.
- Knowledge of heat transfer, mass transfer, mechanical operations and
- Mechanical equipment design.

Course Objectives:

- To understand the basic of design of heat transfer equipments.
- To understand the design of mass transfer equipments.
- To understand the basic of construction and design of high pressure vessels.
- To understand basics of flow diagrams and different equipment inspection methods.

Course Outcomes:

Students would be able to

- Design heat exchanger and evaporator.
- Design distillation and absorption columns.
- Design high pressure vessels.
- Explain different flow sheet presentation and equipment inspection methods.

Module	Contents	Contact Hours
1	Heat exchangers Introduction codes and standards for heat exchangers. Material of construction. <ul style="list-style-type: none"> • Design of shell and tube heat exchanger (U-tube and fixed tube) as per IS: 4503, TEMA standards i.e., shell, tube, tube sheets, channel and channel cover, flanged joints. 	8
2	Evaporators <ul style="list-style-type: none"> • Design of standard vertical evaporator with design of calendria and tube, flange evaporator drums and heads. 	6
3	Distillation and Absorption column Basic features of columns, stresses in column shell. <ul style="list-style-type: none"> • Shell thickness determination at various heights, elastic stability under compression stresses, allowable deflection. • Column internals, design of supports for trays. 	10
4	High Pressure Vessels Materials of construction, constructional method of high pressure vessels and stress analysis. <ul style="list-style-type: none"> • Design of mono block and multi layered high pressure vessels (stress distribution diagram). 	8

5	Flow Diagram <ul style="list-style-type: none"> • Symbols of process equipments and their concepts • Flow sheet representation: <ol style="list-style-type: none"> 1. Block diagram 2. Process Flow Diagram (PFD) 3. Engineering Line Diagram (ELD or PID) 4. Utility line Diagram (ULD) 5. Plant Layout 6. Tank Farm and Plot plan 	8
6	Equipment Inspection <ul style="list-style-type: none"> • Methods of Inspection of Equipments <ol style="list-style-type: none"> 1. Radiography 2. Ultrasound 3. Dye Penetration 4. Fatigue assessment test 	8

Assessment

Internal

- Assessment consists of average of two tests which should be conducted at proper interval

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions to be solved
- Question no.1 will be compulsory and based on entire syllabus where in sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. Process Equipment Design- Vessel Design by E. Brownell and Edwin, H. Young. John Wiley, New York 1963.
2. Chemical Engineering volume 6- Design by J.M Coulson, J.F. Richardson and P.K. Sinnot, Pregamovr press, International edition 1989.
3. Introduction to Chemical Equipment Design- Mechanical aspects by B.C. Bhattacharya CBS Publications
4. Process Equipment Design by M.V.Joshi Macmillan India.

Course Code	Course/ Subject Name	Credits
CHC 702	Process Engineering	04

Prerequisites:

- The students should have knowledge of Heat transfer and Mass Transfer to carry out Mass and Energy balance around process.
- They should be aware about basic principles of economics to evaluate cost and profit of process.
- They should be familiar with process and mechanical design of Process equipments.
- They should be familiar with various types of plant utilities.

Course Objectives:

- To provide training to solve problems relevant to the general practice of chemical engineering and design
- To provide experience in the process of original chemical engineering design in the areas of equipment design, process design and plant design through the process of formulating a design solution to a perceived need and then executing the design and evaluating its performance including economic considerations and societal impacts if any, along with other related constraints, and culminating in both written and oral presentation of results.
- To provide students familiarity with professional issues in chemical engineering including ethics, issues related to the global economy and to emerging technologies and fostering of important job related skills such as improved oral and written communications and experience in working in teams at a number of levels.

Course Outcomes:

- The graduates are expected to have ability to apply knowledge of mathematics, science and engineering.
- The graduates are expected to have ability to design a system, a component, or a process to meet the desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability and sustainability.
- The graduates are expected to possess ability to function on multi disciplinary teams.
- The graduates are expected to possess ability to identify, formulate and solve engineering problems.
- The graduates are expected to have an understanding of professional and ethical responsibility.
- The graduates are expected to engage themselves in lifelong learning.
- The graduates are expected to possess ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Module	Contents	Contact Hours
1	Introduction to Process Engineering Chemical Products, Formulation of the Design Problem, Chemical Process Design and Integration, The Hierarchy of Chemical Process, Design and Integration, Continuous and Batch Processes, New Design and Retrofit , Approaches to Chemical Process Design and Integration, Process Control, Basic concepts regarding PFD, Block diagrams, P and ID Process flow diagram, piping and instrumentation diagram, Importance of safety and environmental aspects.	06
2	Process Design of Piping, Fluid moving Devices and Flow Meters (with numerical). Process design of piping, process design of fluid moving devices, Centrifugal pump performance for viscous fluids, Revision of formulae for power requirement for fans, blowers, adiabatic compressor, Process Design for orifice and rotameter, Trouble shooting in fluid flow systems	08
3	Process Design of Distillation Column Selection criteria, equipment selection, distillation column design (multicomponent with numerical), FUG, Lewis Matheson method, Thiele Geddes method, Selection of tray, process design of tray tower, height of packings, Short path distillation, design and working of short path distillation, energy conservation in distillation	08
4	Process Design of Absorbers Selection criteria, design of absorber including multicomponent (with numerical) using shortcut methods	08
5	Reactors: Mass and Energy Balance for reactor, Choice of reactors-Reactor Configuration(Temperature Control, Catalyst Degradation, Gas-Liquid and Liquid-Liquid Reactors, Reactor Configuration, Reactor Configuration for Heterogeneous Solid-Catalyzed Reactions, Reactor Configuration from Optimization of a Superstructure	06
6	Sizing/Costing of Equipments in Flow Sheet: Distillation columns absorbers, pumps, compressors, heat exchangers(with numerical)	08
7	Role and responsibilities: Role and responsibility of process and chemical engineering profession towards society, environment, ethical aspects, safety concerns.	

Tutorials

- Minimum 8 tutorials should be conducted
- At least one tutorial on each module is expected.
- Tutorial on modules 2 to 6 must include numerical problems.

- One tutorial will be presentation on any process flow sheet demonstrating all the concepts in process engineering.

Term work

Term work should consist of minimum 8 tutorials from entire syllabus which are to be given at regular intervals batch wise.

Tutorial: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Books

1. Process Engineering and Design: Shuchen B. Thakore, Bharat I Bhatt, Second Ed., McGraw Hill Education(I) Private Limited,2011-[modules 2,3].
2. Robin Smith, Chemical Process Design and Integration, John Wiley and Sons,[module 1,5]
3. Systematic Methods Of Chemical Process Design, Loren T Biegler, Grossman E.I., West-berg, A.W. Prentice Hall Intl ed., 1997.[module 4,6]
4. Richard M. Felder, Ronald W. Rousseau, Elementary Principles of Chemical Processes,John Wiley & Sons [Module 5].

References

1. Conceptual Design of Chemical Processes, J.M. Douglas, McGraw Hill International Editions, 1988
2. Chemical Process Equipment: selection & design, Walas, S.M., Butterworth, London,1980
3. Strategy of Process Engineering, John D.F. Rudd& C.C. Watson, Wiley & Sons International, 1968
4. Process Design Principles: synthesis analysis & evaluation, Sieder, W.D., Seader J.D. & Lewin D.R., John Wiley & Sons, 1998.
5. Analysis, Synthesis, and Design of Chemical Processes, Richard Turton, Richard C. Bailie,Wallace B. Whiting, Joseph A. Shaeiwitz, PHI Learning Private Limited, New Delhi, 2011.

Course Code	Course/ Subject Name	Credits
CHC703	Process Dynamics and Control	4

Prerequisites:

- Linear Algebra
- Differential Equations
- Laplace Transforms

Course Objectives:

- To understand dynamic behavior of process systems and equipments.
- To understand frequency response of dynamic systems.
- To understand and analyze stability characteristics of dynamic systems.
- To design controllers.

Course Outcomes:

- The student will be able to model dynamical systems
- Will be able to study their responses in Time, Laplace and Frequency domains.
- The student will be able to design stable controllers, for important chemical processes.

Module	Contents	Contact Hours
1	Introduction To Process Control Typical Control Problems A Blending Process Example Control Strategies Hierarchy of Control Activities An Overview of Control System Design	04
2	The Rationale for Dynamic Process Models General Modeling Principles Degrees of Freedom Analysis Typical Dynamic Models	06
3	Transfer Functions of Typical Systems First and Second Order Systems Properties of Transfer Functions Transfer Functions of Systems in Series Time Delay Processes Linearization of Non-linear Systems	06
4	Dynamic Behavior of Processes Standard Process inputs Response of First Order Processes Response of Second Order Processes Response of Integrating Processes	08
5	Development of Empirical Models From Process Data Fitting First and Second Order Models Using Step Tests	04

	Development of Discrete Time Dynamic Models Identifying Discrete Time Models From Experimental Data	
6	Basic Control Modes Features of PID and On-off Control Response of Feedback Control Systems Digital Versions of PID Controllers	04
7	Closed-Loop Transfer Functions Closed-Loop Response Stability of closed loop systems Frequency Response Stability based on Bode criteria. Gain and Phase Margins	08
8	Controller Design and Tuning Performance Criteria On-line controller Tuning Guidelines for common control loops	04
9	Control Strategies at the process unit level Degrees of Freedom Analysis for process control Selection of Controlled, Manipulated, and Measured Variables Selection of Instrumentation Typical Applications	04

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Books

1. Dale E. Seborg, Thomas F. Edga, Duncan A. Mellichamp Francis J. Doyle; Process Dynamics and Control III; Third Edition; John Wiley & Sons (Asia) Pvt. Ltd., New Delhi - 110002

References

1. William L. Luyben; Process Modeling Simulation and Control for Chemical Engineers; 2nd Edition; Mc-Graw Hill Publishing Co.
2. George Stephanopoulos; Chemical Process Control; PHI Learning Pvt. Ltd.
3. Sudheer S Baghade, G.D. Nageshwar, Process Dynamics and Control; PHI learning Pvt. Ltd.
4. Prabir Kumar Sarkar, Advanced Process Dynamics and Control, PHI Learning Eastern Economy Edition.

Course Code	Name of Subject	Credits
CHDE7031	Department Elective III- Corrosion Engineering	04

Prerequisites:

- Basic knowledge of Chemical Engineering, Physical Chemistry and Electrochemistry, Basic knowledge of Reaction Mechanism, Thermodynamics, Fluid Flow and Chemical Reaction Engineering, Various types of Material and Metals.

Course Objectives:

- To understand the needs for Corrosion Education, The Functions and Roles of an Engineer to prevent Corrosion.
- Understanding of basic concepts of Corrosion, Corrosion in different materials, Corrosion Electrochemistry, Corrosion Thermodynamics, Kinetics and Applications.
- To impart the interdisciplinary subject in which Chemical Engineering, Materials Engineering, Electrical Engineering, Civil Engineering and Metallurgy Engineering are involved.
- Understand the Methodology, Methods and Materials to prevent the Corrosion.

Course Outcomes:

Upon completion of the course, the student should be able to

- Describe the Chemistry behind the corrosion, process of corrosion, different factors affecting the rate of corrosion.
- Discuss Kinetics and different forms of corrosion and will be able to recognize the corrosion occurring in the different materials.
- Explain techniques of corrosion cells, Corrosion avoidance, corrosion failure and the various factors.
- Students shall understand how to prevent the corrosion, selection of materials for corrosion prevention, how to alter the environment for minimal rate of corrosion, different protection techniques and coating to prevent corrosion.
- Gain knowledge of corrosion by water, boilers feed water, cooling tower water and the scaling indices of water used in many processes. They will also learn about atmospheric corrosion, its tests as well as behavior and resistance to such corrosion.

Module	Contents	Contact Hours
01	The Study of Corrosion -Needs for Corrosion Education, The Functions and Roles of a Corrosion Engineer, The Corrosion Engineer's Education, Strategic Impact and Cost of Corrosion Damage. Corrosion Basics -Why Metals Corrode, Matter Building Blocks, Acidity and Alkalinity (pH), Corrosion as a Chemical Reaction, Corrosion in Acids, Corrosion in Neutral and Alkaline Solutions.	06
02	Corrosion Electrochemistry - Electrochemical Reactions,	08

	Anodic Processes, Faraday's Law, Cathodic Processes, Surface Area Effect. Corrosion Thermodynamics -Free Energy, Standard Electrode Potentials, Nernst Equation, Thermodynamic Calculations, Reference Half-Cells (Electrodes), Measuring the Corrosion Potential, Measuring pH, Potential-pH Diagram.	
03	Corrosion Kinetics and Applications of Electrochemistry to Corrosion -What Is Overpotential? Activation Polarization, Concentration Polarization, Ohmic Drop, Graphical Presentation of Kinetic Data(Evans Diagrams), Examples of Applied Electrochemistry	06
04	Eight Forms of Corrosion -Recognizing Corrosion, General or Uniform Attack, Galvanic or Two metal Corrosion, Crevice Corrosion, Pitting, Intergranular, Selective Leaching, Erosion Corrosion, Stress Corrosion, Hydrogen Damage.	08
05	Corrosion Failures, Factors, and Cells -Introduction, Information to Look For, Identifying the Corrosion Factors, Examples of Corrosion Cells, Corrosion Avoidance, Visualizing Corrosion Cells.	06
06	Corrosion Prevention - Materials Selection, Alteration of Environment, Design, Cathodic and Anodic Protection, Coatings.	06
07	Corrosion by Water - Importance of Water, Corrosion and Water Quality and Availability, Types of Water, Cooling Water Systems, Steam Generating Systems, Water Treatment, Scaling Indices. Atmospheric Corrosion - Introduction, Types of Corrosive Atmospheres, Factors Affecting Atmospheric Corrosion, Measurement of Atmospheric Corrosivity Factors, Atmospheric Corrosivity Classification Schemes, Atmospheric Corrosion Tests, Corrosion Behavior and Resistance.	08

Assessment

Internal:

- Assessment consists of an average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.

Textbook/References Book

1. Pierre R. Roberge, Handbook of Corrosion Engineering, McGraw-Hill Publication

2. Mars G. Fontana, Corrosion Engineering, McGraw-Hill Book Company
3. Pierre R. Roberge, Corrosion Engineering Principles and Practice, McGraw-Hill Pubication
4. Zaki Ahmad, Principles of Corrosion Engineering and Corrosion Control, Butterworth-Heinemann Publication
5. By Branko N. Popov, Corrosion Engineering: Principles and Solved Problems, Elsevier Publication

Course Code	Name of Subject	Credits
CHDE7032	Department Elective III- Industrial Organization and Management	04

Prerequisites

- Communication skills
- Basic Mathematical skills
- Analytical, logical and reasoning skills
- Operations Research

Course Objectives:

- To understand basic concepts business, administration and management
- To understand functions of management such as planning, organizing and decision making
- To understand corporate/company governance structures and laws governing industries
- To understand production and quality management
- To understand basics of marketing and sales management
- To understand financial management of companies

Course Outcomes:

5. Students will be able to use concepts and knowledge of management to excel in their career
6. Students should be able to prepare detailed plans, organization structures and able to use modern tools for decision making
7. Students should be able to use the knowledge of corporate government structures and government law to upgrade their skills
8. Students should be able to use concepts of production and quality management to improve productivity and quality in manufacturing plants
9. Students should be able to use concepts of marketing and sales to improve profitability of business they will work in future
10. Students should be able to use tools of finance and accounting to keep control and improve profitability of industry they are working in.

Module	Contents	Contact Hours
1	<p>Introduction to business and management</p> <p>Business: Definition, Characteristics, Divisions, Objectives, Management of business Administration, Organization.</p> <p>Management: Definitions, characteristics, nature, principles, Objectives, difference between policies-goals-objectives role of manager and required managerial skills, Difference of relationship between business, administration and management, types of management, Typical management structure, management structure chart for medium scale industry, difference between</p>	5

	management and administration, development of management thought:-Taylor, Fayol, Follet, Gilbreth, Gantt(in brief)	
2	<p>Functions of management: forecasting, planning, organizing, staffing, directing, controlling, coordinating, decision making (brief),</p> <p>Planning:- type of plans, steps in planning, management business objectives(MBO)</p> <p>Organization: Concept, definition, importance, characterization, process, principles of healthy organization, organization planning, organizational structure, design of organization structure, process of organization, organization chart, types of organizations: military, functional, line and staff, committee, matrix; departmentalization, span of management, delegation of authority, decentralization, organizational conflict</p> <p>Decision making: importance, types, theories, techniques, decision making process, scientific approach to decision making, guidelines for effective decision making, quantitative methods in decision making, markov analysis. Numericals based on decision making quantitative methods</p>	7
3	<p>Corporate Management Structures and laws governing industries</p> <p>Industrial ownership: types of company ownership: single ownership, partnership, joint stock company, cooperative ,government companies; organs of company management and their functions(shareholders, board of directors, CEO, managing director, manager, secretary),state regulation of management, company law board, company meetings and resolutions. Companies act</p> <p>Industries (Development and Regulation) Act, Contract Law, Indian Sale of Goods Act, Foreign Exchange Management Act, Foreign Exchange Regulation Act , labor laws, factories act, payment of wages act, minimum wages act, workmen's compensation act, industrial disputes act, employees state insurance act, Union and industrial labor relations :trade unions and industrial relations, types of industrial disputes, settlements of industrial disputes, collective bargaining, handling of grievances and disputes</p>	7
4	<p>Production and quality management</p> <p>Production system, input -output model, application of microeconomics to industries, productivity and measures to increase productivity.</p> <p>Objectives and activities of production planning and production control, major steps in planning and control: routing, scheduling, dispatching, follow-up and expediting,</p>	6

	types of production systems, supervision and functions of supervisor. Definition of quality, dimensions of quality, Deming's 14 points for management, Juran's quality trilogy, TQM, ISO 9000, ISO 14000 Quality control meaning, objectives, benefits, steps, Inspection, cost of quality, quality control tools for improvement, Quality circles, statistical quality control	
5	Marketing and sales management: Sales management, sales organization, functions of sales department, duties of sales manager, the selling and marketing concept. Marketing: definition, principle and, marketing management and its functions, marketing research, pricing policies, sales forecasting, marketing mix, advertising, sales promotion, channels of distribution, pricing, product mix and, international marketing	6
6	Financial Management: Definition, difference between finance and accounts, functions of financial management, objectives of financial management, role and scope of financial management Sources of finance, cash management, capitalization. Definitions of assets, liabilities, book keeping, capital and types of capital, discounts, commission, debtor, creditor, turnover. Mechanics of accounting: cash books, sales book, purchase book, debit/credit note, journal, ledger. Financial accounting, accounting equation, balance sheet, income statements, preparation and analysis of financial statements, analysis and interpretation of financial statements, cash flow statements, ratio analysis Management information system: MIS Definition, objectives, functions, Difference between data and information, information as organizational resource, qualities of good information, management information categories, designing information systems, integrated information systems. Numericals	7

Assessment

Internal:

- Assessment consists of an average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.

Textbook/References Book

1. Industrial Engineering and Management-O.P. Khanna, Dhanpat Rai publications(Module 1,2,3,4,5,6)
2. Fundamentals of Business Organization and Management, Y.K. Bhushan, S. Chand(Module 1,2,3)
3. Industrial Organization and Management: Dani, Sabhalok, Parikh, Shahani-Mananprakashan (Module 1,2,3,4)
4. Engineering Management, A.K.Gupta, S.Chand (Module 1,4,5,6)
5. Basic Financial Accounting for Management, Paresh Shah, Oxford press(Module 6)
6. Industrial Organization and Management, Basu S.K ,Prentice Hall India Learning Private Limited (1,2,3,4)
7. NPTEL Course Notes, Managerial Science II(Module 1,2,3,4,5)

Course Code	Course/ Subject Name	Credits
CHDE7033	Department Elective III- Petroleum Refining Technology	4

Prerequisites:

- Knowledge about Formation & Origin of petroleum, Composition & testing methods & Basic treatment techniques.

Course Objectives:

- To understand Petroleum Refining processes & products, its evaluation & treatment techniques
- To understand various cracking processes & its applications in Chemical industries.

Course Outcome:

- Characterize crude petroleum and petroleum refinery
- Fractionate crude petroleum into useful fractions
- Measure important physical properties of petroleum products
- Apply refinery processes to maximize desired petro products
- Use treatment techniques to purify petro products
- Manufacture widely used petrochemicals

Module	Contents	Contact Hours
1	Introduction -Origin ,Formation & Composition of Petroleum: Importance, Origin theory, Reserves in India & world. Exploration of Reserves, Types of crude, (Based on constituents, Sulfur contents & Degree API). Indian crude reserves & production scenario, Indian Petroleum Industry Scenario, Agencies engaged in upstream & downstream petroleum industry (Government & Private).	05
2	Crude Oil Assay: Properties, composition, UOP Characterization factors, Correlation index, Crude distillation curves. Important products test & methods, Gasoline, Kerosene, Diesel.	06
3	Crude Oil Processing & Refining: Separation of well fluid, Dehydration & desalting of crude, Heating of crude, Overall refinery flow diagram, its processes & Products, Low boiling products –LPG, Gasoline, Kerosene & their Specifications. Multi component fractionation of petroleum including pump around & side stripping, ADU & VDU, Blending of gasoline, Corrosion problem.	12
4	Treatment ,Techniques & Product Specifications: Treatment of Gasoline, Kerosene, Lubes & Wax.	08
5	Catalytic Cracking & Thermal Processes: Fluidized bed catalytic cracking, Catalytic reforming, Coking,	10

	Hydrogen Processes- Hydro cracking & Hydrodesulphurization, Alkylation Process, Isomerization process, Polymer gasoline.	
6	Asphalt Technology & Environmental issues: Source of Asphalt, Air blowing of Bitumen, Brief review of Bio refinery, Environmental issues in Petroleum industry, Alternative energy sources (Bio Diesel, Heavy Oil, Shale Oil).	07

Assessment

Internal

- Assessment consists of average of two tests which should be conducted at proper interval

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions to be solved
- Question no.1 will be compulsory and based on entire syllabus where in sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. B.K Bhaskara Rao, Modern Petroleum Refining Process.
2. W.L Nelson, Petroleum Refinery Engineering 4th ed, McGraw Hill.
3. Petroleum Chemistry and Refining Edited by James G. Speight, Taylor and Francis .
4. Chemical Process Industries, Austin, G.T Shreves.
5. Encyclopedia of chemical processing and design by John J. McKhetta; Marcel Dekker, Inc.

Course Code	Course/ Subject Name	Credits
CHDE7034	Department Elective III : Food Technology	04

Prerequisites:

- Knowledge of Microbiology, Biochemistry, chemical engineering

Course Objectives:

- To impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation, food adulteration, food related hazards and safety.

Course Outcomes:

- Knowledge of food essential nutrients and the various causes of food deterioration.
- Identification of appropriate processing, preservation, and packaging method.
- Students should be able to analyze product quality and effect of processing technique on it.
- They should Identify important species of pathogenic microbes and describe factors that affect their growth in various types of food.
- Analysis of food related hazards and HACCP method

Module	Contents	Contact Hours
1.	Food Biochemistry and Food Microbiology: Food Constituents: Carbohydrates, Proteins, Vitamins, Lipids, And Minerals, Flavors, Water, Nutritional & sensory characteristics, Food fortification. Water activity enzymes: Production from microorganisms and application in food processing, Growth of microorganisms and food spoilage, D & Z values, Indian laws regulating Foods and Foods processing	06
2	Ambient Temperature Process: Raw material preparation, Size reduction of solid fibrous foods and in liquid foods., Emulsification and Homogenization ,Theory and equipment , Mixing and Forming, Extraction and expression , Membrane concentration Fermentation : Theory , Types, Equipment Effect on foods	08
3	Thermal Processing: Theory, Equipment, Effect on foods, blanching, extrusion, pasteurization, Heat Sterilization, In-container Ultra high temperature (UHT)/aseptic processes, Microbial spoilage, thermal death time curve.	08
4	Freezing and Refrigeration: Types, Equipments, refrigerants, effects of low temperature on quality, chilling, freezing , freeze drying and freeze concentration	08
5	Food Storage & Packaging: Modified Atmosphere Storage(MAS) , Hurdle Technology, Modified atmosphere	06

	packaging(MAP) Food Adulteration & Quality Management: Food Adulteration and food safety. HACCP, GMP, GHP, GLP.	
6	Food Processing: Manufacturing and processing of food products: Fruit juice processing, Alcoholic beverages, Milk and Milk Products; Milk powder, cheese, Ice cream, Tea coffee, cocoa, Bread , Biscuits , confectionary(hard boiled sweets & chocolates)	08

Assessment

Internal

- Assessment consists of average of two tests which should be conducted at proper interval

End Semester Theory Examination

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions to be solved
- Question no.1 will be compulsory and based on entire syllabus where in sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Text Book

1. Fellows,P., Food Processing Technology: Principles and Practice , 2nd ed., Woodhead Publishing Ltd., England , 2000.

Reference Books

1. Toledo, R., Fundamentals of Food Process Engineering, 2nd ed., CBS Publishers &Distributors, New Delhi, 1997.
2. Sharma K., et.al., Food Process Engineering, Theory and Laboratory Experiments, John Wiley and Sons Inc., Canada 2000.
3. Pandey and Srivastava , Chemical Process Technology , Vol.2
4. Singh, R.P. & Heldman , D.R., Introduction to Food Engineering, 3rd ed., Academic press, UK 2001.
5. Lelieveld, H.L.M., et.al. Hygiene in Food Processing, Woodhead Publ. Ltd., England 2003.
6. Subbulakshmi G. & Udipi S.A., Food Processing and Preservation, New Age International Pvt. Ltd., India 2001.
7. Valentas, k.J.et.al., Food Processing Operations and scale up, Marcel Dekker, N.Y 1991.
8. Tamb, I.A. and Singh R.P., Food Storage Stability CRC Press 19981.
9. D. G. Rao, Fundamentals of Food Engineering, PHI Learning Pvt. Ltd.

Course Code	Course Name	Credits
ILO7011	Institute Level Optional Subject I- Product Life Cycle Management	03

Objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Outcomes:

Learner will be able to...

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Contact Hours
01	Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM.	10
02	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X	09

	Tools and Their Use in the Design Process.	
03	Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.	05
04	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	05
05	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design.	05
06	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.	05

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO7012	Institute Level Optional Subject I- Reliability Engineering	03

Objectives:

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes:

Learner will be able to...

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Contact Hours
01	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and	05

	Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
06	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Assessment

Internal

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End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	Institute Level Optional Subject I- Management Information System	03

Objectives

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Outcomes Learner will be able to...

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Contact Hours
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, and Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment

Internal

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End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	Institute Level Optional Subject I- Design of Experiments	03

Objectives:

- To understand the issues and principles of Design of Experiments (DOE)
- To list the guidelines for designing experiments
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes:

Learner will be able to...

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action
- Apply the methods taught to real life situations
- Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Contact Hours
01	Introduction 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	Fitting Regression Models 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	Two-Level Factorial Designs and Analysis 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	Two-Level Fractional Factorial Designs and Analysis 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs	07

	4.6 Fractional Factorial Split-Plot Designs	
05	Conducting Tests 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
06	Taguchi Approach 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment

Internal

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End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss
6. Phillip J Ross, "Taguchi Technique for Quality Engineering," McGraw Hill
7. Madhav S Phadke, "Quality Engineering using Robust Design," Prentice Hall

Course Code	Course Name	Credits
ILO7015	Institute Level Optional Subject I- Operations Research	03

Objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Outcomes:

Learner will be able to...

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems; solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Contact Hours
01	<p>Introduction to Operations Research: Introduction, Structure of the Mathematical Model, Limitations of Operations Research</p> <p>Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p>Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.</p> <p>Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem</p>	14

	Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothing, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment

Internal

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End Semester theory examination

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- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO7016	Institute Level Optional Subject I- Cyber Security and Laws	03

Objectives:

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Outcomes:

Learner will be able to...

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Contact Hours
01	Introduction to Cybercrime: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	Cyber offenses & Cybercrime: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	Tools and Methods Used in Cyberline Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	The Concept of Cyberspace E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking,	8

	The Need for an Indian Cyber Law	
05	Indian IT Act. Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	Information Security Standard compliances SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment

Internal

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End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Course Code	Course Name	Credits
ILO7017	Institute Level Optional Subject I- Disaster Management and Mitigation Measures	03

Objectives:

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Outcomes:

Learner will be able to...

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structures associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Contact Hours
01	Introduction: Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration: Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift	06

	<p>in disaster management.</p> <p>Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.</p>	
04	<p>Institutional Framework for Disaster Management in India: Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.</p>	06
05	<p>Financing Relief Measures: Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.</p>	09
06	<p>Preventive and Mitigation Measures: Pre-disaster, during disaster and post-disaster measures in some events in general structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.</p>	06

Assessment

Internal

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End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. 'Disaster Management' by Harsh K. Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep, Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO7018	Institute Level Optional Subject I- Energy Audit and Management	03

Objectives:

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes:

Learner will be able to...

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Contact Hours
01	Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	Energy Audit Principles: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	Energy Management and Energy Conservation in Electrical	10

	<p>System: Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings.</p> <p>Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers.</p> <p>Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.</p>	
04	<p>Energy Management and Energy Conservation in Thermal Systems: Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system.</p> <p>General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.</p>	10
05	<p>Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.</p>	04
06	<p>Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources</p>	03

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B. Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Institute Level Optional Subject I- Development Engineering	03

Pre-requisite:

- Interest in societal development.

Course Objective:

- To understand the characteristics of rural Society and the Scope and Nature and Constraints of rural Development.
- To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
- The objective of the course is an exploration of human values, which go into making a ‘good’ human being, a ‘good’ professional, a ‘good’ society and a ‘good life’. The context is the work life and the personal life of modern Indian professionals.
- To understand the Nature and Type of Human Values relevant to Planning Institutions.

Course Outcome:

- Students will be able to apply knowledge for Rural Development.
- Students will be able to apply knowledge for Management Issues.
- Students will be able to apply knowledge for Initiatives and Strategies
- Students will be able to develop acumen for higher education and research.
- Students will master the art of working in group of different nature.
- Students will develop confidence to take up rural project activities independently.

Module	Contents	Contact Hours
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development.	04
2	Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	04
3	Post-Independence rural Development BalwantRai Mehta Committee - three tier system of rural local Government; Need and scope for people’s participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	04
4	Rural Development Initiatives in Five Year Plans Five Year	06

	Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
5	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
6	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education.	04
7	Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	06
8	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Recommendation

Students can take any one or two live projects beneficial to rural population or society at large.

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rdGoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Course Code	Course Name	Credits
CHP701	Project-A	03
<p>Guidelines:</p> <ul style="list-style-type: none"> • Project groups: Groups can formed with minimum TWO and not more than THREE students per group. • Students should spend considerable time in applying all the concepts studied, into the Project, hence, eight hours each are allotted in project A and B to the students. • Students are advised to take up industrial/ experimental/ simulation and/or optimization based topics for their project. • Students should report their guides with their work on weekly basis. <p>Exam Guidelines</p> <p>Term Work - 100 Marks:</p> <ul style="list-style-type: none"> • Presentation – 50 Marks • Report -50 Marks <p>Oral – 25 Marks</p>		

Course Code	Course Name	Credits
CHS701	Seminar	03
<p>Guidelines:</p> <ul style="list-style-type: none"> • Each student has to present Seminar on the topic which will be the consensus of the project guide and the student, considering the recent development in the field of Chemical Engineering. • The load for seminar will be calculated as one hour per week irrespective of the number of students <p>Exam Guidelines</p> <p>Term Work - 50 Marks:</p> <ul style="list-style-type: none"> • Seminar Presentation – 25 Marks • Report -25 Marks 		

Course Code	Course Name	Credits
CHL701	Process Equipment Design Lab	1.5

Concept of Lab

The practical shall include Design and Drawing of:

Minimum TEN practicals should be performed

1. Heat Exchangers
2. Short Tube vertical Evaporator
3. Distillation Column
4. High Pressure vessels

With respect to:

- Symbols
- P & I D
- Plot plan and Tank farm
- Plant Layout

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Course Code	Course Name	Credits
CHL702	Chemical Engineering Lab X (PDC)	1.5

Minimum of TEN experiments should be performed from the modules of Theory Course Process Dynamics and Control (CHC703)

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
B.E. Semester VIII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
CHC801	Modeling, Simulation & Optimization (MSO)	4	-	-	4	-	-	4
CHC802	Project Engineering & Entrepreneurship Management	3	-	1	3	-	1	4
CHC803	Energy System Design	3	-	1	3	-	1	4
CHDE804X	Department Elective IV	4	-	-	4	-	-	4
ILO802X	Institute Elective II	3	-	-	3	-	-	3
CHP801	Project B	-	-	8	-	-	6	6
CHL801	Chemical Engineering Lab XI (MSO)	-	2	-	-	1	-	1
Total		17	2	10	17	1	8	26

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC801	Modeling, Simulation & Optimization (MSO)	20	20	20	80	3	-	-	-	100
CHC802	Project Engineering & Entrepreneurship Management	20	20	20	80	3	25	-	-	125
CHC803	Energy System Design	20	20	20	80	3	25	-	-	125
CHDE804X	Department Elective IV	20	20	20	80	3	-	-	-	100
ILO802X	Institute Elective II	20	20	20	80	3	-	-	-	100
CHP801	Project B	-	-	-	-	-	100	-	50	150
CHL801	Chemical Engineering Lab XI (MSO)	-	-	-	-	2	25	25	-	50
Total				100	400	-	175	25	50	750

Department Elective IV (Sem VIII)		
Engineering Stream (Course Code)	Management Stream (Course Code)	Technology Stream (Course Code)
1. Advanced Process Control (CHDE8041)	1.Total Quality Management (CHDE8042)	1. Advanced Separation Technology (CHDE8043) 2. Polymer Technology (CHDE8044)

Institute Level Optional Subject II (Sem VIII)		
1. Project Management (ILO8021)	4. Human Resource Management (ILO8024)	7. IPR and Patenting (ILO8027)
2. Finance Management (ILO8022)	5. Professional Ethics and CSR (ILO8025)	8. Digital Business Management (ILO8028)
3. Entrepreneurship Development and Management (ILO8023)	6. Research Methodology (ILO8026)	9. Environmental Management (ILO8029)

Course Code	Name of Subject	Credits
CHC801	Modelling Simulation and Optimization	04

Prerequisites:

- Linear Algebra, Process Calculations, Computer Programming

Course Objectives:

- To make students understand writing and solving models of chemical engineering system
- To make students understand writing and solving systems of nonlinear equations for single and multiple units
- To make students understand simulation of complete flowsheets
- To make students understand optimization of single and multiple units

Course Outcomes:

- The students will be able to write and solve models of chemical engineering system.
- The students will be able to carry out sequential and equation oriented simulation of complete flowsheets.
- The student will be able to optimize typical chemical processes.

Module	Contents	Contact hrs
01	Modeling Aspects: 1.1 Definition of process model, physical and mathematical modeling, classification of models, model building, classification of mathematical methods 1.2 Mathematical Models of Chemical Engineering Systems: Introduction, uses of mathematical models, scope of coverage, principles of formulation, fundamental laws, continuity equations, energy equations, equation of motion, transport equation, equation of state, equilibrium, kinetics.	08
02	Examples of Mathematical Models of Chemical Engineering Systems: Introduction, series of isothermal, constant-hold up CSTR, CSTR with variable holds up, two heated tanks, gas-phase, pressurized CSTR, non-isothermal CSTR, single-component vaporizer, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup. Degree of Freedom analysis Concept of design and rating problem in context of selection variables after DOF analysis.	10
03	Introduction to Simulation, Sequential and Equation oriented Simulation, Flow sheet topology analysis, Recycle, Partitioning and Tearing of flow sheets. Simulation Examples, Williams Otto Flow sheeting	08

04	Numerical Methods for solving sets of nonlinear equations, Newton's method with Armijo Line search, Successive substitution. Solution for models developed in module 2	08
05	Introduction to Optimization. Unconstrained single and multi variable non-linear optimization. Numerical methods for single and multivariable optimization. Golden section and Newton's method, for Single variable case, and Gradient and Newton's method for multi-variable cases may be considered. Optimization of specific process units such as Heat exchangers, Reactors, Separation equipment etc. can be considered.	16

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Reference

1. William Y. Luyben, Process Modelling simulation and control for chemical Engineer, Second edition McGraw Hill
2. Thomas Edger, David M. Himmelbleau, Optimization of chemical processes, 2nd Ed., John Wiley
3. Lorenz T. Beigler, Ignacio E. Grossman, Arthur W. Wesburg, Systematic Methods of Chemical Process Design, Prentice Hall

Course Code	Course/ Subject	Credits
CHC802	Project Engineering and Entrepreneurship Management	04

Prerequisites:

- Communication skills, Mathematical skills, Analytical, logical and reasoning skills

Course Objectives:

- To understand basic concepts project management and application of PM to process industries
- To understand project feasibility reports and learn about various clearances required to start an industry
- To learn various project organizations and basics of contracting
- To learn various tools and techniques used in PM and understand role of entrepreneurship in the society for the economic growth.

Course Outcomes:

Students will be able to use

- concepts and knowledge of project management to manage projects in process industries
- Students should be able to prepare feasibility reports.
- Students should be able to understand various clearances required to start industry
- Students should be able to prepare project organization charts and contracts
- Students should be able to prepare contracts
- Students should be able to use tools of PM to solve problems and will be motivated to become entrepreneurs

Module	Name of module and contents	Contact Hours
1	<p>Concepts of project management: Definition of project, project management, project types, project life cycle: purpose, inputs, project manager's role and outputs, Tools and techniques in project management, major knowledge areas of project management , Difference between project management and formal management, Role-responsibilities and skills of project manager, project overruns Project management in process industries: project strategy, project specification, project engineering, detailed design, procurement, construction, commissioning and closure Case studies : swagruha constructions, Advanced recycling sciences, super clean paperboards, Instron manufacturing company, Ind constructions, Goshe Corporation, accorn, govt of India bridge project Delhi, Jharkhand project</p>	10
2	Feasibility report, licensing and clearances	06

	<p>Feasibility reports: Raw material survey, Market survey and demand study, technical study, location survey, financial survey and types of cost estimates, Estimation of project profitability Industrial license and LOI, Various laws & regulations governing industries, need for clearances and influences on project, List of various clearances.</p> <p>Case studies: Discussion of feasibility report for soap/mustard oil / ready to eat snacks, Decotile corporation, SIRIS pharma Hyderabad, coal fired boilers project, plant on river Yangtze, IC software, temples and towers. Numerical based on cost benefit analysis, profitability, cost estimation</p>	
3	<p>Project organization and contracting</p> <p>Project scope, project priorities, development of WBS, Development of process breakdown structure, Development of responsibility matrix, development of project communication plan. The traditional management structure, Project management organizational structure: pure project, matrix, task force, Project team, responsibilities of various members. Contracts types, selection criteria, 3R of contracting, types of reimbursements and tendering procedure</p> <p>Case study: Hindustan oil company: Hamad petroleum company, corel production systems, Jones and Shephard Accountants, White manufacturing, Hotel pulkeshi international</p>	06
4	<p>Tools and techniques in project Management and entrepreneurship:</p> <p>Health-safety and environmental guidelines for chemical plants Quality assurance, Hazard analysis, Risk analysis and management, Change Management. Cost benefit analysis, Project execution plan (PEP), Bar charts/GANTT charts, LOB, Networking techniques (PERT/CPM), Productivity budgeting techniques, Value engineering (VE) , ABC and VED Analysis , Economic Order Quantity (EOQ), CAT vs RAT, Time and cost control tools and techniques. Use of Microsoft projects.</p> <p>Entrepreneurship: Definition, Concept of entrepreneur and entrepreneurship, Characteristics, aspects, factors affecting entrepreneurship, Classification and types of entrepreneurship based on business, technology, motivation, growth and stages of development.</p> <p>Case: Prima industries, Rudra offshore, Bhargava oils case, Acme Corporation. Numerical based on topics mentioned above.</p>	08

Term-work Marks: 25 Marks

- Assignments : 20 Marks
- Attendance : 05 Marks

A total of 10 tutorials need to be conducted. At least one tutorial on each module is expected. Six tutorials will be based on case studies and 4 tutorials based on numerical

Assessment

Internal

- Assessment consists of average of two tests which should be conducted at proper interval

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions to be solved
- Question no.1 will be compulsory and based on entire syllabus where in sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. Project Management, Choudhary, S., Tata McGraw Hill(module 1 to 4)
2. Total Project Management, Joy, P. K.,(module 1 and 2)
3. Project Management for process Industries, Gillian Lawson, I chem. E (Module 1 and 4)
4. Project Management Case Studies, Harold Kerzner, Second edition, John Wiley and Sons (for case studies)
5. Project Management Methodology Guidelines, City of Chandler (Module 1)
6. Project Management-The Managerial Process, Clifford Gray, 6th edition, McGraw Hill (module 1, 2, 3)
7. Plant Design and Economics for Chemical Engineers, Klaus D Timmerhaus, 5th edition, McGraw Hill (Module 2 and 4)
8. Theory and problems in financial management, Khan, M.Y.; Jain, P.K.; Second Edition, Tata McGraw Hill (Module 2 and 4)
9. Fundamentals of Financial Management, Vyuptakesh Sharan, Second Edition, Pearson publications(module 2 and 4)
10. Dynamics of entrepreneurial development and management, Vasant Desai (module 4)

Course Code	Course/ Subject Name	Credits
CHC803	Energy System Design	4

Prerequisites:

- The students should have knowledge of Heat transfer to carry out Energy balance.
- They should be aware about basic principles of economics to evaluate cost and profit of energy efficient operations/modifications/techniques.
- They should be familiar with various types of plant utilities.
- They should be familiar with basic Industrial systems/operations like, HVAC, Lighting,
- Steam, Refrigeration, etc.

Course Objectives:

- To provide training to solve problems relevant to the energy conservation.
- To provide students the knowledge in planning conducting energy audit, energy survey, and evaluate energy conservation opportunities.
- To provide knowledge to design and evaluate energy efficient technologies such as heat exchanger networks, multiple effect evaporators, co-generation, etc.

Course Outcomes:

- The graduates should able to design an energy system to meet the desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability and sustainability.
- The graduates should able to function on multidisciplinary teams, identify, formulate and solve engineering problems.
- The graduates are expected to have knowledge of professional and ethical responsibility.
- The graduates should able to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Module	Contents	Contact Hours
1	Energy Audit: Energy audit methodology, Types of energy audit, instrumentation used in energy audit, Safety considerations during energy audit, Post audit analysis.	02
2	Energy Efficient Technologies: Energy efficient techniques for lighting system, motors, belt and drives system, fans and pumps system, compressed air system; steam system, refrigeration system.	02
3	Energy Integration in The Process Industries: Temperature Pinch analysis, concept of minimum number of heat exchangers, Heat Exchanger Network design, Threshold approach temperature difference, targeting for number of shells, Area targets, Optimum approach temperature difference	13

4	Heat Integration in Process Units: Heat integration of Multiple effect evaporators (MEE) with background process. Heat integration MEE with and without vapour re-compression: mechanical vapour re-compression, thermal vapour re-compression. Distillation column: heat integration in distillation column – multiple effect distillation, heat pumping, vapour re-compression, Reboiler flashing. Different arrangements of heat integration of columns with background process.	10
5	Co-generation: Definitions, Brayton cycle, Rankine cycle, topping cycle, bottoming cycle, combined cycle. Steam turbine system, gas turbine system, combined gas steam turbine system, diesel engine system. Heat integration and cogeneration.	06
6	Waste Heat Recovery (WHR): Waste heat sources, quality and classification of waste heat and its applications. Benefits of WHR. WHR equipments like recuperators, radiation/convective hybrid recuperator, ceramic recuperator, regenerator, heat wheel, heat pipe, waste heat boiler, economizer, heat pumps.	03
7	Global Energy Scenario: national and international.	Assignment

Term work

Term work should consist of minimum 8 tutorials from entire syllabus which are to be given at regular intervals batch wise.

Tutorial: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment:

Internal:

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination:

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Books:

1. Robin Smith, Chemical Process Design and Integration, Wiley India, 2005. [Module: 3, 4, 5, 6]

2. Serth, Robert W., Process Heat Transfer Principles and Applications, Elsevier Science & Technology Books, 2007. [Module: 3]
3. Wayne C. Turner, Steve Doty (Ed.), Energy Management Hand Book, John Wiley and Sons, 2000. [Module: 1, 2, 5, 6]

References:

1. Seider W. D., and Seader J. D. and Lewin D. R., Process Design Principles, John Wiley and Sons Inc., 1988.
2. Douglas J. M., Conceptual Design of Chemical Process, McGraw Hill Book Co., 1988.
3. Biegler L. T., Grossman E. I. and Westerberg A. W., .Systematic Methods of Chemical Process Design., Prentice Hall International Ltd., 1997.
4. P K Nag, Power Plant Engineering, The McGraw-Hill Publishing Company Limited.
5. H.M.Robert, J.H.Collins, Handbook of Energy Conservation-Volume 1, CBS Publishers & Distributors.
6. D. P. Kothari, K. C. Singal, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt Ltd, Second Edition.
7. <https://www.beeindia.gov.in>

Course Code	Course/Subject	Credits
CHDE8041	Department Elective IV: Advanced Process Control	4

Prerequisites:

- Linear Algebra, Differential Equations, Difference Equations, Laplace Transforms.

Course Objectives:

- To understand dynamics of MIMO processes.
- To understand Batch Process Control.
- To understand Model Predictive Control.
- To design digital controllers.

Course Outcomes:

- The student will be able to analyze multi-loop and multi-variable control systems.
- The student will be able to design batch controllers.
- The student will be able to design MIMO controllers.
- The student will be able to design Model Predictive Controllers.

Module	Contents	Contact Hours
1.	Advanced SISO Control Strategies: Cascade Control, Time Delay Compensation, Inferential Control, Selective Control/Override Systems, Nonlinear Control Systems, Adaptive control Systems	06
2	Digital Sampling Filtering and Control: Sampling and Signal Reconstruction, Signal Processing and Data Filtering, z-Transform Analysis for Digital Control, Tuning of Digital PID Controllers, Direct Synthesis for Design of Digital Controllers, Minimum Variance Control	06
3	Multiloop and Multivariable Control: Process and Control Loop Interactions, Pairing of Control and Manipulated Variables, Singular Value Analysis, Tuning of Multi-loop PID Control Systems, Decoupling and Multivariable Strategies, Strategies for Reducing Control Loop Interactions	06
4	Model Predictive Control: Overview of Model Predictive Control, Predictions for SISO Models, Predictions for MIMO Models, Model Predictive Control Calculations, Set Point Calculations, Selection of Design and Tuning Parameters, Implementation of MPC	06
5	Batch Process Control: Batch Control Systems, Sequential and Logic Control, Control During The Batch, Run-to-Run Control	06
6	Introduction To Plant wide Control: Plant wide Control Issues, Hypothetical Plant for Plant wide	06

	Control Studies, Internal Feedback of Material and Energy, Interaction of Plant and Control System Design	
7	Plant wide Control System Design: Procedures for the Design of Plant wide Control Systems. A Systematic Procedure for Plant wide Control System Design. Case Study: The Reactor/Flash Unit Plant, Effect of Control Structure on Closed Loop Performance	06
8	Optimal Control: Introduction to Optimal Control, Batch Process Optimisation	06

Assessment

Internal:

Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No. 1 should be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all modules .
- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Melli champ, Francis J. Doyle III, Process Dynamics and Control, 3 Ed., John Wiley & Sons (Asia) Pvt. Ltd., New Delhi.
2. William L. Luyben, Process Modeling Simulation and Control For ChemicalEngineers,2 Ed., McGraw Hill Publishing Co.
3. Stephanopoulos, Chemical Process Control, PHI Learning Pvt. Ltd.
4. D Patranabis, Principles of Process Control, McGraw Hill Education
5. Donald R Coughanowr, Stevan E Leblance, Process System Analysis and Control, McGraw Hill Education.

Course Code	Course/Subject	Credits
CHDE8042	Department Elective IV: Total Quality Management	4

Prerequisites:

Course Objectives:

- To acquaint with the significance and features of TQM philosophy.
- To familiarize with various quality tools and their uses in problem solving.
- To appraise on the modern productivity improvement approaches and their interface with TQM
- To familiarize with various quality standards, quality auditing and certification methodology.
- To give and an insight into the ongoing global trends in quality approach and practices with special forms to the customer relationship

Course Outcomes:

Learner will be able to:

- Appreciate the importance of quality and its dimensions in striving for excellence
- Understand the conscious compromise between cost and quality
- Develop competency in the selection in various manufacturing and service functions
- Develop competency in the use of appropriate quality tools in various manufacturing and service functions
- Integrate quality approaches for productivity improvement.
- Acquire knowledge base and develop skills for conducting quality audits

Module	Contents	Contact Hours
01	Introduction: Definition of Quality, principles and dimensions of TQM Quality in manufacturing and service segments. Approach in implementation of TQM, barriers in implementation. Cost of quality prevention, appraisal and failure costs, hidden costs, trade-o between quality and cost.	8
02	Planning for quality and Quality improvement: Planning for quality: Need for quality policies and objective. Significance of top management commitment, strategic planning for quality. Quality improvement: Management of controllable defects, operator controllable defects, sporadic and chronic problems of operator controllable defects, sporadic and chronic problems of quality, Pareto's principle. Bench marking: Definition and significance, data collection for bench marking and its use.	8
03	Customer relations: Customers, user and consumers, product awareness, types of	8

	customers, customer perception and expectations. Quality feedback and redressal. Basic principles of reliability: quality and reliability, Product life cycle, trade-o between maintainability.	
04	Vendor relations: Vendor as a partner, vendor selection, vendor evaluation. Push Pull view of supply chain and cycle view of chain management	8
05	SQC Tool: Histograms, Pie charts, Scatter diagrams, Cause and diagram etc. Statistical Process Control: Process variability: Variables and process variation, measures of accuracy and centering, precision or spread, normal distribution Process Control: Control charts for variables (X-chart, R- chart, -chart) and attributes (np-charts, p-chart, c-charts, U-chart)Process capability: OC curve, acceptance sampling, single and double sampling producer's and consumer's risk.	8
06	Quality System: Quality standards: <ul style="list-style-type: none"> • ISO 9001:2000 Quality management system. ^ • ISO 14001:2004 Environmental management system. • ISO 27001:2005 Information security management system. Quality assurance: Nature of assurance, reports on quality, measuring performance, internal audit, surveillance audit, quality certification methodology and implications Productivity improvement Tools/ Approaches/ Techniques: Principles of Six-Sigma, approaches like JIT, Lean manufacturing zero defect concept, KANBAN, QFD, FMEA, Basics of DOE and Shining concepts of quality. Productivity improvement techniques like 5S, POKAYOKE, SMED, KAIZEN and Concurrent Engineering.	8

Note: Seminar/Case study presentation with report by individual or in groups comprising of not more than three students can be considered.

Assessment

Internal:

Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No. 1 should be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all modules .

- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. Juran, J. M., Gryana, F. M., Quality planning and analysis, TMH.
2. Bester Fidd, D. H., et.al., Total quality management, Prentice Hall.
3. Erossbly, Pillip b., Quality is free, Mentor/New Americal Library.
4. Ishikawa, K., What is total quality control? The Japanese way, Prentice Hall
5. Fergenbaum, Armand V., Total quality control.
6. Logothetis, N., Managing for total quality, Prentice Hall
7. Aurora, K. C., Total Quality Management, S. K. Kataria and Sons
8. Haldar, U. K., Total Quality Management, Dhanpatrai and Co.

Course Code	Course/ Subject Name	Credits
CHDE8043	Department Elective IV: Advanced Separation Technology	4

Prerequisites:

- Basic knowledge regarding fundamental separation Processes and its application in chemical Industries.

Course Objectives:

The students completing this course are expected to understand:

- The various separation principles like adsorption process, the types and designs.
- The supercritical extraction and modern distillation process.
- Introduction to foam fractionation process and application in waste water treatment.
- Liquid chromatography – types and separation of enzymes using it.
- Types of membranes, membrane characterization, membrane material, membrane modules, membrane applications in biotechnology and other industries.

Course Outcomes:

- The graduates are expected to have ability to apply knowledge of mathematics, science and engineering.
- The graduates are expected to have ability to design a system, a component, or a process to meet the desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, manufacturability and sustainability.
- The graduates are expected to possess ability to identify, formulate and solve engineering problems.
- The graduates are expected to possess ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Module	Content	Contact Hours
1.	Adsorption Process: Absorbent such as activated carbon, molecular sieves of various types, activated alumina. Their characteristics and applications. Regeneration & Activation of absorbents. Thermal & pressure swing process. Fixed bed, moving bed, stimulated moving bed and other processing schemes. Design of adsorption process for separation and purification. Industrial examples and related numericals.	8
2.	Super critical extraction and advanced distillation techniques: Working principle, advantages and disadvantages of supercritical solvents over conventional liquid solvents, advantages and disadvantages of supercritical extraction over liquid- liquid extraction. Commercial applications of supercritical extraction. The concept of advanced distillation techniques, advantages and disadvantages and comparison with conventional techniques.	8

3.	Foam Fractionation Process: Foam Formation, coalescence, collapse and drainage phenomena Adsorption properties of foams. Principle of froth flotation,. Application of froth flotation in industries and waste water treatment.	8
4.	Liquid Chromatographic Process: Basic concept of chromatography, phenomena and characterization. Various chromatography options. Typical chromatographic separation systems for preparative chromatography. Applications of chromatography in enzymes and other Industrial separations.	8
5.	Membrane process: Introduction to the membrane process, definition of membrane, importance, process. Characterization of membranes: Characterization of porous membranes, characterization of ionic membranes, characterization of non-ionic membranes. Preparation of synthetic membranes. Preparation of phase inversion membranes. Preparation techniques for immersion precipitation, preparation techniques for composite membranes, influence of various parameters on membrane morphology, preparation of inorganic membranes. Transport process in membrane driving force. Polarization phenomenon and fouling concentration polarization, characteristic flux behavior in pressure driven membrane preparation, various models, membrane fouling, methods to reduce fouling. Modules and process design plate and frame, spiral wound, tubular, capillary, hollow fibre modules and liquid membranes.	10
6	Applications of membranes in industries: Introduction to various applications in the chemical and allied industries. Basics of design and numericals based on reverse osmosis and dialysis techniques	6

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No. 1 should be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all modules .
- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. Ruthven, D.M., Principal Adsorption & Adsorption Process, Wiley, 1984.
2. Lemlich, R., Adsorptive Bubble Separation Techniques, Academic Press, 1972.

3. Coulson, Richardson, Chemical Engineering, Vol.3, Pergamon.
4. Terybal, R.E, Mass Transfer Operations, McGraw Hill.
5. Ruthven, Faruqh, Knalbal, Pressure Swing Adsorption, VCH, 1994.
6. Snyder, Kirl, Introduction To Liquid Chromatography, 2 ed., 1979. University of Mumbai Chemical Engineering Rev 2014-15 42
7. Scott RTW, Liquid Chromatography Column Theory, Wiley, 1992.
8. Marcel Mulder, Basic Concepts Of Membrane Technology, Kluwer Academic Publishers (1997).
9. E.J. Hoffman, Membrane Separation Technology, Gulf Professional Publishing.
10. Nath, Membrane Separation Process, Prentice Hall of India.
11. Membrane Handbook - Editors W.S. Winston Ho, K.K. Sirkar, Van Nostrand Reinhold Publication.
12. J. D. Seader and E. J. Henely, Separation Process Principles.
13. C. J. King, Separation Processes.

Course Code	Course/ Subject Name	Credits
CHDE8044	Department Elective IV: Polymer Technology	04

Prerequisites:

- Chemistry, physics, Chemical reaction engineering

Course Objectives:

- To understand thermodynamics of polymer structure.
- To select polymerization reactor for a polymer product.
- To characterize polymers and state polymer additives, blends and composites.

Course Outcomes:

At the end of the course students will be able to

- Understand thermodynamics of polymer structure. .
- Student will identify various types of advance material in polymer, ceramics, & composites. Understand the properties of various polymeric, ceramic and metallic materials and their application in various fields.
- Select polymerization reactor for a polymer product
- Characterize polymers and state polymer additives, blends and composites.
- Student will have knowledge of different types of composite material, their properties and application
- After acquiring the knowledge in this subject, students become familiar with various aspects related to polymerization and can apply them for economic evaluation of chemical process and decide its feasibility

Module	Contents	Contact Hours
1	Introduction: Introduction and Classification of Polymers. Thermosets, Factors influencing the polymer properties, Glass Transition Temperature Monomers used for polymer synthesis, Thermoplastics, Linear Branch, Cross Linked Polymers. Addition and Condensation Polymerisation: Mechanism, kinetics, synthesis and reactions.	05
2	Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications, applications of polymers such as cellulose, lignin, starch, rosin, shellac, latexes, vegetable oils and gums, proteins etc. Polymerization Techniques: Bulk polymerization, Solution polymerization, Emulsion polymerization and Suspension polymerization, Interfacial Polymerization with their merits Comparison of the various processes Advantages and disadvantages.	12
3	Molecular Weight and Molecular Weight Distribution: Molecular Weights, Polydispersity Index, Different Methods of	08

	determination of Molecular weight, Effect of Molecular weight on Engineering Properties of Polymers. Co-Polymerization: Basic concept, Technical significance, steady state assumptions in free radical copolymerization, The copolymer equation, Instantaneous molar composition of copolymer formed; Monomer reactivity ratios; Significance and method of determination, Types of copolymers.	
4	Polymerization Reactor: Polymerization reactors types and mode of operation, Polymerization reactor design, control of polymerization, Post polymerization unit operations and unit processes Polymer Degradation.	06
5	Polymer Processing: High Performance and Specialty Polymers, Polymer additives, compounding. Fillers plasticizers lubricants colourants UV stabilizers, fire retardants, antioxidants, Different moulding methods of polymers. Injection moulding , blow moulding, thermoforming, film blowing etc.	08
6	Manufacturing Processes: Manufacturing of typical polymers with flow-sheet diagrams properties & application: PE, PP, PS, Polyesters, Nylons, ABS, PC, Teflon, Epoxy, Ureaformaldehyde, and poly Urathane. Manufacturing of thermoset polymers such as Phenolic resins	13

Assessment

Internal

- Assessment consists of average of two tests which should be conducted at proper interval

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions to be solved
- Question no.1 will be compulsory and based on entire syllabus where in sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

References

1. Fried J R, Polymer Science and Technology, Prentice Hall of India Pvt. Ltd., New Delhi, Eastern Economy Edition, 2000.
2. Premamoy Ghosh, Polymer Science and Technology, 3rd Edition, Tata Mc. Graw-Hill Publishing Company, New Delhi, 2010.
3. R. Sinha, Outlines of Polymer Technology: Manufacture of Polymers, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
4. Gowarikar V.R. et.al., Polymer Science Wiley Eastern 1984.

5. Ghosh P, Polymer Science & Technology of Plastics & Rubbers Tata McGraw Hill, 1990.
6. Encyclopedia of Polymer Science & Engineering., Wiley 1988.
7. Rosen S.L. Fundamental Principles of Polymeric materials, 2nd e.d., John Wiley & Sons Inc, 1993
8. Niranjankarak, Fundamentals of Polymers, PHI Learning Pvt. Ltd.

Course Code	Course Name	Credits
ILO8021	Institute Level Optional Subject II- Project Management	03

Objectives;

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes:

Learner will be able to...

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Contact Hours
01	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	Planning Projects: Crashing project time, Resource loading and leveling,	6

	<p>Goldratt's critical chain, Project Stakeholders and Communication plan.</p> <p>Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks</p>	
05	<p>5.1 Executing Projects: Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings.</p> <p>5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.</p> <p>5.3 Project Contracting Project procurement management, contracting and outsourcing,</p>	8
06	<p>6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects. Multicultural and virtual projects.</p> <p>6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.</p>	6

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK[®] Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9th Ed.

Course Code	Course Name	Credits
ILO8022	Institute Level Optional Subject II- Finance Management	03

Objectives:

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Outcomes:

Learner will be able to...

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module	Detailed Contents	Contact Hours
01	<p>Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.</p> <p>Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p>Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p>Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	06
02	<p>Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.</p> <p>Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.</p>	06
03	<p>Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p>Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of</p>	09

	Ratio Analysis.	
04	<p>Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)</p> <p>Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.</p>	10
05	<p>Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.</p> <p>Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure</p>	05
06	<p>Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach</p>	03

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.

3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Institute Level Optional Subject II- Entrepreneurship Development and Management	03

Objectives:

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Outcomes:

Learner will be able to...

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

Module	Detailed Contents	Contact Hours
01	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	Indian Environment for Entrepreneurship: key regulations and legal aspects, MSME Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08

05	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGraw Hill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Institute Level Optional Subject II- Human Resource Management	03

Objectives:

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes:

Learner will be able to...

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Contact Hours
01	Introduction to HR <ul style="list-style-type: none"> • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues. 	5
02	Organizational Behavior (OB) <ul style="list-style-type: none"> • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness 	7

	<ul style="list-style-type: none"> • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study 	
03	Organizational Structure & Design <ul style="list-style-type: none"> • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. 	6
04	Human resource Planning <ul style="list-style-type: none"> • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods 	5
05	Emerging Trends in HR <ul style="list-style-type: none"> • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation. 	6
06	HR & MIS Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries Strategic HRM Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals Labor Laws & Industrial Relations	10

	Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	
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Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Institute Level Optional Subject II- Professional Ethics and Corporat Social Responsibility (CSR)	03

Objectives:

- To understand professional ethics in business
- To recognized corporate social responsibility

Outcomes:

Learner will be able to...

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Contact Hours
01	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of	08

	India, Legal Aspects of Corporate Social Responsibility— Companies Act, 2013.	
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Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Institute Level Optional Subject II- Research Methodology	03

Objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes:

Learner will be able to...

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Module	Detailed Contents	Contact Hours
01	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
03	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem	08

	c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	
05	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	Outcome of Research 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	04

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	Institute Level Optional Subject II- IPR and Patenting	03

Objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Outcomes:

Learner will be able to...

- understand Intellectual Property assets
- assist individuals and organizations in capacity building
- work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Contact Hours
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris	08

	convention etc.)	
06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	07

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohdIqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi, IPR: Drafting,

- Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
 15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO8028	Institute Level Optional Subject II - Digital Business Management	03

Objectives:

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Outcomes:

The learner will be able to

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module	Detailed content	Contact Hours
1	Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts. Difference between physical economy and digital economy. Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services). Opportunities and Challenges in Digital Business,	09
2	Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement. B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals. Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing. EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC.	06
3	Digital Business Support services: ERP as e –business backbone, knowledge Top Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure	06
4	Managing E-Business- Managing Knowledge, Management skills for e-business, Managing Risks in e –business. Security Threats to e-business -Security Overview, Electronic commerce Threats, Encryption, Cryptography, Public Key and Private Key	06

	Cryptography, Digital signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	
5	E-Business Strategy -E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition(Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization -Business plan preparation. Case Studies and presentations	08

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:[10.1787/9789264221796-en](https://doi.org/10.1787/9789264221796-en)OECD Publishing

Course Code	Course Name	Credits
ILO8029	Institute Level Optional Subject II- Environmental Management	03

Objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Outcomes:

Learner will be able to...

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Module	Detailed Contents	Contact Hours
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, and The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.

- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Credits
CHP801	Project-B	06
<p>Guidelines:</p> <ul style="list-style-type: none"> • Project groups: Students can form groups with minimum two and not more than 3 (three). • Students should spend considerable time in applying all the concepts studied, into the Project, hence, eight hours each are allotted in project A and B to the students. • Students are advised to take up industrial/ experimental/ simulation and/or optimization based topics for their project • Students should report their guides weekly with work. <p>Exam Guidelines</p> <p>Term Work - 100 Marks:</p> <ul style="list-style-type: none"> • Presentation – 50 Marks • Report -50 Marks <p>Oral – 50 Marks</p>		

Course Code	Course Name	Credits
CHL801	Chemical Engineering Lab XI (MSO)	1

Concept of Experiment:

Students should be able to simulate process models using computer program or mathematical and chemical engineering software such as COCOO/DWSIM/Unisim,/CWSim, /Chem CAD,/Hysys/ Aspen Plus / or any simulator.

Minimum TEN experiments must be performed.

- Simulation of pipe and pump network flows
- Simulation of linear and non linear systems
- Simulation of mass transfer processes like distillation, Absorption
- Simulation of Heat Transfer Process like Shell and tube heat exchanger
- Simulation of chemical reactor like batch, Semibatch, Continuous reactor
- Simulation of Multicomponent flash calculation for ideal and non ideal system
- Simulation of flow sheet calculation (Any chemical manufacturing process)
- Optimisation of chemical processes.

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Biomedical Engineering

Sr. No.	Subject Code	Subject Name	Count
1	BML301	Object Oriented Programing	1
2	BML302	Basics of Human Physiology	1
3	BML303	Electrical Network Analysis and Synthesis	1
4	BML304	Electronic Circuit Analysis and Design	1
5	BML305	Biomaterials, Prosthetics and Orthotics	1
6	BML401	Introduction to Simulations Tools	1
7	BML402	Biomedical Transducers and Measuring Instruments	1
8	BML403	Linear Integrated Circuits	1
9	BML404	Digital Electronics	1
10	BML405	Signals and Control Systems	1
11	BML501	Business Communication and Ethics	1
12	BML502	Diagnostic and Therapeutic Instruments	1
13	BML503	Integrated and Communication Circuit Design	1
14	BML504	Biomedical Digital Signal Processing	1
15	BMDLL501X	Department Level Optional Course Laboratory – I	1
16	BML601	Biomedical Monitoring Equipment	1
17	BML602	Microprocessors and Microcontrollers	1
18	BML603	Digital Image Processing	1
19	BML604	Medical Imaging-I	1
20	BMDLL602X	Department Level Optional Course Laboratory – II	1
21	BML701	Life Saving and Surgical Equipment	1
22	BML702	Basics of VLSI	1
23	BML703	Medical Imaging-II	1
24	BMDLL 703X	Department Level Optional Course Laboratory – III	1
25	BML704	BML704	1
26	BML801	Biomedical Microsystems	1
27	BML802	Hospital Management	1
28	BMDLL804X	Department Level Optional Course Laboratory – IV	1
29	BML803	Project Stage II	1
		Total	29

AC 11/05/2017

Item No. 4.179

UNIVERSITY OF MUMBAI



Revised syllabus (Rev- 2016) from Academic Year
2016 -17

Under

FACULTY OF TECHNOLOGY

Biomedical Engineering

Second Year with Effect from AY 2017-18

Third Year with Effect from AY 2018-19

Final Year with Effect from AY 2019-20

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

From Co-ordinator's Desk:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System were implemented for First Year Bachelor of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Bachelor of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and to achieve recognition of the institution or program meeting certain specified standards. The focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a student will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Electrical Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for the graduate program in Biomedical Engineering, more than ten senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for graduate program in Biomedical Engineering are listed below:

Program Educational Objectives (PEOs)

1. To provide sound knowledge of basic sciences, human anatomy, human physiology, electrical and electronic systems, building a strong foundation for career advancement.
2. To develop a logical approach, analytical thinking and problem solving capabilities in order to make the learner competent to face and address the global challenges in their chosen field.
3. To impart technical knowledge and competency skills to perform in various areas like sales & marketing, product engineering, research-development, hospital administration, regulatory affairs and also to venture into entrepreneurship.
4. To develop proficiency in various soft skills and bring awareness about social obligations and professional ethics to pursue professional career in a healthcare industry.
5. Motivate to pursue research and specialization in a plethora of domains in the field of Biomedical Engineering covering disciplines such as, Medical Instrumentation, Neuroscience, Computational Engineering, Robotics Engineering, Medical Signal and Image processing, Rehabilitation Engineering, VLSI, Nanotechnology and Biosensors, etc.

Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Dr. S. R. Deore,
Chairman,
Board of Studies in Electrical Engineering,
Member - Academic Council
University of Mumbai

**Program Structure for
B.E. Biomedical Engineering
University of Mumbai
(With effect from academic year 2017 - 18)**

Scheme for Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC301	Applied Mathematics III	04	----	01	04	----	01	05
BMC302	Basics of Human Physiology	04	----	----	04	----	----	04
BMC303	Electrical Network Analysis and Synthesis	04	----	----	04	----	----	04
BMC304	Electronic Circuit Analysis and Design	04	----	----	04	----	----	04
BMC305	Biomaterials, Prosthetics and Orthotics	04	----	----	04	----	----	04
BML301	Object Oriented Programing	----	04#	----	----	02	----	02
BML302	Basics of Human Physiology	----	02	----	----	01	----	01
BML303	Electrical Network Analysis and Synthesis	----	02	----	----	01	----	01
BML304	Electronic Circuit Analysis and Design	----	02	----	----	01	----	01
BML305	Biomaterials, Prosthetics and Orthotics	----	02	----	----	01	----	01
Total		20	12	01	20	06	01	27

Out of four hours, 2 hours theory shall be taught to the entire class and 2 hours practical in batches.

Examination Scheme for Semester III

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC301	Applied Mathematics III	80	32	20	8	25	10	---	---	---	---	---	---	125
BMC302	Basics of Human Physiology	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC303	Electrical Network Analysis and Synthesis	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC304	Electronic Circuit Analysis and Design	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC305	Biomaterials, Prosthetics and Orthotics	80	32	20	8	---	---	---	---	---	---	---	---	100
BML301	Object Oriented Programing	---	---	---	---	50	20	---	---	---	---	50	20	100
BML302	Basics of Human Physiology	---	---	---	---	25	10	---	---	25	10	---	---	50
BML303	Electrical Network Analysis and Synthesis	---	---	---	---	25	10	---	---	25	10	---	---	50
BML304	Electronic Circuit Analysis and Design	---	---	---	---	25	10	---	---	---	---	25	10	50
BML305	Biomaterials, Prosthetics and Orthotics	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		400	160	100	40	175	70	---	---	75	30	75	30	825

Scheme for Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC401	Applied Mathematics IV	04	----	01	04	----	01	05
BMC402	Biomedical Transducers and Measuring Instruments	04	----	----	04	----	----	04
BMC403	Linear Integrated Circuits	04	----	----	04	----	----	04
BMC404	Digital Electronics	04	----	----	04	----	----	04
BMC405	Signals and Control Systems	04	----	----	04	----	----	04
BML401	Introduction to Simulations Tools	----	02	----	----	01	----	01
BML402	Biomedical Transducers and Measuring Instruments	----	02	----	----	01	----	01
BML403	Linear Integrated Circuits	----	02	----	----	01	----	01
BML404	Digital Electronics	----	02	----	----	01	----	01
BML405	Signals and Control Systems	----	02	----	----	01	----	01
Total		20	10	01	20	05	01	26

Examination Scheme for Semester IV

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC401	Applied Mathematics - IV	80	32	20	8	25	10	---	---	---	---	---	---	125
BMC402	Biomedical Transducers and Measuring Instruments	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC403	Linear Integrated Circuits	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC404	Digital Electronics	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC405	Signals and Control Systems	80	32	20	8	---	---	---	---	---	---	---	---	100
BML401	Introduction to Simulations Tools	---	---	---	---	25	10	25	10	---	---	---	---	50
BML402	Biomedical Transducers and Measuring Instruments	---	---	---	---	25	10	---	---	25	10	---	---	50
BML403	Linear Integrated Circuits	---	---	---	---	25	10	---	---	---	---	25	10	50
BML404	Digital Electronics	---	---	---	---	25	10	---	---	---	---	25	10	50
BML405	Signals and Control Systems	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		400	160	100	40	150	60	25	10	50	20	50	20	775

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC301	Applied Mathematics III (Abbreviated as AM – III)	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC301	Applied Mathematics III (AM – III)	20	20	20	80	03	25	--	--	--	125

Course Code	Course Name	Credits
BMC301	Applied Mathematics III	05
Course Objectives	<ul style="list-style-type: none"> To build the strong foundation in Mathematics of learner needed for the field of Biomedical Engineering. To provide learner with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice. To prepare learner to work as part of teams on multi-disciplinary projects. 	
Course Outcomes	<ul style="list-style-type: none"> Learner will demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable. Learner will demonstrate an ability to identify and Model the problems of the field of Biomedical Engineering and solve it. Learner will be able to apply the application of Mathematics in Biomedical Engineering. 	

Module No	Unit No.	Topic	Hours
1		Laplace Transform	
	1.1	Laplace Transform (LT) of Standard Functions: Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace transform of e^{at} , $\sin(at)$, $\cos(at)$, $\sinh(at)$, $\cosh(at)$, t^n Heaviside unit step function, Dirac-delta function, Laplace transform of Periodic function	7

	1.2	Properties of Laplace Transform: Linearity, first shifting theorem, second shifting theorem, multiplication by t^n , Division by t , Laplace Transform of derivatives and integrals, change of scale, convolution theorem, Evaluation of integrals using Laplace transform.	
2		Inverse Laplace Transform & its Applications	
	2.1	Partial fraction method, Method of convolution, Laplace inverse by derivative	6
	2.2	Applications of Laplace Transform: Solution of ordinary differential equations, Solving RLC circuit differential equation of first order and second order with boundary condition using Laplace transform (framing of differential equation is not included)	
3		Fourier Series	
	3.1	Introduction: Orthogonal and orthonormal set of functions, Introduction of Dirichlet's conditions, Euler's formulae	11
	3.2	Fourier Series of Functions: Exponential, trigonometric functions of any period $=2L$, even and odd functions, half range sine and cosine series	
	3.3	Complex form of Fourier series, Fourier integral representation, Fourier Transform and Inverse Fourier transform of constant and exponential function.	
4		Vector Algebra & Vector Differentiation	
	4.1	Review of Scalar and Vector Product: Scalar and vector product of three and four vectors, Vector differentiation, Gradient of scalar point function, Divergence and Curl of vector point function	7
	4.2	Properties: Solenoidal and irrotational vector fields, conservative vector field	
5		Vector Integral	
	5.1	Line integral	6
	5.2	Green's theorem in a plane, Gauss' divergence theorem and Stokes' theorem	
6		Complex Variable & Bessel Functions	
	6.1	Analytic Function: Necessary and sufficient conditions (No Proof), Cauchy Reiman equation Cartesian form (No Proof) Cauchy Reiman Equation in polar form (with Proof), Milne Thomson Method and its application, Harmonic function, orthogonal trajectories	11
	6.2	Mapping: Conformal mapping, Bilinear transformations, cross ratio, fixed points	
	6.3	Bessel Functions: Bessel's differential equation, Properties of Bessel function of order $+1/2$ and $-1/2$, Generating function, expression of	

		cos (xsin θ), sin (x sin θ) in term of Bessel functions	
--	--	---	--

Books Recommended:

Text Books:

1. H.K. Das, “Advanced engineering mathematics”, S . Chand, 2008
2. A. Datta, “Mathematical Methods in Science and Engineering”, 2012
3. B.S. Grewal, “Higher Engineering Mathematics”, Khanna Publication

Reference Books:

1. B. V. Ramana, “Higher Engineering Mathematics”, Tata Mc-Graw Hill Publication
2. Wylie and Barret, “Advanced Engineering Mathematics”, Tata Mc-Graw Hill 6th Edition
3. Erwin Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, Inc
4. Murry R. Spieget, “Vector Analysis”, Schaum’s outline series, Mc-Graw Hill Publication

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Term work:

Term work shall consist of minimum eight tutorials and assignments (minimum 2).

The distribution of marks for term work shall be as follows:

- Tutorials :15 marks
- Assignments :05 marks
- Attendance (Theory and Tutorial) :05 marks

The final certification and acceptance of term work ensures minimum passing in the term work.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC302	Basics of Human Physiology (Abbreviated as BHP)							
		04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC302	Basics of Human Physiology (BHP)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC302	Basics of Human Physiology	04
Course Objectives	<ul style="list-style-type: none"> To understand the human anatomy and functions of various body structures. To understand different physiological processes taking place inside human body. 	
Course Outcomes	<p>Learners will be able to:</p> <ul style="list-style-type: none"> Understand the structure and function of cell, the action potential and muscle physiology. Distinguish the different anatomical parts of cardiovascular and respiratory system. Understand the physiology of heart, and other organs of cardiovascular system, concept of Blood pressure and use of ECG. Understand the exchange in gases taking place in body and use of spirometer. To know the composition of blood, blood cells with their functions, basics of cell counting, blood grouping and coagulation of blood. Distinguish different organs of digestive and urinary system. Understand the process of digestion, secretions and their functions. Understand the process of urine formation and micturition Understand the anatomy of nervous system, working of different parts of brain, parasympathetic and sympathetic nervous system, reflex arc and reflex action. Distinguish different parts of eyes and ear, their structure and function. Understand the hearing mechanism and image formation on the retina, understand the use of ophthalmoscope and design of hearing aid Understand the different parts of male and female reproductive system with their working, action of sex hormones. To know all the endocrine glands with their secretion and function, and control action. 	

Module	Contents	Hours
1	<p>Organization of Human Body: Cell, Tissue, Organ, Organ system, Structure and functions of cell, Polarization and Depolarization of Cell, Types of tissues, Homeostasis, Positive and Negative Feedback Mechanism</p> <p>Muscle Physiology: Muscle physiology and aspects of Skin Resistance</p>	05
2	<p>Cardiovascular System: Anatomy of Cardiovascular System, Heart, Conductive Tissues of Heart, Cardiac Cycle, Heart Valves, Systemic and Pulmonary Circulation, Transmission of Cardiac Impulse, Blood Pressure, ECG, Einthoven's Triangle, Twelve Lead System and ECG Waveforms</p> <p>Respiratory System: Anatomy of Respiratory System, Ventilation, Exchange in gases in the alveoli, Spirometer (Forced Expiratory Volumes)</p>	12
3	<p>Blood: Composition of Blood – Blood cells and their functions, Haemoglobin, Blood Grouping, Coagulation, Wound Healing.</p>	05
4	<p>Alimentary System: All organs of the Digestive System, other secretions and main Functions, Deglutition and Defecation.</p> <p>Urinary System: Structure of Nephron, Function of Kidney, Urinary Bladder, Urethra, Internal/External Sphincters, Formation of Urine, Micturition</p>	08
5	<p>Nervous System: Different parts, their functions. Reflex actions and reflex arc, Function of Sympathetic and Parasympathetic nervous system. Nerve conduction and action potentials.</p> <p>Special Senses: Eyes-Structure, Refractive Medias of the Eye, Formation of Image on the Retina. Ear – Structure of Cochlea, Hearing mechanism</p>	10
6	<p>Reproductive System: (Male and Female) Different Organs and their functions. Main actions of Androgens, Oestrogens and Progesterone.</p> <p>Endocrine System: All glands, their Secretions and functions. Control of secretions.</p>	08

Books Recommended:

Text books:

1. Anatomy and Physiology in Health and Illness: Ross and Wilson. (ELBS Pub)
2. Essentials of Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Reference Books:

1. Physiology of Human Body. : Guyton. (Prism Book)
2. Review of Medical Physiology: William Ganong. (Prentice Hall Int)
3. Principles of Anatomy and Physiology: Tortora and Grabowski. (Harper collin Pub)
4. Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

3. Question paper will comprise of 6 questions, each carrying 20 marks.
4. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC303	Electrical Network Analysis and Synthesis (Abbreviated as ENAS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC303	Electrical Network Analysis and Synthesis (ENAS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC303	Electrical Network Analysis and Synthesis	04
Course Objectives	<ul style="list-style-type: none"> To learn a number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, source transformation and several methods of simplifying networks. To apply concept of network theorems to the electrical circuits. To understand the concept of graphical solution to electrical network. To understand frequency response in electrical circuits. To make the learner learn how to synthesize an electrical network from a given impedance/admittance function. 	
Course Outcomes	<p>Learner will be able to</p> <ul style="list-style-type: none"> Apply number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, source transformation and several methods of simplifying networks. Apply the concept of circuit analysis to understand network theorems Apply the concept of graphical solution to electrical network. Distinguish between different one port and two port network parameters Analyse time and frequency response of the electrical circuits. To make the learner learn how to synthesize an electrical network from a given impedance/admittance function. 	

Module	Contents	Hours
1	<p>Introduction: Review of D.C. & A.C. circuits, DC Circuits: Current & Voltage Source Transformation, Source Shifting</p> <p>Mesh & Node Analysis: Mesh & Node Analysis of D.C. & A.C. circuits with independent & dependent sources. (Introduction to coupled circuits).</p>	07
2	<p>Network Theorems (D.C. & A.C. circuits): Superposition, Thevenin's & Norton's Theorem (with independent and dependent sources), Maximum power transfer theorem.</p>	06
3	<p>Circuit Analysis: Introduction to Graph Theory. Tree, link currents, branch voltages, cut set & tie set, Mesh & Node Analysis, Duality.</p>	06
4	<p>Time and Frequency Response of Circuits: First & second order Differential equations, initial conditions. Evaluation & Analysis of Transient Steady state responses using Classical Technique as well as by Laplace Transform (for simple circuits only). Transfer function, Concept of poles and zeros.</p>	09
5	<p>Two-Port Networks: Concept of two-port network. Driving point and Transfer Functions, Open Circuit impedance (Z) parameters, Short Circuit admittance (Y) parameters, Transmission (ABCD) parameters. Inverse Transmission (A'B'C'D') parameters. Hybrid (h) parameters. Inter Relationship of different parameters. Interconnections of two-port networks. Terminated two-port networks.</p>	10
6	<p>Fundamentals of Network Synthesis: Positive real functions, Driving Point functions, Properties of positive real functions. Testing Positive real functions. Testing driving point functions, Maximum modulus theorem, Properties of Hurwitz polynomials, Residue computations, Even & odd functions, Driving Point Synthesis with L-C, R-C, R-L and R-L-C networks.</p>	10

Books Recommended:

Text Books:

1. Sudhakar & S.P. Shyammoan, Circuits and Networks, Tata McGraw Hill, thirteenth reprint, 2000.
2. William H. Hayt, Jack e. Kemmerly & Steven M. Durbin, Engineering Circuit Analysis, McGraw Hill International, sixth edition, 2202.
3. Raymond A. DeCarlo & Pen-Min Lin, Linear Circuit Analysis, Oxford University Press, second edition, 2001.
4. M. E. Van Valkenburg, Introduction to Modern Network Synthesis, Wiley Eastern Ltd.

Reference Books:

1. Artice M. Davis, Linear Circuit Analysis, Thomson Asia Pte. Ltd, Singapore, first edition, 2001.

2. M.E. Van Valkenburg, Network Analysis, Prentice Hall of India, third edition
3. C.L.Wadhwa, Network Analysis and Synthesis, New Age International Publisher, Third Edition.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
- 3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
- 4: Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC304	Electronic circuit analysis and design (Abbreviated as ECAD)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC304	Electronic Circuit Analysis and Design (ECAD)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC304	Electronic Circuit Analysis and Design	04
Course Objectives	<ul style="list-style-type: none"> To understand basic characteristics of semiconductor devices. To design small signal amplifiers using BJT and FET 	
Course Outcomes	<p>Learner will be able to:</p> <ul style="list-style-type: none"> Understand the basic semiconductor components like P-N junction diodes, zener diodes and their various applications. Understand BJT working and its various configurations and DC operating conditions Understanding AC operating conditions and Design of single stage small signal CE amplifiers Design of single stage small signal CS amplifiers Understand the working of MOSFETs, its characteristics and its various applications Understanding the concept of multistage amplifiers 	

Module	Contents	Hours
1.	Diodes Circuits: Basics of PN junction diode - Equation, characteristics. Clipper and Clamper Circuits using diodes, Zener Diode – Characteristics and Working, Study Zener as a voltage regulator	05
2.	Bipolar Junction Transistor: Working of PNP and NPN Transistor. Configurations (CB, CC, CE), comparison, Q-Point, DC load line. BJT Biasing - DC analysis, Stability. (Fixed, Self, Voltage divider, Collector to base, Collector to base self). BJT as a switch.	10
3.	A.C. Equivalent Model – r_e model, h-parameter model (Exact and Approximate), Hybrid- π model A.C. Analysis-(Using any one model): A.C. load line, A.C. analysis of CE, CB, CC amplifier configurations, Effects of R_S and R_L , Comparison between various amplifiers. Low frequency and High frequency analysis, Frequency response of Single stage amplifier. Design of single stage amplifier using BJT.	10
4.	Junction Field Effect Transistor: Working and basic terminology related to JFET. Configurations (CS, CG, CD), comparison, Q-Point, DC load line. JFET Biasing – Fixed, Self, Voltage divider, Concept of stability against device parameters and temperature, zero temperature drift. A.C. Equivalent model of JFET. A.C. Analysis of amplifiers using CS, CG and CD amplifier configurations, Effects of R_S and R_L , Comparison between various amplifiers. Low frequency and High frequency analysis, Frequency response of Single stage amplifier. Design of single stage amplifier using JFET.	12
5.	MOSFET: Working of Depletion and Enhancement type MOSFET Construction, Characteristics and equations, Basic MOSFET Applications	04
6.	Multistage Amplifiers: Cascade: BJT-BJT, FET-BJT. Cascode – DC and AC analysis, characteristics Darlington amplifier- DC and AC analysis, characteristics	07

Books Recommended:

Text Books:

1. Neamen Donald A., *Electronics Ckt. Analyzer & Design*, 2nd ed., Tata McGraw Hill.
2. Boylestad Robert L., Nashelsky Louis, *Electronics Devices & Circuits*, Pearson Education.
3. *Semiconductor Data Manual*, BPB Publications.

Reference Books:

1. Malvino—Electronic Principles , 6/e ,TMH
2. Millman & Halkias: Basic Electronic Principles; TMH.
3. Martin Roden, Gordon carpenter, William Wieseman, Electronic design, Fourth edition, Sroff publishers.
4. Donald Schilling & Charles Belove, Electronic Circuits Discrete and Integrated, Third edition, Mcgraw Hill.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
- 3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
- 4: Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC305	Biomaterials , Prosthetics and Orthotics (Abbreviated as BPO)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Dur a tion (hrs)					
		Test 1	Test 2	Av g.							
BMC305	Biomaterials Prosthetics and Orthotics (BPO)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC305	Biomaterials, Prosthetics and Orthotics	04
Course Objectives	<ul style="list-style-type: none"> To understand the fundamentals of materials used for manufacturing implants that has wide application in healthcare industry. To understand design principles of prostheses and orthoses. 	
Course Outcomes	<ul style="list-style-type: none"> Understand the definition, classification and general applications of biomaterials. Study the surface characterization techniques. Understand properties and applications of polymeric, degradable and composite biomaterials. Understand properties and applications of metals and ceramic biomaterials. Selection of materials on the basis of testing of the biomaterials done biologically, mechanically, physio-chemically and thermally before implantation in the human body. Study anatomical levers, gait cycle and gait parameters Understand the definition of prostheses and orthoses and its design principles. 	

Module	Contents	Hours
1	Introduction: Introduction of Biomaterials, Classification of Biomaterials, General Applications. Techniques for characterization of Surface properties of Biomaterials: Electron Spectroscopy for Chemical Analysis (ESCA), Secondary Ion Mass Spectrometry(SIMS), Infrared Spectroscopy, Contact Angle Method.	08
2	Properties and Applications of Polymeric and degradable Biomaterials: Classification, polyurethanes, PTFE, Polyethylene, Polypropylene, Polyacrylates, PMMA, PHEMA, Hydrogel, Silicone rubber, Biopolymer in fabrication of biodevices and implants, Thermoplastic and thermosetting plastics. Degradable biomaterials (PGA and PLA), applications in drug delivery systems. Composite Biomaterials: Properties, classification and Applications of Composite Biomaterials in fabrication of biodevices and implants. Applications of biomaterials in Drug delivery systems,	09
3	Properties and Applications of Metallic Biomaterials and its Biocompatibility: Stainless steel, Titanium, Titanium based alloys, Cobalt – Chromium alloys in fabrication of bio-devices and implants. Properties and Applications of Ceramic Biomaterials: Classification, Alumina, Zirconia and types, Bioglass, Calcium Phosphate, Tricalcium phosphate in fabrication of biodevices and implants.	08
4	Biological Testing of Biomaterials: Physiochemical Test, Mechanical Test, Invitro and In vivo types, Different forms of corrosion, Wear, Electrochemical Corrosion Testing.	08
5	Movement biomechanics Overview of joints and movements, anatomical levers, gait cycle (stance and swing phase with stick diagram), gait parameters	05
6	Prosthetics and Orthotics Principles of three point pressure, Lower limb prostheses, partial weight bearing-PTB socket, total contact- quadrilateral socket. Upper limb prosthesis (terminal devices) Spinal orthoses.	10

Books Recommended:

Text Books:

1. Biomaterial Science and Engineering: J.V. Park (Plenum Press- New York)
2. Fundamentals of Biomedical Engineering: G S. Sawhney (New Age International Publication)
3. Biomaterial Science: An Introduction to Materials in Medicine, Ratner & Hoffmann
4. American Atlas of Orthopedics: Prosthetics, C. V. Mosby.
5. American Atlas of Orthopedics: Orthotics, C. V. Mosby
6. Basics of Biomechanics by Ajay Bahl, Jaypee publications.

Reference Books:

1. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).
2. Encyclopedia – Handbook of Biomaterials and Bioengineering: Part-A: Materials Vol I, II (Marcel Dekkar Pub) Part – B: Applications Vol. I, II.
3. Design Engineering on Biomaterials for medical devices: David Hill, John Willey Publication
4. Biological Performance of Materials, 2nd Edition – Jonathan Black, Marcel Dekker Inc. New York. Basel. Hong Kong

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML301	Object Oriented Programming (Abbreviated as OOPM)	--	04#	--	--	02	--	02

Out of four hours, 2 hours theory shall be taught to the entire class and 2 hours practical in batches.

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML301	Object Oriented Programming (OOPM)	--	--	--	--	50	--	--	50	100

Course Code	Course Name	Credits
BML301	Object Oriented Programming	02
Course Objective	<ul style="list-style-type: none"> To learn the object oriented programming concepts To study various java programming constructs like multithreading, exception handling, packages etc. To explain components of GUI based programming. 	
Course Outcome	<ul style="list-style-type: none"> To apply fundamental programming constructs. To illustrate the concept of packages, classes and objects. To elaborate the concept of strings, arrays and vectors. To implement the concept of inheritance and interfaces. To implement the notion of exception handling and multithreading. To develop GUI based application. 	

Prerequisite: Structured Programming Approach

Sr. No.	Module	Detailed Content	Hours
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1	Introduction to Object Oriented Programming	1.1OO Concepts: Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism. 1.2Features of Java, JVM 1.3 Basic Constructs/Notions: Constants, variables and data types, Operators and Expressions,Revision of Branching and looping	02
2	Classes, Object and Packages	2.1 Class,Object, Method. 2.2 Constructor, Static members and methods 2.3 Passing and returning Objects 2.4 Method Overloading 2.5 Packages in java, creating user defined packages, access specifiers.	05
3	Array, String and Vector	3.1 Arrays, Strings, StringBuffer 3.2 Wrapper classes, Vector	04
4	Inheritance and Interface	4.1 Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword, 4.2 Implementing interfaces, extending interfaces	03
5	Exception Handling and Multithreading	5.1 Error vs Exception, try, catch, finally, throw, throws, creating own exception 5.2 Thread lifecycle, Thread class methods, creatingthreads, Synchronization	04
6	GUI programming in JAVA	6.1 Applet: Applet life cycle, Creating applets, Graphics class methods, Font and Color class, parameter passing. 6.2 Event Handling: Event classes and event listener 6.3 Introduction to AWT: Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Check Box, and Radio Buttons.	06

Note: #Out of four hours of practical two hours to be conducted as theory

List of Laboratory Experiments: (Any Fifteen experiments and three assignments)

1. Program on various ways to accept data through keyboard and unsigned right shift operator.
2. Program on branching, looping, labelled break and labelled continue.
3. Program to create class with members and methods, accept and display details for single object.
4. Program on constructor and constructor overloading
5. Program on method overloading
6. Program on passing object as argument and returning object
7. Program on creating user defined package
8. Program on 1D array

9. Program on 2D array
10. Program on String
11. Program on StringBuffer
12. Program on Vector
13. Program on single and multilevel inheritance (Use super keyword)
14. Program on abstract class
15. Program on interface demonstrating concept of multiple inheritance
16. Program on dynamic method dispatch using base class and interface reference.
17. Program to demonstrate try, catch, throw, throws and finally.
18. Program to demonstrate user defined exception
19. Program on multithreading
20. Program on concept of synchronization
21. Program on Applet to demonstrate Graphics, Font and Color class.
22. Program on passing parameters to applets
23. Program to create GUI application without event handling using AWT controls
24. Program to create GUI application with event handling using AWT controls

Books Recommended:

Text books:

1. Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
2. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.
2. DietalandDietal, 'Java: How to Program', 8/e, PHI
3. 'JAVA Programming', Black Book, Dreamtech Press.

Assessment:

Term Work:

Term work shall consist of minimum 15 experiments and 3 Assignments

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments):	20 Marks
Laboratory work (journal)	: 10 Marks
Assignments	: 15 Marks
Attendance	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML302	Basics of Human Physiology (BHP)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML302	Basics of Human Physiology (BHP)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML302	Basics of Human Physiology	01
Course Objective	<ul style="list-style-type: none"> To understand the human anatomy and functions of various body structures. To understand different physiological processes taking place inside human body 	
Course Outcome	<ul style="list-style-type: none"> To measure blood pressure using occlusive cuff method To apply blood cell counting principle for measuring blood composition. To analyse electrical activity of heart. To apply the knowledge of instruments used for supporting cardio-vascular system 	

Syllabus: Same as that of BMC302 Basics of Human Physiology.

List of Laboratory Experiments: (Any Seven)

1. To measure Blood Pressure using sphygmomanometer using occlusive cuff method.
2. To determine hemoglobin count in the blood by Sahli's method.
3. In-vitro recognition of A, B, O blood groups by slide test.
4. To find the total Red Blood Cell count using Neubauer's haemocytometer.
5. To find the total White Blood Cell count using Neubauer's haemocytometer.
6. To study ECG Machine

7. To study electrical activity of heart
8. To measure heart-beats using PQRST Waveform of ECG.
9. To study Cardiac Pacemaker.
10. To study Defibrillator.
11. Visit to the hospital anatomy department to view specimen.
12. Presentations on the given topic.

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text books:

1. Anatomy and Physiology in Health and Illness: Ross and Wilson. (ELBS Pub)
2. Essentials of Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Reference Books:

1. Physiology of Human Body. : Guyton. (Prism Book)
2. Review of Medical Physiology: William Ganong. (Prentice Hall Int)
3. Principles of Anatomy and Physiology: Tortora and Grabowski. (Harper collin Pub)
4. Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks

Laboratory work (programs / journal) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML303	Electrical Network Analysis and Synthesis (ENAS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML303	Electrical Network Analysis and Synthesis (ENAS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML303	Electrical Network Analysis and Synthesis	01
Course Objective	<ul style="list-style-type: none"> To implement several methods of simplifying networks. To verify network theorems for analyzing electrical circuits. To understand the concept of graphical solution to electrical network To study frequency response in electrical circuits. To make the learner learn how to synthesize an electrical network from a given impedance/admittance function. 	
Course Outcome	Learner will be able to <ul style="list-style-type: none"> Apply number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, source transformation and several methods of simplifying networks. Implement network theorems to analyze the circuit Apply the concept of graphical solution to electrical network. Discriminate between different one port and two port network parameters Analyze time and frequency response of the electrical circuits Synthesize an electrical network from a given impedance/admittance function. 	

Syllabus: Same as that of BMC303 Electrical Network Analysis and Synthesis.

List of Laboratory Experiments: (Any five)

1. To study superposition theorem
2. To study Norton theorem
3. To study Thevenin's theorem
4. To study and verify Maximum power theorem
5. To study transfer functions
6. a) To study Y parameters of a two-port network.
b) To study Z parameters of a two-port network.
7. Interconnection of two-port network
8. To study Time Response of first order system
9. To study the second order frequency response of an RLC circuit

Suggested Tutorials: (Any six)

1. Mesh & Node Analysis with Independent Sources
2. Mesh & Node Analysis with Dependent Sources
3. Network Theorems
4. Circuit Analysis
5. Time and Frequency Response of Circuits (Transient Analysis)
6. Time and Frequency Response of Circuits (Laplace Transform Analysis)
7. Two-Port Networks (Two-Port Parameters)
8. Two-Port Networks (Inter Relationship of different parameters. Interconnections of two-port networks)
9. Fundamentals of Network Synthesis (Hurwitz polynomials and Positive real functions)
10. Fundamentals of Network Synthesis (Driving Point Synthesis with L-C, R-C, R-L and R-L- C networks)

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1. Sudhakar & S.P. Shyammohan, Circuits and Networks, Tata McGraw Hill, thirteenth reprint, 2000.
2. William H. Hayt, Jack e. Kemmerly & Steven M. Durbin, Engineering Circuit Analysis, McGraw Hill International, sixth edition, 2202.
3. Raymond A. DeCarlo & Pen-Min Lin, Linear Circuit Analysis, Oxford University Press, second edition, 2001.
4. M. E. Van Valkenburg, Introduction to Modern Network Synthesis, Wiley Eastern Ltd.

Reference Books:

1. Artice M. Davis, Linear Circuit Analysis, Thomson Asia Pte. Ltd, Singapore, first edition, 2001.
2. M.E. Van Valkenburg, Network Analysis, Prentice Hall of India, third edition
3. C.L.Wadhwa, Network Analysis and Synthesis, New Age International Publisher, Third Edition.

Assessment:

Term Work:

Term work shall consist of minimum 5 experiments and 6 tutorials

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks

Laboratory work (Tutorials) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML304	Electronic Circuit Analysis and Design (ECAD)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML304	Electronic Circuit Analysis and Design (ECAD)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML304	Electronic Circuit Analysis and Design	01
Course Objective	<ul style="list-style-type: none"> To apply the theoretical knowledge of semiconductor devices to practical circuits. To design and implement Clippers, Clampers, Zener regulator and small signal amplifiers 	
Course Outcome	Learner will be able to: <ul style="list-style-type: none"> Verify the outputs of various electronic circuits such as clipper, clampers etc. Verify the transfer characteristics of basic semiconductor devices. Design amplifier circuits and verify their results practically. Study frequency response of small signal amplifiers. 	

Syllabus: Same as that of BMC304 Electronic Circuit Analysis and Design.

List of Laboratory Experiments: (Any seven)

1. To study Clipper circuit
2. To study Clampers circuit
3. Study of zener as a regulator
4. Study of BJT characteristics
5. Study of BJT as switch
6. Implementation of biasing circuit of BJT

7. Study of frequency response of CE amplifier
8. Study of FET characteristics
9. Implementation of biasing circuit of FET
10. Study of Frequency response of CE amplifier

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1. Neamen Donald A., *Electronics Ckt. Analyzer & Design*, 2nd ed., Tata McGraw Hill.
2. Boylestad Robert L., Nashelsky Louis, *Electronics Devices & Circuits*, Pearson Education.
3. *Semiconductor Data Manual*, BPB Publications.

Reference Books:

1. Malvino—*Electronic Principles*, 6/e, TMH
2. Millman & Halkias: *Basic Electronic Principles*; TMH.
3. Martin Roden, Gordon carpenter, William Wieseman, *Electronic design*, Fourth edition, Sroff publishers.
4. Donald Schilling & Charles Belove, *Electronic Circuits Discrete and Integrated*, Third edition, McGraw Hill.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments)	: 10 Marks
Laboratory work (Journal)	: 10 Marks
Attendance	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML305	Biomaterials, Prosthetics and Orthotics (BPO)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML305	Biomaterials, Prosthetics and Orthotics (BPO)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML305	Biomaterials, Prosthetics and Orthotics	01
Course Objective	<ul style="list-style-type: none"> To understand the fundamentals of materials used for manufacturing implants that has wide application in healthcare industry. To understand design principles of prostheses and orthoses 	
Course Outcome	<p>Learners will be able to:</p> <ul style="list-style-type: none"> Understand the definition, classification and general applications of biomaterials. Study the surface characterization technique Understand properties and applications of polymeric, degradable and composite biomaterials. Understand properties and applications of metals and ceramic biomaterials. Selection of materials on the basis of testing of the biomaterials done biologically, mechanically, physio-chemically and thermally before implantation in the human body. Study anatomical levers, gait cycle and gait parameters Understand the definition of prostheses and orthoses and its design principles. 	

Syllabus: Same as that of BMC305 Biomaterials, Prosthetics and Orthotics

List of Laboratory Experiments: (Any seven)

- 1) Introduction of Biomaterials.
- 2) Techniques for characterization of Surface properties of Biomaterials.
- 3) Biological Testing of Biomaterials.
- 4) Mechanical and Physiochemical Testing of Biomaterials
- 5) Properties and Applications of Metallic Biomaterials and its Biocompatibility.

- 6) Properties and Applications of Polymeric Biomaterials.
- 7) Properties and Applications of Ceramic Biomaterials.
- 8) Properties and Applications of Composite Biomaterials.
- 9) Corrosion of biomaterials
- 10) Biomaterials for Soft Tissue Replacements.

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1. Biomaterial Science and Engineering: J.V. Park (Plenum Press- New York)
2. Fundamentals of Biomedical Engineering: G S. Sawhney (New Age International Publication)
3. Biomaterial Science: An Introduction to Materials in Medicine, Ratner & Hoffmann
4. American Atlas of Orthopedics: Prosthetics, C. V. Mosby.
5. American Atlas of Orthopedics: Orthotics, C. V. Mosby
6. Basics of Biomechanics by Ajay Bahl, Jaypee publications.

Reference Books:

1. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).
2. Encyclopedia – Handbook of Biomaterials and Bioengineering: Part-A: Materials Vol I, II (Marcel Dekkar Pub) Part – B: Applications Vol. I, II.
3. Design Engineering on Biomaterials for medical devices: David Hill, John Willey Publication
4. Biological Performance of Materials, 2nd Edition – Jonathan Black, Marcel Dekker Inc. New York. Basel. Hong Kong

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments / tutorials

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments / Tutorials): 20 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC401	Applied Mathematics IV (Abbreviated as AM - IV)	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC401	Applied Mathematics IV (AM - IV)	20	20	20	80	03	25	--	--	--	125

Course Code	Course Name	Credits
BMC401	Applied Mathematics IV	05
Course Objectives	<ul style="list-style-type: none"> To develop analytical insight of the student to prepare them for graduates studies in Biomedical Engineering To enhance their ability to solve and analyse Biomedical Engineering problem. To provide learner with a strong mathematical foundation to acquire the professional competence knowledge and skills. 	
Course Outcomes	<ul style="list-style-type: none"> It is expected that learner will develop the proactive approach towards the selection of methods to a solution of Biomedical Engineering problems. Learner will be able identify different probability distribution , learn sampling technique, compute Eigen values and Eigen vectors and evaluate complex integrals and use their application in Biomedical Engineering problems. Learner will be able to know new subjects that are required to solve in industry. 	

1		Calculus of Variation:	06
	1.1	Euler's Langrange equation, solution of Euler's Langrange equation (only results for different cases for Function) independent of a variable, independent of another variable, independent of differentiation of a variable and independent of both variables	
	1.2	Isoperimetric problems, several dependent variables	
	1.3	Functions involving higher order derivatives: Rayleigh-Ritz method	
2		Linear Algebra: Vector Spaces	06
	2.1	Vectors in n-dimensional vector space: properties, dot product, cross product, norm and distance properties in n-dimensional vector space.	
	2.2	Vector spaces over real field, properties of vector spaces over real field, subspaces.	
	2.3	The Cauchy-Schwarz inequality, Orthogonal Subspaces, Gram-Schmidt process.	
3		Linear Algebra: Matrix Theory	10
	3.1	Characteristic equation, Eigen values and Eigen vectors, properties of Eigen values and Eigen vectors	
	3.2	Cayley-Hamilton theorem (without proof), examples based on verification of Cayley- Hamilton theorem.	
	3.3	Similarity of matrices, Diagonalisation of matrices.	
	3.4	Functions of square matrix, derogatory and non-derogatory matrices.	
4		Probability	10
	4.1	Baye's Theorem (without proof)	
	4.2	Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function, expectation, variance.	
	4.3	Moments, Moment Generating Function.	
	4.4	Probability distribution: Binomial distribution, Poisson & normal distribution (For detailed study)	
5		Correlation	04
	5.1	Karl Pearson's coefficient of correlation, Covariance, Spearman's Rank correlation,	
	5.2	Lines of Regression.	
6		Complex integration	12
	6.1	Complex Integration: Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula.	
	6.2	Taylor's and Laurent's Series	
	6.3	Zeros, singularities, poles of $f(z)$, residues, Cauchy's Residue theorem.	
	6.4	Applications of Residue theorem to evaluate real Integrals of different types.	

Books Recommended:

Text books:

1. H.K. Das, “*Advanced engineering mathematics*”, S . Chand, 2008
2. A. Datta, “*Mathematical Methods in Science and Engineering*”, 2012
3. B.S. Grewal, “*Higher Engineering Mathematics*”, Khanna Publication
4. P.N.Wartilar & J.N.Wartikar, “*A Text Book of Applied Mathematics*” Vol. I & II, Vidyarthi Griha Prakashan., Pune.

Reference Books:

1. B. V. Ramana, “*Higher Engineering Mathematics*”, Tata Mc-Graw Hill Publication
2. Wylie and Barret, “*Advanced Engineering Mathematics*”, Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, “*Advanced Engineering Mathematics*”, John Wiley & Sons, Inc
4. Seymour Lipschutz “*Beginning Linear Algebra*” Schaum’s outline series, Mc-Graw Hill Publication
- 5.Seymour Lipschutz “*Probability*” Schaum’s outline series, Mc-Graw Hill Publication

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Term Work:

Term work shall consist of minimum 8 tutorials

The distribution of marks for term work shall be as follows:

Tutorials	: 20 Marks
Attendance	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
- 3 Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked
- 4: Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC402	Biomedical Transducers and Measuring Instruments (Abbreviated as BTMI)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Av g.							
BMC402	Biomedical Transducers and Measuring Instruments (BTMI)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC402	Biomedical Transducers and Measuring Instruments	04
Course Objectives	<ul style="list-style-type: none"> To provide the knowledge of basic concepts such as measuring instruments and generalized instrumentation system, general properties of input transducers, static and dynamic characteristics of transducers and sensors. To provide a thorough understanding of principle and working of transducers and sensors used for displacement, motion, pressure and temperature measurement, bio-potential electrodes, chemical sensors, biosensors, fiber optic sensors, and radiation sensors. To study the biomedical applications of the above transducers and sensors. To perform experiments based on some of the above transducers and sensors. 	
Course Outcomes	<ul style="list-style-type: none"> To clearly understand generalized medical instrumentation system, general properties of transducers, static and dynamic characteristics of transducers and sensors. Understand the fundamental principles and applications of various types of sensors including motion, displacement and pressure sensors. Present different transduction methods for measuring temperature. To understand principle of various biopotential electrodes Understand principle and working of chemical sensor To understand principle of various biosensors, and differentiate various amperometric and potentiometric sensors. 	

Module	Contents	Hours
1	Introduction: Generalized Instrumentation System, General Properties Of Input Transducer. Static Characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift, Hysteresis, Linearity, Input Impedance and Output Impedance. Dynamic Characteristics: First Order and Second Order Characteristics, Time Delay, Error Free Instrument, Transfer Functions. Design Criteria, Generalized Instrument Specifications.	04
2	Medical Instruments: Electronic and Digital Voltmeter Types: FET Voltmeter, Peak and Average Responding voltmeter, True RMS responding voltmeter. Digital to Analog Converter: Binary weighted and R-2R ladder. Analog to digital converter: Ramp type, Dual Slope type, Successive Approximation type ADC, DVM: Ramp type, Dual Slope type, Successive Approximation type, Flash type DVM. Resolution & Sensitivity. Multimeter: Working, Specifications. Oscilloscopes: Block Diagram of C.R.O (in details). Requirements of Time base, Delayed Time Base, Post deflection acceleration, triggering. Description of Panel Layout and working of controls. Specifications of CRO. Applications: Measurement of voltage, current. Types: Dual trace, Dual beam, Digital Storage – Block diagram, working, application, comparison.	14
3	Displacement, motion and Pressure Measurement: (with applications) Resistive: Potentiometers, Strain Gauges and Bridge Circuits. Inductive: Variable Inductance and LVDT Capacitive type, Piezoelectric Transducers. Types of Diaphragms, Bellows, Bourdon Tubes.	10
4	Temperature Measurement: Thermistor, Thermocouple, Resistive Temperature Detector, IC based Temperature Measurement Radiation Sensors	06
5	Bio potential Electrodes: Electrodes Electrolyte Interface, Half-Cell Potential, Polarization, Polarizable and Non Polarizable, Electrodes, Calomel Electrode, Electrode Circuit Model, Electrode Skin-Interface and Motion Artifact. Body Surface Electrodes. Internal Electrodes: Needle and Wire Electrodes (Different Types). Microelectrodes: Metal, Supported Metal Micropipette (Metal Filled Glass And Glass Micropipette Electrodes)	06
6	Chemical Sensors: Blood gas and Acid- Base Physiology, Potentiometric Sensors (pH, pCO ₂ Electrodes, Amperometric Sensors (pO ₂), ISFETS, Transcutaneous Arterial O ₂ and CO ₂ Tension Monitoring. Fiber Optic Sensors: Principle of Fiber Optics, Fiber Optic Sensors - Temperature, Chemical, Pressure. Biosensor: Classifications and types with examples.	08

Books Recommended:

Text Books:

1. Kalasi H.S.- Electronic Instrumentation
2. A.K. Sawhney- Electrical & Electronic Measurement & Instrumentation.
3. Medical Instrumentation-Application and Design by John G. Webster.
4. Instrument Transducer – An Intro to their performance and design, Hermann K P. Neubert.
5. Biomedical sensors – fundamentals and application by Harry N, Norton.
6. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamma and P. Ake Öberg.
7. Electronics in Medicine and Biomedical Instrumentation by Nandini K. Jog PHI Second Edition 2013.

Reference Books:

1. Principles of applied Biomedical Instrumentation by La Geddes and L.E. Baker.
2. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred. J. Weibell and Pfeiffer.
3. Principles of Biomedical Instrumentation and Measurement, Richard Aston, Merril Publishing Co., Columbus, 1990.
4. Measurement Systems, Application and Design, Ernest O. Doebelin, McGraw-Hill, 1985.
5. Handbook of Modern Sensors – Physics, Design and Application, Jacob Fraden, AIP press.
6. Transducers for Biomedical Measurements: Principles and Applications, Richard S.C. Cobbold, John Wiley & Sons, 1974.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC403	Linear Integrated Circuits (Abbreviated as LIC)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Av g.							
BMC403	Linear Integrated Circuits (LIC)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC403	Linear Integrated Circuits	04
Course Objectives	<ul style="list-style-type: none"> To provide concepts of differential, operational and power amplifiers with their applications and design methodology To cover analysis of circuits with negative feedback 	
Course Outcomes	Learner will be able to: <ul style="list-style-type: none"> Analyse different types of differential amplifiers Demonstrate basics of operational amplifiers Analyse and design operational amplifier to perform mathematical operations Analyse and design operational amplifier as oscillators Illustrate basics of negative feedback and perform analysis on different types of circuits with negative feedback Exhibit working of power amplifiers, its types and DC and AC analysis and designing 	

Module	Contents	Hours
1.	Differential Amplifiers: <ul style="list-style-type: none"> • Basic Concept • Types: Dual Input Balanced Output, Dual Input Unbalanced Output, Single Input Balanced Output And Single Input Unbalanced Output. • Common mode and Differential mode analysis - DC and AC analysis. • Differential amplifiers with Swamping Resistor • Constant current source, current mirror circuits 	05
2.	Introduction to operational Amplifier : <ul style="list-style-type: none"> • Introduction to an Ideal Operational Amplifier, Block Diagram, DC and AC Characteristics, Equivalent circuit of Op-amp • Op-amp IC 741 characteristics, frequency response and concept of virtual ground. 	05
3.	Applications of operational Amplifier : <ul style="list-style-type: none"> • Adder, Subtractor /differential Amplifier, Voltage follower, Integrator (practical and Ideal), Differentiator (practical and Ideal), Instrumentation amplifier • Voltage to Current and Current to Voltage converters, Active Half wave rectifiers, Active Full wave rectifier, Clipper, Clampers, Log and Antilog amplifiers, Sample & hold circuits, Peak detector, Multipliers and Dividers, • Schmitt Trigger (Regenerative comparator), Voltage comparators, zero crossing detector. 	15
4.	Oscillators using Operational Amplifier: <ul style="list-style-type: none"> • Concepts of Oscillation. Barkhausen's criteria for an oscillator. • Types of oscillators: RC Phase shift Oscillator, Wien Bridge oscillator, Colpitt's Oscillator, Hartley Oscillator, Crystal Oscillator, Clapp Oscillator, (Phase shift, Frequency of oscillation, condition of sustained oscillation, circuit operation and Amplitude stability in the above oscillators). 	08
5.	Negative Feedback: <ul style="list-style-type: none"> • Introduction to Feedback • Negative feedback characteristics: Gain Sensitivity, Bandwidth Extension, Noise Sensitivity, Reduction of Non-Linear Distortion. • Feedback Topologies, Series-Shunt, Shunt-Series, Series-Series, Shunt-Shunt Configurations • Negative feedback amplifiers: Voltage Amplifiers, Current Amplifiers, Trans-Conductance Amplifiers, Trans-Resistance Amplifiers (DC and AC analysis). 	10
6.	Power Amplifiers : <ul style="list-style-type: none"> • Classes of Power amplifiers, Class-A, Class-B, Class AB, Class C • Analysis: Class-A Power Amplifiers (Direct coupled and Transformer coupled), Class-B Power Amplifiers, Class-AB Push Pull and Complementary Symmetry Power amplifier • Power amplifier design, Heat Sinks and its design 	05

Books Recommended:*Text Books:*

- 1.. Electronic Circuit Analysis and Design- Donald A Neamen,
2. Electronic Devices and circuits – R Bolystead.
3. Op-Amps and linear integrated circuits – R. Gayakwad
4. Linear Integrated Circuits: Roy Chaudhary

Reference Books:

1. Integrated Electronics –Millman & Halkias
2. Opamps and linear integrated circuits, Theory and Applications- James Fiore

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC404	Digital Electronics (Abbreviated as DE)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Av g.							
BMC404	Digital Electronics (DE)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC404	Digital Electronics	04
Course Objectives	<ul style="list-style-type: none"> To make learner aware of basics of Digital circuits, logic design, various Logic Families and Flip-flops. Learner should be able to design of various counters, registers and their applications. 	
Course Outcomes	Learner will be able to: <ul style="list-style-type: none"> Understand various number systems and its arithmetic (BCD, Binary, Octal, Hexadecimal etc.) Solve sums on K-maps, Boolean algebra and SOP-POS implementations. Design code converter circuits, parity generator-checker circuits and magnitude comparator circuits. Design circuits using multiplexers, demultiplexers, and decoders. Design synchronous and asynchronous counters and registers using flip flops. Design various gates using various logic families. 	

Module	Contents	Hours
1.	<p>Introduction: Number system, Binary, Octal, Hexadecimal and other. Conversion from One system to another, Binary, BCD and Hexadecimal. Binary Arithmetic (addition, subtraction, multiplication, division) Hexadecimal and octal arithmetic, first and second complement methods.</p> <p>Binary Codes: Weighted Reflective, Sequential, Gray, Error detecting codes, Odd, Even parity, Hamming Codes, Alphanumeric, Morse, Teletypewriter ASCII, EBCDIC codes, Converting Binary to Gray & Gray to Binary, Conversion from BCD to XS3. Application of gray code, shaft position encoding.</p> <p>Boolean Algebra Logic Gates: AND, OR, NOT, XOR, XNOR, operation NAND, NOR used of the universal gate for Performing different operation. Laws of Boolean algebra. De- Morgan's theorems. Relating a Truth Table to a Boolean Expression. Multi level circuits.</p>	05
2.	<p>Combinational Circuits: K-MAPS and their use in specifying Boolean Expressions, Minterm, Maxterm SOP and POS Implementation. Implementation a logic function using universal gates. Variable entered maps For five and six variable functions Quine Mc Clusky tabular techniques.</p>	05
3.	<p>Combinational Logic Circuit Design: Designing code converter circuits e.g. Binary to Gray, BCD to Seven Segments, Parity Generator. Binary Arithmetic circuits:- Adders, Subtractors (Half and full) BCD adder- Subtractor, carry Lookahead adder, Serial adder, Multiplier Magnitude Comparators, 7485 comparator, Arithmetic Logic units.</p> <p>Use of Multiplexers in Logic Design: Multiplexer (ULM) Shannon's theorem. ULM trees. De- Multiplexers, Line decoders, Designing using ROMs and ULMs. Hazards in combinational circuits.</p>	15
4.	<p>Sequential Logic Circuits: Comparison of Combinational & Sequential Circuits, Multi-vibrators (Astable, Monostable And Bistable) Flip-Flops, SR, T, D, JK, Master Slave JK, Converting one Flip-Flop to another, State transition diagrams, Use of Denounce switch. Counter Modulus of a counter, Ripple counter, Up/Down Counter, Designing sequential counters using gate IC and counter IC by drawing state transition Diagram & state transition table. Ring counter Johnson counter, twisted ring counter, Pseudo Random number generator, Unused states and locked conditions.</p>	08
5.	<p>Registers: Serial input serial output, serial input parallel output, Left Right shift register, Use of register ICs for sequence generator and counter. Bidirectional shift register, Universal shift register</p>	10
6.	<p>Logic Families: RTL, DTL, TTL, schotkey clamped TTL, Tristate gate ECL, IIL, MOS device CMOS Comparison of logic families, interfacing different families. TTL with CMOS, NMOS, TTL, ECL, & TTL, IIL, & TTL.</p>	05

Books Recommended:

Text Books:

1. R.P.Jain, "Modern Digital Electronics," Tata McGraw Hill, 1984
2. M Morris Mono, "Digital Design," Prentice Hall International-1984.
3. Malvino & Leach, "Digital Principal and Applications", Tata McGraw Hill, 1991.
4. Malvino, "Digital Electronics", Tata McGraw Hill, 1997.

Reference Books:

1. James Bignell & Robert Donovan, “Digital Electronics”, Delmar, Thomas Learning,
2. Jog N.K, “Logic Circuits”, 2nd edition, Nandu Publisher & Printer Pvt .Ltd. 1998.
3. Alan b. Marcovitz, “Introduction to Logic Design “, McGraw Hill International 2002.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC405	Signals and Control System (Abbreviated as SCS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC405	Signals and Control System (Abbreviated as SCS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC405	Signals and Control Systems	04
Course Objectives	<ul style="list-style-type: none"> To introduce the concepts and techniques associated with the understanding of signals and systems such as the basic parameters, properties and interaction of signals and system. To familiarize with techniques suitable for analysing and synthesizing signals and systems in continuous domain. 	
Course Outcomes	<ul style="list-style-type: none"> Represent signals and system mathematically Represent integral of LTI systems, properties of system in terms of impulse response Determine Fourier series representation of CT, properties of Fourier series Derive and determine Laplace transform, region of convergence, application of Laplace transform, Inverse Laplace transform. Analyse given systems and suggest modifications. 	

Module	Contents	Hours
1	Introduction to Signals: Basic of continuous time signals like unit step, ramp, exponential, operation on signals like flipping, shifting, scaling, and multiplication. Classification of signals: Periodic /Aperiodic, Power and Energy, Even and Odd.	07
2	Introduction to Systems: System representation in the continuous and discrete time domain. Classification of systems on the basis of Causal/non-Causal, Time variance/Time invariance, Linear/Non-Linear, Stable/Unstable. Continuous convolution	07

3	Fourier Analysis of Continuous time Signals Orthogonal functions, Representation of signals in terms of weighted orthogonal basis functions, Coefficient calculation on the basis of minimum square error. Fourier series: Representation of Fourier series in terms of sine, cosine, exponential functions. The complex Fourier spectrum, Properties of Fourier series, convergence of Fourier series, Gibbs phenomenon. Fourier transform and its properties. Fourier transform of singular functions. Energy density spectrum	07
4	Laplace Transform: Double sided Laplace transforms, Region of Convergence, properties, Unilateral Laplace Transform, properties, applications of Laplace transform to the solution of differential equations. Inverse Laplace Transform.	08
5	Introduction to Control Systems: Basic concepts of control systems, open loop and closed loop systems, difference between open loop and closed loop systems, signal flow graph.	07
6	Time domain and Frequency domain behaviour of Systems Time domain analysis of first order and second order systems. Condition of BIBO stability in time domain. Frequency response of linear systems. Stability and Routh array, Bode plots, Root Locus	12

Books Recommended:

Text Books:

1. Oppenheim A. V. & Alan S. Willsky, Signals and Systems, Pearson Education
2. Simon Haykin & Barry Van Veen, Signals and Systems, Wiley-India
3. Modern Control Engineering : D.Roy Choudhury, PHI
4. Modern Control Engineering : K. Ogata , PHI
5. Control Systems Engineering: L.J. Nagrath, M. Gopal, Third Edition, New Age International Publishers.

Reference Books:

1. Proakis J. G. & Manolakis D. G., Digital Signal Processing, Principles, algorithms & applications, Pearson Education
2. Ramesh Babu P., Signals and Systems, Scitech Publications (India) Pvt. Ltd.
3. Charles L. Phillips, John M. Parr & Eve A Riskin, Signals, Systems and Transforms, Pearson Education
4. Control System, Theory & Applications : Samarjit Ghosh, Pearson Education
5. System Dynamic and Control : Eroni Umez Erani., PWS Publishing, International Thompson Publishing Company

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML401	Introduction to Simulations Tools (IST)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML401	Introduction to Simulations Tools (IST)	--	--	--	--	25	25	--	--	50

Course Code	Course Name	Credits
BML401	Introduction to Simulations Tools	01
Course objective	<ul style="list-style-type: none"> To study Simulation software Study Proteus 	
Course Outcome	Learner will be able to: <ul style="list-style-type: none"> Understand various tools of simulation software Write Programme in Programming Software Simulate Digital and analog circuits Understand use of Proteus software Simulate differential equations 	

List of Laboratory Experiments: (Any seven)

1. Study of Various simulation software Commands
2. Plotting variable using software
3. Study of various Proteus commands.
4. Simulating Inverting and Non inverting Amplifier in Proteus
5. Implementing logic gates using Proteus
6. Decade Counter using flip-flop in Proteus
7. Simulating differential Equations
8. Simulate basic electrical circuit using pspice

Any other experiment using these simulation tools which will help learner to understand the application of these tools during their B.E project work

Assessment:**Term Work:**

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks

Laboratory work (Journal) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical examination will be based on suggested practical list.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML402	Biomedical Transducers and Measuring Instruments (BTMI)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML402	Biomedical Transducers and Measuring Instruments (BTMI)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML402	Biomedical Transducers and Measuring Instruments	01
Course objective	<ul style="list-style-type: none"> To display and record signals using CRO. To implement digital to analog converter. To analyse step response of a thermometer and measure temperature using various temperature transducers. To measure displacement using various displacement transducers. To measure pressure using a pressure transducer. To measure pH of a solution using pH electrodes. 	
Course Outcome	Learner will be able to: <ul style="list-style-type: none"> Record and display signals using CRO. Convert analog data into digital form. Analyse step response of a thermometer and measure temperature using various temperature transducers. Measure displacement using various displacement transducers. Measure pressure using a pressure transducer. Measure pH of a solution using pH electrodes. 	

Syllabus: Same as that of BMC402 Biomedical Transducers and Measuring Instruments

List of Laboratory Experiments: (Any seven)

1. Study of Front panel of CRO
2. A to D converter
3. To study the dynamic behaviour of thermometer system.
4. To study the characteristics of a thermistor.
5. To study thermistor linearization.
6. To study the characteristics of a light dependent resistor.

7. To study the principle and working of a thermocouple.
8. To study principle and working of LVDT.
9. To study principle and working of a capacitive Transducer.
10. To study principle and working of a strain gage sensor.
11. To study principle and working of a pressure sensor.
12. To study pH electrode.

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1. Kalasi H.S.- Electronic Instrumentation
2. A.K. Sawhney- Electrical & Electronic Measurement & Instrumentation.
3. Medical Instrumentation-Application and Design by John G. Webster.
4. Instrument Transducer – An Intro to their performance and design, Hermann K P. Neubert.
5. Biomedical sensors – fundamentals and application by Harry N, Norton.
6. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamma and P. Ake Öberg.
7. Electronics in Medicine and Biomedical Instrumentation by Nandini K. Jog PHI Second Edition 2013.

Reference Books:

1. Principles of applied Biomedical Instrumentation by La Geddes and L.E. Baker.
2. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred. J. Weibell and Pfeiffer.
3. Principles of Biomedical Instrumentation and Measurement, Richard Aston, Merril Publishing Co., Columbus, 1990.
4. Measurement Systems, Application and Design, Ernest O. Doebelin, McGraw-Hill, 1985.
5. Handbook of Modern Sensors – Physics, Design and Application, Jacob Fraden, AIP press.
6. Transducers for Biomedical Measurements: Principles and Applications, Richard S.C. Cobbold, John Wiley & Sons, 1974.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments)	: 10 Marks
Laboratory work (Journal)	: 10 Marks
Attendance	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML403	Linear Integrated Circuits (LIC)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML403	Linear Integrated Circuits (LIC)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML403	Linear Integrated Circuits	01
Course Objective	<ul style="list-style-type: none"> To provide designing methodology and implementation technique for differential, operational and power amplifiers. 	
Course Outcome	<ul style="list-style-type: none"> To design and implement various mathematical operations using operational amplifier To implement waveform generation using operational amplifier To implement circuits of differential amplifiers, power amplifiers and negative feedback. 	

Syllabus: Same as that of BMC403 Linear Integrated Circuits

List of Laboratory Experiments: (Any seven)

- Differential amplifier
- Inverting amplifier
- Non-inverting amplifier
- Designing circuit using operational amplifier for given mathematical equation
- Integrator
- Differentiator
- Half wave rectifier
- RC-phase shift oscillator
- Wein bridge oscillator
- Instrumentation amplifier
- Negative feedback

12. Schmitt trigger
13. Comparator
14. Zero crossing detector
15. Class B push pull power amplifier

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

- 1.. Electronic Circuit Analysis and Design- Donald A Neamen,
2. Electronic Devices and circuits – R Bolystead.
3. Op-Amps and linear integrated circuits – R. Gayakwad
4. Linear Integrated Circuits: Roy Chaudhary

Reference Books:

1. Integrated Electronics –Millman & Halkias
2. Opamps and linear integrated circuits, Theory and Applications- James Fiore

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments)	: 10 Marks
Laboratory work (Journal)	: 10 Marks
Attendance	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML404	Digital Electronics	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML404	Digital Electronics	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML404	Digital Electronics	01
Course Objective	<ul style="list-style-type: none"> To make learner aware of basics of digital circuits, logic design and Flip-flops. Learner should be able to design of various counters, registers and their applications. 	
Course Outcome	<p>Learners will be able to:</p> <ol style="list-style-type: none"> Understand various ICs used for basic gates, EX-OR and EX-NOR gates Design code converter circuits. Design parity generator-checker circuits, adder-subtractor circuits and magnitude comparator circuits Design circuits using multiplexers, demultiplexers, and decoders. Design synchronous and asynchronous counters using flipflops. Design various registers using flip flops. 	

Syllabus: Same as that of BMC404 Digital Electronics

List of Laboratory Experiments: (Any seven)

- To study the various Logic gates.
- To design various gates using Universal gates.
- To design binary to gray code converter and gray to binary converter.
- To design BCD to Excess3 converter.
- To design parity generator and parity checker circuits.
- To design adder and subtractor circuits.

7. To design various circuits using multiplexers.
8. To design various circuits using de-multiplexer.
9. To study S-R , J-K, T and D Flip flops.
10. To design Asynchronous counter.
11. To design decade counter
12. To design Synchronous counter.

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1. R.P.Jain, “Modern Digital Electronics,” Tata McGraw Hill, 1984
2. M Morris Mono, “Digital Design,” Prentice Hall International-1984.
3. Malvino & Leach, “Digital Principal and Applications”, Tata McGraw Hill, 1991.
4. Malvino, “Digital Electronics”, Tata McGraw Hill, 1997.

Reference Books:

1. James Bignell & Robert Donovan, “Digital Electronics”, Delmar, Thomas Learning,
2. Jog N.K, “Logic Circuits”, 2nd edition, Nandu Publisher & Printer Pvt .Ltd. 1998.
3. Alan b. Marcovitz, “Introduction to Logic Design “, McGraw Hill International 2002.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments)	: 10 Marks
Laboratory work (Journal)	: 10 Marks
Attendance	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML405	Signals and Control Systems (SCS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML405	Signals and Control Systems (SCS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML405	Signals and Control Systems	01
Course objective	<ul style="list-style-type: none"> To introduce the concepts and techniques associated with the understanding of signals and systems such as the basic parameters, properties and interaction of signals and system. To familiarize with techniques suitable for analyzing and synthesizing signals and systems in continuous domain. 	
Course Outcome	<ul style="list-style-type: none"> Represent signals and system mathematically Represent integral of LTI systems, properties of system in terms of impulse response Determine Fourier series representation of CT, properties of Fourier series Derive and determine Laplace transform, region of convergence, application of Laplace transform, Inverse Laplace transform. Analyze given systems and suggest modifications. 	

Syllabus: Same as that of BMC405 Signals and Control Systems

List of Laboratory Experiments: (Any Five)

1. Introduction to signals and plotting of signals
2. Operations on Signal
3. Classification of Signals
4. Open Loop and Closed loop
5. Stability
6. Bode Plot
7. Root Locus
8. Convolution
9. Pole Zero plot

List of suggested Tutorials: (Any Six)

1. Introduction to signals and systems
2. Fourier Series
3. Laplace Transform
4. Inverse Laplace Transform
5. Application of Laplace Transform
6. Open Loop and Closed loop
7. Signal Flow graph
8. Stability
9. Bode Plot
10. Root Locus
11. Time domain analysis

Any other practical and tutorial based on syllabus which will help learner to understand topic/concept

Assessment:**Term Work:**

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments)	: 10 Marks
Laboratory work (Tutorial)	: 10 Marks
Attendance	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral examination will be based on suggested practical list and entire syllabus.

**Program Structure for
TE Biomedical Engineering
University of Mumbai
(With effect from academic year 2018 - 19)**

Scheme for Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC501	Diagnostic & Therapeutic Instruments	04	----	----	04	----	----	04
BMC502	Analog and Digital Circuit Design	04	----	----	04	----	----	04
BMC503	Principles of Communication Engineering	04	----	----	04	----	----	04
BMC504	Biomedical Digital Image Processing	04	----	----	04	----	----	04
BMDLO501X	Department Level Optional Course – I	04	----	----	04	----	----	04
BML501	Business Communication and Ethics	----	02*+02	----	----	02	----	02
BML502	Diagnostic and Therapeutic Instruments	----	02	----	----	01	----	01
BML503	Integrated and Communication Circuit Design	----	02	----	----	01	----	01
BML504	Biomedical Digital Image Processing	----	02	----	----	01	----	01
BMDLL501X	Department Level Optional Course Laboratory – I	----	02	----	----	01	----	01
Total		20	12	----	20	06	----	26

***2 hrs. theory shall be taught to the entire class.**

Examination Scheme for Semester V

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC501	Diagnostic & Therapeutic Instruments	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC502	Analog and Digital Circuit Design	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC503	Principles of Communication Engineering	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC504	Biomedical Digital Image Processing	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 501X	Department Level Optional Course – I	80	32	20	8	---	---	---	---	---	---	---	---	100
BML501	Business Communication and Ethics	---	---	---	---	50	20	---	---	---	---	---	---	50
BML502	Diagnostic and Therapeutic Instruments	---	---	---	---	25	10	---	---	25	10	---	---	50
BML503	Integrated and Communication Circuit Design	---	---	---	---	25	10	25	10	---	---	---	---	50
BML504	Biomedical Digital Image Processing	---	---	---	---	25	10	---	---	---	---	25	10	50
BMDLL 501X	Department Level Optional Course Laboratory – I	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		400	160	100	40	150	60	25	10	50	20	25	10	750

Scheme for Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC601	Biomedical Monitoring Equipment	04	----	----	04	----	----	04
BMC602	Microprocessors and Microcontrollers	04	----	----	04	----	----	04
BMC603	Digital Image Processing	04	----	----	04	----	----	04
BMC604	Medical Imaging-I	04	----	----	04	----	----	04
BMDLO602X	Department Level Optional Course – II	04	----	----	04	----	----	04
BML601	Biomedical Monitoring Equipment	----	02	----	----	01	----	01
BML602	Microprocessors and Microcontrollers	----	02	----	----	01	----	01
BML603	Digital Image Processing	----	02	----	----	01	----	01
BML604	Medical Imaging-I	----	02	----	----	01	----	01
BMDLL602X	Department Level Optional Course Laboratory – II	----	02	----	----	01	----	01
Total		20	10	----	20	05	----	25

Examination Scheme for Semester VI

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC601	Biomedical Monitoring Equipment	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC602	Microprocessors and Microcontrollers	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC603	Digital Image Processing	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC604	Medical Imaging-I	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 602X	Department Level Optional Course – II	80	32	20	8	---	---	---	---	---	---	---	---	100
BML601	Biomedical Monitoring Equipment	---	---	---	---	25	10	---	---	---	---	25	10	50
BML602	Microprocessors and Microcontrollers	---	---	---	---	25	10	---	---	---	---	25	10	50
BML603	Digital Image Processing	---	---	---	---	25	10	---	---	---	---	25	10	50
BML604	Medical Imaging-I	---	---	---	---	25	10	---	---	25	10	---	---	50
BMDLL 602X	Department Level Optional Course Laboratory – II	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		400	160	100	40	125	50	---	---	50	20	75	30	750

**Program Structure for
BE Biomedical Engineering
University of Mumbai
(With effect from academic year 2019 - 20)**

Scheme for Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC701	Life Saving and Surgical Equipment	04	----	----	04	----	----	04
BMC702	Very Large Scale Integrated System	04	----	----	04	----	----	04
BMC703	Medical Imaging-II	04	----	----	04	----	----	04
BMDLO703X	Department Level Optional Course – III	04	----	----	04	----	----	04
ILO701X	Institute Level Optional Course – I	03	----	----	03	----	----	03
BML701	Life Saving and Surgical Equipment	----	02	----	----	01	----	01
BML702	Very Large Scale Integrated System	----	02	----	----	01	----	01
BML703	Medical Imaging-II	----	02	----	----	01	----	01
BMDLL703X	Department Level Optional Course Laboratory – III	----	02	----	----	01	----	01
BML704	Project Stage I	----	06	----	----	03	----	03
Total		19	14	----	19	07	----	26

Examination Scheme for Semester VII

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC701	Life Saving and Surgical Equipment	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC702	Very Large Scale Integrated System	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC703	Medical Imaging-II	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 703X	Department Level Optional Course - III	80	32	20	8	---	---	---	---	---	---	---	---	100
ILO701 X	Institute Level Optional Course – I	80	32	20	8	---	---	---	---	---	---	---	---	100
BML701	Life Saving and Surgical Equipment	---	---	---	---	25	10	---	---	25	10	---	---	50
BML702	Very Large Scale Integrated System	---	---	---	---	25	10	---	---	25	10	---	---	50
BML703	Medical Imaging-II	---	---	---	---	25	10	---	---	25	10	---	---	50
BMDLL 703X	Department Level Optional Course Laboratory – III	---	---	---	---	25	10	---	---	25	10	---	---	50
BML704	Project Stage I	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		400	160	100	40	125	50	---	---	125	50	---	---	750

Scheme for Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC801	Biomedical Microsystems	04	----	----	04	----	----	04
BMC802	Hospital Management	04	----	----	04	----	----	04
BMDLO804X	Department Level Optional Course – IV	04	----	----	04	----	----	04
ILO802X	Institute Level Optional Course – II	03	----	----	03	----	----	03
BML801	Biomedical Microsystems	----	02	----	----	01	----	01
BML802	Hospital Management	----	02	----	----	01	----	01
BMDLL804X	Department Level Optional Course Laboratory – IV	----	02	----	----	01	----	01
BML803	Project Stage II	----	12	----	----	06	----	06
Total		15	18	----	15	09	----	24

Examination Scheme for Semester VIII

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC801	Biomedical Microsystems	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC802	Hospital Management	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 804X	Department Level Optional Course - IV	80	32	20	8	---	---	---	---	---	---	---	---	100
ILO802X	Institute Level Optional Course –II	80	32	20	8	---	---	---	---	---	---	---	---	100
BML801	Biomedical Microsystems	---	---	---	---	25	10	---	---	25	10	---	---	50
BML802	Hospital Management	---	---	---	---	25	10	---	---	25	10	---	---	50
BMDLL 801X	Department Level Optional Course Laboratory – IV	---	---	---	---	25	10	---	---	25	10	---	---	50
BML803	Project Stage II	---	---	---	---	50	20	---	---	---	---	100	40	150
Total		320	128	80	32	125	50	---	---	75	30	100	40	700

Department Level Optional Courses

Course Code	Department level Optional Course - I
BMDLO5011	Healthcare Database Management
BMDLO5012	Biostatistics
BMDLO5013	Rehabilitation Engineering

Course Code	Department level Optional Course - II
BMDLO6021	Healthcare Software
BMDLO6022	Lasers and Fibre Optics
BMDLO6023	Biological Modelling and Simulation

Course Code	Department level Optional Course - III
BMDLO7031	Networking and Information in Medical System
BMDLO7032	Advanced Image Processing
BMDLO7033	Embedded Systems

Course Code	Department level Optional Course - IV
BMDLO8041	Health Care Informatics
BMDLO8042	Robotics in Medicine
BMDLO8043	Nuclear Medicine

Institute Level Optional Courses

Course Code	Institute level Optional Course - I
ILO7011	Product Lifecycle Management
ILO7012	Reliability Engineering
ILO7013	Management Information System
ILO7014	Design of Experiments
ILO7015	Operation Research
ILO7016	Cyber Security and Laws
ILO7017	Disaster Management and Mitigation Measures
ILO7018	Energy Audit and Management
ILO7019	Development Engineering

Course Code	Institute level Optional Course - II
ILO8021	Project Management
ILO8022	Finance Management
ILO8023	Entrepreneurship Development and Management
ILO8024	Human Resource Management
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)
ILO8026	Research Methodology
ILO8027	IPR and Patenting
ILO8028	Digital Business Management
ILO8029	Environmental Management

Biotechnology Engineering

Sr. No.	Subject Code	Subject Name	Count
1	BTL301	Microbiology Lab	1
2	BTL302	Biochemistry Lab	1
3	BTL303	Unit Operations-I Lab	1
4	BTL401	Fermentation Technology Lab	1
5	BTL402	Analytical Methods in Biotechnology Lab	1
6	BTL403	Unit Operations –II Lab	1
7	BTL501	Bioinformatics Lab	1
8	BTL502	Genetic Engineering Lab	1
9	BTL503	Lab I	1
10	BTL601	Lab-II	1
11	BTL602	Lab-III	1
12	BTL701	Lab - IV	1
13	BTL702	Lab - V	1
14	BTL801	Lab - VI	1
15	BTL802	Lab - VII	1
		Total	15

UNIVERSITY OF MUMBAI



Revised syllabus (Rev- 2016) from Academic Year 2016 -17

Biotechnology

Second Year with Effect from **AY 2017-18**

Third Year with Effect from **AY 2018-19**

Final Year with Effect from **AY 2019-20**

Under

FACULTY OF TECHNOLOGY

As per **Choice Based Credit and Grading System**

With effect from the AY 2016-17

From Coordinator's Desk

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) give freedom to affiliated Institutes to add few (PEO's) course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and grading based system is implemented for Second Year of B.E. in Biotechnology Engineering from the academic year 2017-2018. This system will be carried forward for Third Year of B.E. in Biotechnology Engineering in the academic year 2018-2019 and for Fourth Year B.E. in the year 2019-2020 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble to the Revision of Syllabus in Biotechnology Engineering

The onset of nineties brought about some paradigm shifts. One was in the sphere of market economics. Suddenly the Indian manufacturing sector started jostling for a place with international competition in the arena. The presence of International products at competitive rates and quality forced some small and medium scale units to close their operations. The larger industry players realized the importance of R&D and accordingly set up separate cells to optimize production and improve quality. The second major impact was in the sphere of knowledge. With the advent of World Wide Web in the early nineties and its subsequent growth, the latest research trends have become accessible from drawing rooms across the globe. This acted as a positive feedback mechanism in increasing the pace of research in all fields including Biotechnology. This was the motivation for an in depth analysis of what is actually required for today's technology. It is also important to take advantage of the freely available software to enhance the quality and quantity of material that can be covered in the class room.

With this scenario as the backdrop, the first meeting was conducted by Board of Studies in Biotechnology at Thadomal Shahani College of Engineering Bandra on 3rd February 2017. It was attended by the various heads of departments of Biotechnology engineering as well as experts from industry. The academic scheme and exam scheme of the program was discussed along with the program objectives and outcomes. The core structure of the syllabus was formulated keeping in mind **choice based credit and grading system** curriculum to be introduced in this revised syllabus for B.E. (Biotechnology) for all semesters. A second meeting was held in Datta Meghe College of Engineering Airoli on 20th February 2017 and detailed syllabus of Semesters III and IV was finalised. Subsequently another meeting was held in Thadomal Shahani Engineering College Bandra on 11th April 2017 to finalise the detail syllabus of subjects pertaining to semester V, VI, VII and VIII.

Dr. Kalpana S. Deshmukh,
Chairman, Board of Studies in Chemical Engineering (Adhoc),
University of Mumbai, Mumbai.

General Guidelines

Tutorials

- The number of tutorial batches can be decided based on facilities available in the institution.
- Tutorials can be creative assignments in the form of models, charts, projects, etc.

Term Work

- Term work will be an evaluation of the tutorial/practical done over the entire semester.
- It is suggested that each tutorial/practical be graded immediately and an average be taken at the end.
- A minimum of eight tutorials/ten practical will form the basis for final evaluation.
- The total 25 marks for term work (except project and seminar) will be awarded as follows:

Tutorial / Practical Journal – 20 marks

Overall Attendance – 05

Further, while calculating marks for attendance, the following guidelines shall be adhered to:

75 % to 80%. – 03 marks

81% to 90% - 04 marks

91% onwards – 05 marks

Theory Examination

- In general all theory examinations will be of 3 hours duration.
- Question paper will comprise of total six questions, each of 20 Marks.
- Only four questions need to be solved.
- Question one will be compulsory and based on maximum part of the syllabus.

Note:

In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus as far as possible.

Practical Examination:

- Duration for practical examination would be the same as assigned to the respective Lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Project and Seminar Guidelines

- Project Groups: Students can form groups with minimum 2 (Two) and not more than 3 (Three)
- The load for projects may be calculated proportional to the number of groups, not exceeding two hours per week.
- The load for projects may be calculated as:
Sem VII: ½ hr for teacher per group.
Sem VIII: 1 hr for teacher per group.
- Each teacher should have ideally a maximum of three groups and only in exceptional cases four groups can be allotted to the faculty.
- Seminar topics will be the consensus of the project guide and the students. Each student will work on a unique topic.
- The load for seminar will be calculated as one hour per week irrespective of the number of students
- Students should spend considerable time in applying all the concepts studied, into the project. Hence, eight hours each were allotted in Project A, B and three hours for Seminar to the students.

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
S.E. Semester III (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC301	Applied Mathematics-III	3	-	1	3	-	1	4
BTC302	Microbiology	4	-	-	4	-	-	4
BTC303	Cell Biology	3	-	1	3	-	1	4
BTC304	Biochemistry	4	-	-	4	-	-	4
BTC305	Unit Operations-I	3	-	-	3	-	-	3
BTC306	Process Calculations	3	-	1	3	-	1	4
BTL301	Microbiology Lab	-	3	-	-	1.5	-	1.5
BTL302	Biochemistry Lab	-	3	-	-	1.5	-	1.5
BTL303	Unit Operations-I Lab	-	2	-	-	1	-	1
	Total	20	8	3	20	4	3	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC301	Applied Mathematics-III	20	20	20	80	3	25	-	-	125
BTC302	Microbiology	20	20	20	80	3	-	-	-	100
BTC303	Cell Biology	20	20	20	80	3	25	-	-	125
BTC304	Biochemistry	20	20	20	80	3	-	-	-	100
BTC305	Unit Operations-I	20	20	20	80	3	-	-	-	100
BTC306	Process Calculations	20	20	20	80	3	25	-	-	125
BTL301	Microbiology Lab							25		25
BTL302	Biochemistry Lab							25		25
BTL303	Unit Operations-I Lab								25	25
	Total			120	480	-	75	50	25	750

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Program Structure for B.E. Biotechnology (Revised 2016)
S.E. Semester IV (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC401	Applied Mathematics-IV	3	-	1	3	-	1	4
BTC402	Molecular Genetics	3	-	1	3	-	1	4
BTC403	Fermentation Technology	4			4			4
BTC404	Analytical Methods in Biotechnology	4	-	-	4	-	-	4
BTC405	Immunology and Immunotechnology	3	-	1	3	-	1	4
BTC406	Unit Operations -II	3			3			3
BTL401	Fermentation Technology Lab	-	3	-		1.5	-	1.5
BTL402	Analytical Methods in Biotechnology Lab	-	3	-		1.5	-	1.5
BTL403	Unit Operations –II Lab	-	2	-		1	-	1
	Total	20	8	3	20	4	3	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC401	Applied Mathematics-IV	20	20	20	80	3	25	-	-	125
BTC402	Molecular Genetics	20	20	20	80	3	25	-	-	125
BTC403	Fermentation Technology	20	20	20	80	3	-			100
BTC404	Analytical Methods in Biotechnology	20	20	20	80	3	-			100
BTC405	Immunology and Immunotechnology	20	20	20	80	3	25	-	-	125
BTC406	Unit Operations -II	20	20	20	80	3	-	-	-	100
BTL401	Fermentation Technology Lab		-	-	-	3	-	25		25
BTL402	Analytical Methods in Biotechnology Lab	-	-	-	-	3	-	25	-	25
BTL403	Unit Operations –II Lab	-	-	-	-	-	-	-	25	25
	Total			120	480	-	75	50	25	750

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Program Structure for B.E. Biotechnology (Revised 2016)
T.E. Semester V (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
BTC501	Bioinformatics	4	-	-	4	-	-	4
BTC502	Genetic Engineering	4	-	-	4	-	-	4
BTC503	Thermodynamics and Biochemical Engineering	3	-	1	3	-	1	4
BTC504	Bioreactor Analysis and Technology	3	-	1	3	-	1	4
BTC505	Business Communication and Ethics	2	-	2	-	-	2	2
BTE501X	Elective I	3	-	1	3	-	1	4
BTL501	Bioinformatics Lab	-	2	-	-	1	-	1
BTL502	Genetic Engineering Lab		3			1.5		1.5
BTL503	Lab I		3			1.5		1.5
Total		17	12	3	17	6	3	26

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC501	Bioinformatics	20	20	20	80	3	-	-	100	
BTC502	Genetic Engineering	20	20	20	80	3		-	100	
BTC503	Thermodynamics and Biochemical Engineering	20	20	20	80	3	25	-	125	
BTC504	Bioreactor Analysis and Technology	20	20	20	80	3	25	-	125	
BTC505	Business Communication and Ethics	-	-	-	-	-	50	-	50	
BTE501X	Department Elective I	20	20	20	80	3	25	-	125	
BTL501	Bioinformatics Lab					2		25	25	
BTL502	Genetic Engineering Lab					3		25	25	
BTL503	Lab I	-	-	-	-	3		25	25	
Total				100	400	-	125	75	700	

Department Elective I (Sem V)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Biosensors and Diagnosis (BTE5011)	1. Biophysics (BTE5012) 2. Biostatistics (BTE5013)	1. Pharmaceutical Technology (BTE5014)

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Program Structure for B.E. Biotechnology (Revised 2016)
T.E. Semester VI (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
BTC601	Food Technology	3	-	1	3	-	1	4
BTC602	Cell & Tissue Culture	4	-	-	4	-	-	4
BTC603	Enzyme Engineering	4	-	-	4	-	-	4
BTC604	IPR, Bioethics and Bio safety	3	-	1	3	-	1	4
BTC605	Process Control & Instrumentation	3	-	1	3	-	1	4
BTE602X	Elective-II	3	-	1	3	-	1	4
BTL601	Lab-II	-	3	-	-	1.5	-	1.5
BTL602	Lab-III	-	3	-	-	1.5	-	1.5
	Total	20	6	4	20	3	4	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC601	Food Technology	20	20	20	80	3	25	-	-	125
BTC602	Cell & Tissue Culture	20	20	20	80	3	-	-	-	100
BTC603	Enzyme Engineering	20	20	20	80	3	-	-	-	100
BTC604	IPR, Bioethics and Bio safety	20	20	20	80	3	25	-	-	125
BTC605	Process Control & Instrumentation	20	20	20	80	3	25	-	-	125
BTE602X	Elective-II	20	20	20	80	3	25	-	-	125
BTL601	Lab-II	-	-	-	-	3	-	25	-	25
BTL602	Lab-III	-	-	-	-	3	-	25	-	25
	Total			120	480	-	100	50	--	750

Department Elective II (Sem VI)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Computational Fluid Dynamics (BTE6021)	1. Protein Engineering (BTE6022) 2. Cancer Biology(BTE6023)	1. Green technology (BTE6024)

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Program Structure for B.E. Biotechnology (Revised 2016)
B.E. Semester VII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC701	Bioseperation & Downstream Processing Technology-I	4	-	1	4	-	1	5
BTC702	Bioprocess Modelling and Simulation	4	-	1	4	-	1	5
BTC703	Agriculture Biotechnology	3	-	1	3	-	1	4
BTE703X	Department Elective III	3	-	1	3	-	1	4
ILO701X	Institute Level optional Subject I	3	-	-	3	-	-	3
BTP701	Project A	-	-	6	-	-	3	3
BTL701	Lab - IV	-	3	-	-	1.5	-	1.5
BTL702	Lab - V	-	3	-	-	1.5	-	1.5
Total		17	6	10	17	3	7	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC701	Bioseperation & Downstream Processing Technology-I	20	20	20	80	3	25	-	-	125
BTC702	Bioprocess Modelling and Simulation	20	20	20	80	3	25	-	-	125
BTC703	Agriculture Biotechnology	20	20	20	80	3	25	-	-	125
BTE703X	Department Elective III	20	20	20	80	3	25	-	-	125
ILO701X	Institute Level optional Subject I	20	20	20	80	3	-	-	-	100
BTP701	Project A	-	-	-	-	-	100	-	50	150
BTL701	Lab - IV	-	-	-	-	-	-	25	-	25
BTL702	Lab - V	-	-	-	-	-	-	25	-	25
Total				100	400	-	200	50	50	800

Department Elective III (Sem VII)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Stem Cell & Tissue Engineering (BTE7031)	1. Operation research in Biotechnology (BTE7032) 2. Project Management (BTE7033)	1. Nanotechnology (BTE7034)

Institute Level Optional Subject I (Sem VII)		
1. Product Lifecycle Management (ILO7011)	4. Design of Experiments (ILO7014)	7. Disaster Management and Mitigation Measures (ILO7017)
2. Reliability Engineering (ILO7012)	5. Operation Research (ILO7015)	8. Energy Audit and Management (ILO7018)
3. Management Information System (ILO7013)	6. Cyber Security and Laws (ILO7016)	9. Development Engineering (ILO7019)

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Program Structure for B.E. Biotechnology (Revised 2016)
B.E. Semester VIII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
BTC801	Environmental Biotechnology	4	-	-	4	-	-	4
BTC802	Bioseperation & Downstream Processing technology-II	4	-	-	4	-	-	4
BTC803	Bioprocess Plant & Equipment design	3	-	1	3	-	1	4
BTE804X	Department Elective IV	3	-	1	3	-	1	4
ILO802X	Institute Level optional Subject II	3	-	-	3	-	-	3
BTP801	Project B	-	-	8	-	-	6	6
BTL801	Lab - VI	-	3	-	-	1.5	-	1.5
BTL802	Lab - VII	-	3	-	-	1.5	-	1.5
Total		17	6	10	17	3	8	28

Course code	Course Name	Examination Scheme								
		Theory				Term Work	Pract/Oral	Oral	Total	
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC801	Environmental Biotechnology	20	20	20	80	3	-	-	-	100
BTC802	Bioseperation & Downstream Processing technology-II	20	20	20	80	3	-	-	-	100
BTC803	Bioprocess Plant & Equipment design	20	20	20	80	3	25	-	-	125
BTE804X	Department Elective IV	20	20	20	80	3	25	-	-	125
ILO802X	Institute Level optional Subject II	20	20	20	80	3	-	-	-	100
BTP801	Project B	-	-	-	-	-	100	-	50	150
BTL801	Lab - VI	-	-	-	-	3	-	25	-	25
BTL802	Lab - VII	-	-	-	-	3	-	25	-	25
Total				100	400	-	150	50	50	750

Department Elective IV (Sem VIII)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Non-conventional Sources of Energy (BTE8041)	1. Total Quality Management (BTE8042) 2. Entrepreneurship (BTE8043)	1. Advanced Bioinformatics (BTE8044)

Institute Level Optional Subject II (Sem VIII)		
1. Project Management (ILO8021)	4. Human Resource Management (ILO8024)	7. IPR and Patenting (ILO8027)
2. Finance Management (ILO8022)	5. Professional Ethics and CSR (ILO8025)	8. Digital Business Management (ILO8028)
3. Entrepreneurship Development and Management (ILO8023)	6. Research Methodology (ILO8026)	9. Environmental Management (ILO8029)

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
S.E. Semester III (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
BTC301	Applied Mathematics-III	3	-	1	3	-	1	4
BTC302	Microbiology I	4	-	-	4	-	-	4
BTC303	Cell Biology	3	-	1	3	-	1	4
BTC304	Biochemistry	4	-	-	4	-	-	4
BTC305	Unit Operations-I	3	-	-	3	-	-	3
BTC306	Process Calculations	3	-	1	3	-	1	4
BTL301	Microbiology Lab	-	3	-	-	1.5	-	1.5
BTL302	Biochemistry Lab	-	3	-	-	1.5	-	1.5
BTL303	Unit Operations-I Lab	-	2	-	-	1	-	1
	Total	20	8	3	20	4	3	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC301	Applied Mathematics-III	20	20	20	80	3	25	-	-	125
BTC302	Microbiology I	20	20	20	80	3	-	-	-	100
BTC303	Cell Biology	20	20	20	80	3	25	-	-	125
BTC304	Biochemistry	20	20	20	80	3	-	-	-	100
BTC305	Unit Operations-I	20	20	20	80	3	--	-	-	100
BTC306	Process Calculations	20	20	20	80	3	25	-	-	125
BTL301	Microbiology Lab	-	-	-	-	3	--	25	-	25
BTL302	Biochemistry Lab	-	-	-	-	3	--	25	-	25
BTL303	Unit Operations-I Lab	-	-	-	-	-	--	-	25	25
	Total			120	480	-	75	50	25	750

Course Code	Name of Subject	Credits
BTC301	Applied Mathematics III	04

Pre-requisites:

- Basics of complex numbers: modulus, argument; equation of a circle, roots of unity, Euler's formula; hyperbolic functions; matrices: symmetric, orthogonal and unitary matrices, rank, normal form, solutions of systems of linear equations; basics of LPP: graphical method; calculus: partial derivatives, Hessian, maxima/minima of functions of 1 and 2 real variables.

Course Objectives:

- To introduce students to the basic methods of Laplace transforms.
- Laplace transforms and inverse Laplace transforms of all the standard functions.
- To enable students to solve initial value ODE problems using L-transforms.
- To study eigen values and eigen spaces of matrices.
- Orthogonal and congruent reduction of quadratic forms.
- Complex analysis: C-R equations, Milne-Thomson method.
- Bilinear transformations and cross-ratios.
- Introduction to statistics.
- Lagrange multiplier method for 2 and 3 variables with no more than two constraints.
- To introduce the basics of optimization using Kuhn-Tucker conditions.

Course outcomes:

- The student will be able to solve initial value ODE problems.
- The student will have a good understanding of real and complex analysis.
- The student will have a thorough grounding in matrix algebra.
- The student will be ready for any further courses on optimization.

Module	Contents	Contact Hours
01	The Laplace transform: Definition and properties (without proofs); all standard transform methods for elementary functions including hyperbolic functions; Heaviside unit step function, Dirac delta function; the error function; evaluation of integrals using Laplace transforms; inverse Laplace transforms using partial fractions and $H(t-a)$; convolution (no proof).	07
02	Matrices: Eigen values and eigenspaces of 2×2 and 3×3 matrices; existence of a basis and finding the dimension of the eigen space (no proofs); non-diagonalisable matrices; minimal polynomial; Cayley - Hamilton theorem (no proof); quadratic forms; orthogonal and congruent reduction of a quadratic form in 2 or 3 variables; rank, index, signature; definite and indefinite forms.	07
03	Complex analysis: Cauchy-Riemann equations (only in Cartesian co-ordinates) for an analytic function (no proof); harmonic function; Laplace's equation; harmonic conjugates and orthogonal trajectories (Cartesian co-ordinates); to find $f(z)$ when $u+v$ or $u -$	07

	v are given; Milne-Thomson method; cross-ratio (no proofs); conformal mappings; images of straight lines and circles.	
04	Complex Integration Cauchy's integral formula; poles and residues; Cauchy's residue theorem; applications to evaluate real integrals of trigonometric functions; integrals in the upper half plane; the argument principle.	06
05	Statistics: (No theory questions expected in this module) Mean, median, variance, standard deviation; binomial, Poisson and normal distributions; correlation and regression between 2 variables.	05
06	Optimization (No theory). Non-linear programming: Lagrange multiplier method for 2 or 3 variables with at most 2 constraints; conditions on the Hessian matrix (no proof); Kuhn-Tucker conditions with at most 2 constraints.	07

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Mathematical Methods in Chemical Engineering, V.G. Jenson and G.V. Jeffreys, Academic Press, 1970
2. Laplace transforms, Murray Spiegel, Schaum's Outline Series, 1974
3. Complex variables, Murray Spiegel, Schaum's Outline Series, 1964
4. Linear Algebra, Murray Spiegel, Schaum's Outline Series, 1964
5. Probability and Statistics: Murray R. Spiegel, Schaum's Outline Series, 1965
6. Advanced Engineering Mathematics by *Erwin Kreyszig*, 9TH Edition, Wiley India.

Course Code	Course/Subject Name	Credits
BTC302	Microbiology	4

Prerequisites:

Basic Knowledge of Living Cells

Course Objectives:

- The course aims to develop skills of the Students in the area of Microbiology particularly to identify microbes, their structure, their metabolism and their industrial applications.
- They will study various sterilization techniques and their effects.
- This will be a prerequisite for all courses offered in Bioprocess Technology

Course outcomes:

- Students will be able to carry out various microbiological techniques like staining and isolation very well.
- They would be able to identify microbes.
- They would have detailed knowledge of various sterilization techniques, which would be useful for other courses.

Module	Contents	Contact Hours.
1	<p>History and Scope of Industrial Microbiology:</p> <ul style="list-style-type: none"> • Introduction: Discovery of Microbial world • The experiments of Pasteur; The discovery of Anaerobic Life • Physiological significance of Fermentation; Pasteur and Fermentation • The Era of discovery of Antibiotics; Growth of Industrial fermentation 	03
2	<p>Classification of Microorganisms:</p> <ul style="list-style-type: none"> • Types and general characteristics of microorganisms: <ol style="list-style-type: none"> 1) Bacteria- Archaeobacteria, Actinomycetes, Rickettsia, Mycoplasma, Chlamydia 2) Fungi – Molds and yeasts 3) Algae 4) Protozoa 5) Viruses • The classification of bacteria Species: The unit of classification, New approaches to bacterial taxonomy, Bacterial taxonomy the problems of taxonomic arrangements, Bacterial phylogeny. • Aerobic and Anaerobic cultures <p>Microbial Pathogenesis:</p> <ul style="list-style-type: none"> • Epidemiology of infectious diseases, Bacterial, Fungal, Protozoal, Viral Diseases; • Bacterial invasion and colonization • Bacterial toxins- types and mode of action 	08

3	Microbial Nutrition: <ul style="list-style-type: none"> • Nutritional requirements of microorganisms • Different types of media- Synthetic media, complex media Selective media, differential media, enrichment media. 	05
4	Microbial Growth: <ul style="list-style-type: none"> • Introduction: phases of growth • Growth curve • Kinetics of growth • Measurement of growth • Continuous & batch culture • Synchrony • Chemostat & turbidostat • Effects of solutes, temperature, ion concentration, oxygen, hydrostatic pressure, heavy metal ions, and UV light on microbial growth 	05
5	Microbiological Techniques: <ul style="list-style-type: none"> • Sterilization and disinfection techniques, • Principles and methods of sterilization. • Physical methods - autoclave, hot-air oven, pressure cooker, laminar airflow, filter sterilization. • Radiation methods – UV rays, gamma rays, ultrasonic methods. • Chemical methods - Use of alcohols, aldehydes, fumigants, phenols, halogens and hypochlorites. Phenol coefficient. • Isolation of pure culture techniques - Enrichment culturing, dilution plating, streak- plate, spread-plate and micromanipulator. • Preservation of microbial cultures - sub culturing, overlaying cultures with mineral oils, lyophilization, sand cultures, storage at low temperature. 	09
6	Antimicrobial Therapy: <ul style="list-style-type: none"> • Antimicrobial sensitivity tests. • Agents used in treating infection: Antibacterial, antiviral, antiretroviral, antifungal, anti-protozoan & anti helminthes. • Resistance mechanism. 	07
7	Water & Soil Microbiology: <ul style="list-style-type: none"> • Microbiological analysis of water purity-sanitary tests for coliforms (presumptive test, confirmed test, competed test), MPN test, defined substrate test, IMVIC test. • Soil microbiology- soil as a habitat for microorganisms, physico-chemical properties of soil, microbial community in soil, role of microorganisms in organic matter decomposition. 	07

**Assessment
Internal:**

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Textbook of Microbiology ;R. Ananthnarayan, C. K. J. Panicker, Orient Longman 6th Edition (2003)
2. General Microbiology, R.Y. Stanier, J.L. Ingraham, M.L.Wheelis and P.R. Painter, Macmillian
3. Microbiology VI Edition, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill Microbiology by Prescott
4. Microbiology: An Introduction (9th Ed.) by Tortora GJ, Funke BR, and Case CL, Pearson Education, 2008.
5. Industrial Microbiology, Casida, New Age International
6. Industrial Microbiology, Prescott and Dunn, C.B.S. Publishers Principles of Microbiology, R.M. Atlas, WMC. Brown Publisher.
7. Microbiology – Fundamentals and Application, 6th Ed. – Purohit, S.S. (Agrobios)
8. Textbook of Microbiology, P.Charkborthy
9. General Microbiology Vol. II by Powar and Daginawala Himalaya Publ. House 8th edition (2004)

Course Code	Course/Subject Name	Credits
BTC303	Cell Biology	4

Prerequisites:

- Knowledge of basic terminology of cell and cell organelles
- Knowledge of structure and function of prokaryotic and eukaryotic cell
- Knowledge of different compartments of cell organelle.
- Knowledge of cell division
- Basic knowledge of cell events like photosynthesis, respiration

Course Objectives:

- In this course, Students will explore the great diversity of all cellular form and function.
- Course emphasis is placed on the molecular mechanisms of cell metabolism, growth, division, and communication.
- This course is central to the cell biology and serves as the bridge between foundational courses in the cell and advanced courses in the complexity of sorting in the cell.

Course Outcome:

- By the end of the course students should be able to grasp the fundamentals in Understanding the molecular organization of the cells, function and structure of The different organelles including transport mechanisms for processes like; Protein sorting, cell communication and flow of information and transport across the unit membrane, cell signaling.
- Students will have good knowledge of cancer, its types and etiology. Students will be able to appreciate all basic concepts which he may encounter in future courses in biotechnology engineering.
- Students will be ready for application of these concepts in the field of research in biotechnology.

Module	Contents	Contact Hours
1	<p>Cytology:</p> <ul style="list-style-type: none"> • Developmental history of cytology: Origin of cell, Robert Hooke's Experiment, Cell theory, Miller's Experiment • Properties & Types of cells: Prokaryotic & Eukaryotic cell • Structure and function of cells such as Viruses, Bacteria, Animal cells, Plant cells. 	05
2	<p>Cell cycle & cell death:</p> <ul style="list-style-type: none"> • Cell cycle and its regulation: Cyclins, CDKs, Checkpoints • Cell division: Mitosis & Meiosis • Programmed cell death: Apoptosis, Extrinsic & Intrinsic pathway • Apoptosis vs. Necrosis 	05
3	<p>Structural organization of cell and role of cell organelles in sorting and intracellular transport:</p>	08

	<ul style="list-style-type: none"> • Cell membrane: Function, Composition, Membrane proteins, Fluid Mosaic model, Electrical properties of membrane, Neurotransmission • Nucleus: Nuclear Envelop, Nuclear Pore Complex & its role in nucleocytoplasmic exchange • Overview of endomembrane system: secretory and endocytic pathway • Endoplasmic Reticulum: SER & RER, Protein synthesis on membrane bound and free ribosomes, Protein Glycosylation in ER & Golgi complex, Membrane biosynthesis in the ER • Golgi bodies: Movement of materials through the Golgi complex • Structure & function of Cell wall, Mitochondria, Lysosomes • Structure and function of cytoskeleton: <ul style="list-style-type: none"> (i) Microtubules – Structure & composition, MAPs, MTOCs, Dynamic properties of microtubules, Overview of motor proteins. (ii) Microfilaments – Structure, Assembly & disassembly. (iii) Intermediate filaments – Structure, Assembly & disassembly, Types and functions. 	
4	<p>Transport across cell:</p> <ul style="list-style-type: none"> • Bulk transport: Exocytosis, Phagocytosis, Endocytosis – Pinocytosis & Receptor mediated endocytosis • Mechanism of transport of substances through membrane: <ul style="list-style-type: none"> (i) Active Transport – Ion pumps (ii) Passive Transport – Diffusion, Osmosis, Facilitated diffusion, Ion channels 	05
5	<p>Cellular communication:</p> <ul style="list-style-type: none"> • General principles of cell communication: Types of adhesion, CAMs • Extracellular matrix: Components – Collagen, Proteoglycans, Fibronectin, Laminin • Interactions of cells with extracellular materials: Integrins, Focal Adhesions & Hemidesmosomes • Interactions of cells with other cells: Selectins, IgSF, Cadherins, Adherens junction, Desmosomes • Tight junctions • Gap junctions and plasmodesmata 	07
6	<p>Cell Signaling:</p> <ul style="list-style-type: none"> • Types of intercellular signaling: Auto, Para & Endocrine • Overview of cellular signaling pathway • Various extracellular messengers and their receptors • Signal transduction by RTKs: Receptor dimerization, Protein kinase activation, Activation of downstream signaling pathways, Ending the response. Signaling by Insulin receptor 	05

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Cell and Molecular biology: Concepts and Experiments, Gerald Karp, John Wiley and sons Inc, 6th Edition (2010)
2. Molecular Cell Biology, H. Lodish et. al., W.H. Freeman & Co Ltd, 5th Edition (2003)
3. Cell and Molecular Biology, DeRobertis; Lippincott Williams & Wilkins 8th Edition (2001)
4. Molecular Biology of the Cell and the Hypercell with CDROM; Alberts, Bray; Garland Publishing 1st Edition (1999)
5. Molecular Biology of the Cell with CDROM Alberts, Bruce; Johnson, Alexander; Lewis, Julian 4th Edition (2005).

Course Code	Course/Subject Name	Credits
BTC304	Biochemistry	4

Prerequisites:

- Knowledge of organic chemistry: functional groups and their reactions
- Knowledge of living cell and its components

Course Objectives:

- The major objective is to provide complete understanding of all the chemical processes associated with living cells at the molecular level.
- To ensure students have a strong grounding in structures and reactions of biomolecules.
- To introduce them to the metabolic pathways of the major biomolecules.
- To correlate biochemical processes with biotechnological applications.

Course outcomes:

- The students will be able to understand and analyze the correlation between biomolecules, their associated pathways and various biological processes underlying the living systems.

Module	Contents	Contact Hours
1	<ul style="list-style-type: none"> • Introduction, aims and scope • Chemical foundations of Biology- Properties of water, acids, bases and buffers, covalent bonds, Non-covalent interactions in biological systems. 	05
2	<p>Biomolecules: Classification, Structure and Functions of :</p> <ul style="list-style-type: none"> • Carbohydrates: • Lipids • Proteins • Nucleic acids 	10
3	<p>Enzymes:</p> <ul style="list-style-type: none"> • Working of Enzymes • Concept of Activation energy and transition state • Factors affecting enzyme activity- pH, Temperature, Substrate & Enzyme Concentration 	05
4	<p>Vitamins and Hormones:</p> <ul style="list-style-type: none"> • Vitamins: Classification, functions, role in metabolism, vitamins as cofactors. • Hormones: Classification, endocrine glands, function and mechanism of action of hormones. 	05
5	<p>Metabolism:</p> <ul style="list-style-type: none"> • Carbohydrates- Glycolysis, TCA cycle • Lipids- Digestion by GI enzymes and breakdown of Triglycerides: α, β, ω oxidation of fatty acids 	15

	<ul style="list-style-type: none"> • Amino acids- decarboxylation, deamination & transamination. Urea cycle; fate of amino acids (connection to TCA) • Electron Transport Chain • Photophosphorylation- Photosystems, reaction centers, pigments, cyclic and non-cyclic photophosphorylation, Z pathway 	
6	Bioenergetics: <ul style="list-style-type: none"> • Laws of Thermodynamics • Concept of Enthalpy, Entropy • Energy rich compounds – ATP as energy currency 	05

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Nelson, D.L. and M.M. Cox, "Lehninger's Principles of Biochemistry", 4th Edition, W.H. Freeman & Co., 2005.
2. Murray, R.K., et al "Harper's Biochemistry", 23rd Edition, Prentice Hall International, 1993
3. Lubert Stryer. 2007. Principles of Biochemistry. Freeman.
4. Voet and Voet. 2005. Biochemistry. Wiley.
5. D. Skoog, D. West, F.Holler, S. Crouch "Fundamentals of Analytical Chemistry" 8th Edition, 2004. Thomson Brooks/ Cole
6. David T. Plummer, An Introduction to practical biochemistry, Tata McGraw Publishing Company Ltd.

Course Code	Course/Subject Name	Credits
BTC305	Unit Operations – I	3

Prerequisites:

Basic knowledge in physics, units and dimensions and thermodynamics

Course Objectives:

- To impart the basic concepts of fluid statics and dynamics
- To study the basic equations of fluid flow.
- They should be comfortable with measurement of pressure or pressure drop.
- To enable students to determine viscosity using method such as Stokes Law.
- To study the different types of size reduction equipment used in Industries.
- To study about the metering and pumping of fluids.

Course Outcomes:

- The student will have a thorough grounding on measurement of pressure drop, velocity, flow rates etc. of fluids.
- They can select pumps and would be able to calculate power requirement for pumping as well as agitation operations.
- They will be able to operate certain flow measurement devices and size reduction equipment.

Module	Content	Contact Hours
1	Introduction: Classification of fluids, Rheological behavior of fluids & Newton's Law of viscosity. Effect of temperature & pressure on viscosity of fluids. Fluid statics: Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement (problems)	05
2	Fluid Dynamics: Continuity Equation, Equation of motion, Euler's equation of motion, Bernoulli's equation (problems), Bernoulli's equation for compressible fluids (isothermal and adiabatic process) concept of Reynold's number, Laminar flow in pipes, Turbulent flow in pipes, velocity and shear stress distribution across pipe, Boundary layer formation and separation of boundary layer.	07
3	Flow of Incompressible fluids: Relationship between skin friction and wall shear, Fanning friction factor, friction factor law for smooth pipes, Form friction, effect of roughness, energy relationships, pipe fittings, major and minor losses in pipe flow. (problems) Flow measurements: Venturimeter, Orificemeter, Pitot tube, Rotameter. (problems) Pumping: Reciprocating pumps, Rotary pumps, centrifugal pumps (Characteristics, NPSH, and Cavitation) and blowers.	08
4	Particle Size distribution: Importance of particle size in reactions, particle size, shape and mass distributions,	07

	<p>measurement and analysis, concept of average diameter. (problems)</p> <p>Screening: Screening equipment, capacity and effectiveness of screen, effect of mesh size on capacity of screen. Particle size analysis – mean diameter, derived diameter. Sieving - cumulative method and differential method.</p> <p>Transportation and storage of solids: Studies performance and operation of different conveyor systems like Belt, Screw, Apron, Flight, pneumatic conveyor and elevators; Storage of solids and discharge pattern from storage bin.</p>	
5	<p>Size Reduction: Factors affecting size reduction, comminution laws – Kick’s law, Rittinger’s law and Bond’s law and their limitations. Crushing efficiency & power consumption (problems)</p> <p>Size reduction equipment: Grinder – Construction and operation of Hammer mill, Ball mill (problems), Ultrafine grinder – Fluid energy mill, Cutting machines: knife cutters.</p>	04
6	<p>Sedimentation: Free settling and Hindered settling, Stoke’s law & Newton’s law regimes of settling. Clarifiers and thickeners, flocculation, batch Sedimentation (Kynch theory), rate of sedimentation.</p>	04

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Text books

1. Dr. R. K. Bansal, “A Textbook of Fluid Mechanics & Hydraulic Machines”, Laxmi Publications, 9th Edition, 2010.
2. R. S. Hiremath & A. Kulkarni. Mechanical Operations Vol. I.
3. McCabe, W.L, Smith J.C and Harriot, P., “Unit Operations in Chemical Engineering”, McGraw Hill, Fourth Edition, 1984.
4. Narayanan C.M. & Bhattacharya B.C. “Mechanical operations for chemical engineers”, Khanna.

References

1. Coulson, J.M., Richardson, J.F., “Chemical Engineering”, Volume 2, Third Edition, Pergamon Press, 1977.
2. Badger and Bencharo, “Introduction to Chemical Engineering”. TMH,
3. Fluid Mechanics and Hydraulics by Suresh Ukarande, Ane Books, 2012.

Course Code	Course/Subject Name	Credits
BTC306	Process Calculations	4

Prerequisites:

- Linear Algebra
- Differential Equation

Course Objectives:

- To study the laws regarding gas, liquid and vapor
- To develop understanding about material balance and energy balances
- To study the stoichiometry and thermodynamics of microbial growth and product formation

Course outcomes:

- The student will be able to understand basic application of various unit operations & unit processes to industrial & theoretical problems
- They will have a clear understanding of the various systems of units will be able to do the conversion of units of one system to another.
- They will be able to do basic calculations for biological systems & access the property data from appropriate sources.

Module	Content	Contact Hours
1	Units and dimensions: Systems of units, fundamental and derived units, unit conversions, dimensional homogeneity and dimensional analysis problems. Conversion of units Chemical arithmetic: Mole concept, atomic weight, molecular weight and equivalent weight- methods of determination. Chemical composition: Methods of expressing compositions of mixtures and solutions- mole percent, mass percent, volume percent, molarity, molality, normality etc. P-V-T behavior of pure liquids- Gas laws, real and ideal gases, equation of state, critical properties, properties of gas mixtures- Dalton's laws, Amagat's law-Average molecular weight and density problems. Biochemical stoichiometry: Limiting and excess reactants-conversion, degree of completion, selectivity, yield problems.	07
2	Fundamentals of material balances- Law of conservation of mass- Types of material balances, material balance with recycle bypass and purge streams	07
3	Material Balance for process involving chemical reaction, Calculations using Psychrometric chart; Humidity and saturation	07
4	Fundamentals of energy balances, Law of conservation of energy, Heat capacity, sensible heat, latent heat, calculation of enthalpy changes. General energy balance equation; Energy balance calculations with and without reactions, Energy	07

	balance for fermentation and downstream processing problems.	
5	Stoichiometry of microbial growth and product formation, Growth, Stoichiometry and elemental balances, respiratory quotient, degree of reduction, Yield and maintenance coefficients, Oxygen consumption in aerobic microbial cultures. Theoretical Oxygen demand- problems. Biochemical energetics: Metabolic reaction coupling, energetics of metabolic processes (respiration and biosynthesis). Transport across cell membranes, Thermodynamics of microbial growth, Heat generation in microbial cultures problems.	07

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. David M. Himmelblau. 1989. Basic Principles and Calculations in Chemical Engineering. Prentice Hall of India (P) Ltd.
2. Hogen, K. M. Watson and R. A. Ragatz. 1970. Chemical Process Principles, Part - I, John Wiley and Asia Publishing Co.
3. Bhat B.I and S. M. Vora, 2005. Stoichiometry. Tata McGraw Hill.
4. Richard Felder and Ronald W. Rausseau. 1986. Elementary Principles of Chemical Processes. John Wiley & Sons.
5. Doran P.M, Bioprocess Engineering Principles, Academic Press
6. Bailey G.E and Ollis D.F, Bioprocess Engineering Fundamentals McGraw Hill
7. Shuler M.L and Kargi F, Bioprocess Engineering- Basic Concepts, Pearson Education
8. Segel I.H, Biochemical Calculations, John Wiley
9. Blanch H.W and Clark D.S, Biochemical Engineering Marcel Dekker Inc.

Course Code	Course/Subject Name	Credits
BTL301	Microbiology Lab	1.5

List of Experiments Suggested:

- Study of different equipments- Bunsen burner, water bath, Autoclave, Laminar air flow, Incubator, Hot air oven, Centrifuge, and Refrigerator.
- Study of Microscope- Compound Microscope & its parts. Use of oil Immersion objective.
- Preparation of medium -nutrients broth, nutrient agar, agar slant.
- Staining: Simple, Differential staining methods, Capsule, Endospore; Study of shape and arrangement of bacterial cells
- Isolation of microorganism by Pure Culture Techniques.
- Effect of disinfectants on microbial flora
- Isolation and identification of microorganisms from different sources – soil, water and milk
- Antibiotic sensitivity assay
- Effect of different parameters on bacterial growth (pH, temperature & UV irradiation)
- Culture of aerobic & anaerobic bacteria
- Effect of TDP & TDT on bacterial growth
- Filter paper disc methods for evaluation of antiseptics
- Study of growth curve of *E. coli*
- Bacterial colony counting using Haemocytometer

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL302	Biochemistry Lab	1.5

List of Experiments Suggested:

- Preparations of solutions –molar, normal, ppm, percent
- Study of pH meter and preparation of buffers
- Study of Beer and Lambert’s Law and absorption maxima
- Glucose estimation by DNSA method
- Protein estimation by Biurette Test
- DNA estimation by DPA method
- RNA estimation by Orcinol method
- Estimation of Vitamin C by Iodometry
- Extraction and separation of plant pigment by paper chromatography
- TLC of Fatty acids
- Study of Enzyme Activity
- Estimation of Lipids

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL303	Unit Operations - I Lab	1.0

List of Experiments Suggested:

- Viscosity by Stoke's Law
- Venturimeter
- Orificemeter
- Flow through Helical coil
- Reynold's Apparatus.
- Bernoulli's apparatus
- Sieve analysis
- Screen effectiveness
- Major and Minor losses
- Ball mill
- Hammer mill
- Sedimentation
- Centrifugal pumps

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
S.E. Semester IV (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC401	Applied Mathematics-IV	3	-	1	3	-	1	4
BTC402	Molecular Genetics	3	-	1	3	-	1	4
BTC403	Fermentation Technology	4	-	-	4	-	-	4
BTC404	Analytical Methods in Biotechnology	4	-	-	4	-	-	4
BTC405	Immunology and Immunotechnology	3	-	1	3	-	1	4
BTC406	Unit Operations-II	3	-	-	3	-	-	3
BTL401	Fermentation Technology Lab	-	3	-	-	1.5	-	1.5
BTL402	Analytical Methods in Biotechnology Lab	-	3	-	-	1.5	-	1.5
BTL403	Unit Operations-II Lab	-	2	-	-	1	-	1
	Total	20	8	3	20	4	3	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC401	Applied Mathematics-IV	20	20	20	80	3	25	-	-	125
BTC402	Molecular Genetics	20	20	20	80	3	25	-	-	125
BTC403	Fermentation Technology	20	20	20	80	3	-	-	-	100
BTC404	Analytical Methods in Biotechnology	20	20	20	80	3	-	-	-	100
BTC405	Immunology and Immunotechnology	20	20	20	80	3	25	-	-	125
BTC406	Unit Operations-II	20	20	20	80	3	--	-	-	100
BTL401	Fermentation Technology Lab	-	-	-	-	3	--	25	-	25
BTL402	Analytical Methods in Biotechnology Lab	-	-	-	-	3	--	25	-	25
BTL403	Unit Operations-II Lab	-	-	-	-	-	--	-	25	25
	Total			120	480	-	75	50	25	750

Course Code	Course/Subject Name	Credits
BTC401	Applied Mathematics IV	4

Prerequisites:

- **Vector Calculus:-** Multiple Integral, Partial differentiation, basic knowledge of vectors and their products, Knowledge of spherical and cylindrical coordinate system.
- **Partial Differential Equation:-** Integration, Knowledge of partial derivatives.

Course Objectives:

- The syllabus/module aims to introduce the above topics (to the Learner) so as to equip the learner with mathematic tools to effectively model, analyze and find the solution of various problems in Chemical Engineering and Biotechnology processes.
- One can use vector formation and calculus together to describe and solve many problems in two/three dimension. The Fourier Transform and PDE module does the ground work for the techniques required to solve and find the answer for various physiochemical problems.

Course Outcomes:

- It is expected that the learner will develop the proactive approach towards the selection of methods to a solution of Chemical Engineering and Biotechnology problems coming across while studying higher level of the Course. (Example: Flow of Liquid through Pipes/Gases etc.)

Module	Contents	Contact Hours
01	Fourier Series Expansion of functions in any interval (a, b). Half range expansion; Complex form; Parseval's identity theorem; Orthogonal and Orthonormal functions. NO PROOFS REQUIRED.	09
02	Fourier Integrals and Fourier Transform; sine & cosine Integrals, sine & cosine transforms, complex transforms. NO PROOFS REQUIRED.	10
03	Partial Differential Equations Elliptic, Parabolic & Hyperbolic Equations; Laplace's equation; One dimensional Heat & Wave Equation, Two Dimensional wave equation. (ONLY NUMERICAL PROBLEMS. NO PROOFS REQUIRED).	10
04	Vector Integration Green's Theorem in the plain; Conservative & Solenoidal Fields. Green's Theorem in the plain; Conservative, Gauss Divergence Theorem, Stokes' Theorem. (ONLY NUMERICAL PROBLEMS. NO PROOFS REQUIRED).	10

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Advanced Engineering Mathematics by *Erwin Kreyszig*, 9TH Edition, Wiley India.
2. Schuam's outline series in Fourier series.
3. Schuam's outline series in partial differential equations.
4. Partial differential equations Vol 1 by Rutherford Aris.

Course Code	Course/Subject Name	Credits
BTC402	Molecular Genetics	4

Prerequisites:

- Knowledge of Cell and its components
- Knowledge of Biomolecules and their functions
- Knowledge of Cellular Metabolism

Course Objective:

- Understand the Central Dogma of gene expression
- Explain the foundations of Mendelian genetics and chromosomal theory and apply these, with appropriate terminology, to contemporary concepts in genetics.
- Understand the redundant and universal qualities of the genetic code and how it is used to determine the amino acid sequence of a polypeptide.
- Describe the processes of transcription and translation in both prokaryotes and eukaryotes at the molecular level.
- Describe how prokaryotes control their gene expression through positive and negative regulatory mechanisms.

Course outcome:

- Students will get knowledge of molecular biology and genetics of Prokaryotic and eukaryotic organisms.
- Students will get insight on Replication, Transcription and translation processes in prokaryotes and eukaryotes, various mutations, their Repair mechanisms. Genetic syndromes.

Module	Contents	Contact Hours
01	Structure of Nucleic Acid: <ul style="list-style-type: none"> • DNA, RNA: mRNA, tRNA, rRNA, • Denaturation and Renaturation of DNA, • T_m, GC content from T_m, • Complexity of DNA, Cot curves • Satellite DNA: Repetitive DNA, SNP, STR 	04
02	Mendelism and its extensions <ul style="list-style-type: none"> • Mendel's Laws, problems based on his laws • Linkage and Crossing Over • Multiple allelism • ABO blood group inheritance 	06
03	Cytogenetics <ul style="list-style-type: none"> • International System for Human Chromosome Nomenclature • Mechanisms of numerical and structural chromosomal aberrations • Chromosomal and non-chromosomal basis of sex determination • Syndromes – Down's, Turner, Cri Du Chat, Klinefelter • Transposons • Fluorescence in-situ hybridization technique and applications 	04

04	DNA Replication and Repair: <ul style="list-style-type: none"> • Prokaryotic and Eukaryotic DNA replication mechanism - Enzymes and accessory proteins involved in DNA replication , • DNA Mutations: Types of Mutations and Mutagens • DNA Repair Mechanism – Excision, recombinational, SOS, Photo reactivation, Mis-match repair 	06
05	Transcription <ul style="list-style-type: none"> • Relationship between Genes and Proteins • Prokaryotic transcription • Eukaryotic transcription: Eukaryotic RNA Polymerases, Transcription of protein coding genes, Production of mature mRNAs in Eukaryotes- 5' Modification , 3' Modification , Intron splicing, RNA Editing 	05
06	Translation <ul style="list-style-type: none"> • The nature of Genetic Code • Synthesis of aminoacyl-tRNA, Ribosomal RNA genes • Mechanism of initiation, elongation and termination of • Translation in bacteria • Co-and post-translational modifications of proteins 	05
07	Regulation of gene expression <ul style="list-style-type: none"> • Operon theory • lac Operon: Structure, Regulation of Lac genes, Positive control of Lac Operon • trp Operon: Gene organization of the tryptophan biosynthetic genes, Regulation of the trp operon, attenuation • ara operon: structure and regulation of ara operon 	05

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Molecular Biology; David Freifelder, Narosa Publishing House, 2nd edition (2004).
2. Microbial Genetics; David Freifelder, Narosa Publishing House, 2nd edition (2004).
3. Principles of Gene Manipulations; S. B. Primrose, R. M. Twyman, R. W. Old, Blackwell Science, 6th Edition (2003)
4. Genetics: A molecular Approach, 2nd edition; Peter J Russell
5. Gene VIII; Benjamin Lewin; Oxford Univ. Press, 8th edition (2004)
6. Cell and Molecular biology: Concepts and Experiments, Gerald Karp, John Wiley and sons Inc, 6th Edition (2010)

Course Code	Course/Subject Name	Credits
BTC403	Fermentation Technology	4

Prerequisites:

- Knowledge of microbiology

Course Objectives: To gain broad knowledge on

- Role of microorganisms in fermentation
- The various fermentation technologies used
- Production of important products through fermentation

Course Outcomes:

- Appreciate the use of microorganisms for the production of value added commodities.
- Understand the working of a fermentation system.
- To describe key industrial bioprocesses, from the traditional to the recently evolved.
- Integrate biological and engineering principles involved in the production and recovery of commercial products.
- Develop critical thinking skills and learn to employ a quantitative, scientific approach towards conversion of biological materials to value added products.

Module	Contents	Contact Hours
01	Introduction to fermentation History and development of fermentation, general requirements of the fermentation, range of fermentation processes, parts of a fermentation process- upstream and downstream processing, aerobic and anaerobic fermentation, solid state and submerged fermentation.	04
02	Introduction to Microbial Growth Kinetics Batch culture (Quantifying cell concentration, Growth patterns and Kinetics), Continuous culture, Comparison of batch and continuous cultures in industrial processes, Fed batch culture, Examples of use of fed batch cultures.	05
03	Isolation, preservation and improvement of industrial microorganisms <ul style="list-style-type: none"> • Isolation methods utilizing selection of the desired characteristics • Isolation methods not utilizing selection of the desired characteristics • The preservation of industrially important microorganisms • Improvement of industrial microorganisms 	07
	<ul style="list-style-type: none"> • The selection of induced mutants synthesizing improved levels of products • The use of rDNA techniques 	
04	Regulatory Mechanisms controlling the catabolic and	03

	anabolic pathways of microbes Induction, carbon catabolite repression, crab tree effect, feedback inhibition and repression	
05	Media for industrial fermentations & sterilization Introduction, Typical media, Energy sources, Carbon sources, Nitrogen sources, Buffers, Oxygen requirements, Antifoams, Medium optimization, Medium sterilization: The design of batch sterilization processes, The design of continuous sterilization processes, Sterilization of the fermenter, feeds and air, Filter sterilization	06
06	The development of inocula for industrial fermentations The development of inocula for yeast , bacterial and fungal processes, The aseptic inoculation of plant fermenters	04
07	Aeration and agitation The oxygen requirements and supply of industrial fermentations, Determination of KLa, Factors affecting KLa values, The balance between oxygen supply and demand	04
08	Design of fermenter Basic function of a fermenter for microbial or animal cell culture, body construction, various parts of a fermenter	04
09	Important products through Fermentation Organic acids: citric and acetic acid; enzymes : amylase, protease, lipase; antibiotics: penicillin; vitamins: vitB12; aminoacids: lysine, Glutamic acid ; organic solvents: ethanol, acetone butanol; alcoholic beverages: wine, beer; biomass : bakers yeast; biofertilizers; biopesticides; biosurfactant; steroid transformation; biopolymers	08

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Principles of Fermentation Technology – Stanbury P.F., Whitaker A, Hall S. J.
2. Bioprocess Engineering: Basic concepts – Shuler M.L., Kargi F. (PHI)
3. Bioprocess Engineering Principles – Doran Pauline M. (Elsevier Pub.)
4. Biotechnology: A textbook of Industrial Microbiology- Cruger, W. and A. Cruger
5. Introduction to Biochemical Engineering - DG Rao, 2005, Tata McGraw-Hill, New Delhi

Course Code	Course/Subject Name	Credits
BTC404	Analytical Methods In Biotechnology	4

Pre-requisites:

- Basic knowledge of Physical and Analytical Chemistry
- Knowledge of various types of spectra
- Knowledge of Biomolecules and their properties

Course Objective:

- To study the various analytical techniques used in Biotechnology.

Course outcomes:

- The students will be capable of handling different instruments in the laboratory.
- They would be able to compare different separation techniques and use them effectively in research work

Module	Contents	Contact Hours
01	<p>Centrifugation:</p> <ul style="list-style-type: none"> <input type="checkbox"/> General principle- sedimentation velocity, sedimentation equilibrium <input type="checkbox"/> Types of centrifuges, preparative and analytical centrifugation, differential centrifugation, density gradient methods <input type="checkbox"/> Applications 	08
02	<p>Chromatographic Techniques:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Introduction to chromatography, General principles <input type="checkbox"/> Planar Chromatography: Thin layer chromatography, paper chromatography <input type="checkbox"/> Column chromatography–columns, stationary phases. Packing of columns, application of sample, column development, fraction collection and analysis. <input type="checkbox"/> Partition chromatography, Adsorption chromatography Affinity Chromatography, Ion Exchange Chromatography, Chromato focussing, Size exclusion chromatography. <input type="checkbox"/> Gas Chromatography, HPLC: Principle & Components: pumping systems, detectors systems <input type="checkbox"/> Applications 	12
03	<p>Electro kinetic methods of separation:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Electrophoresis: General principle and application, factors affecting electrophoresis – voltage, current, resistance, buffer, composition, concentration, pH. <input type="checkbox"/> Agarose Gel electrophoresis <input type="checkbox"/> SDS-PAGE – Native and denaturing gels, gradient gels, discontinuous buffer system <input type="checkbox"/> Two dimensional gel electrophoresis <input type="checkbox"/> Isoelectric focusing <input type="checkbox"/> Capillary electrophoresis 	09

	<input type="checkbox"/> Immuno electrophoresis	
04	Spectroscopy: <input type="checkbox"/> Spectroscopic Techniques; Beers Lamberts law, molar and extinction coefficient, limitations of Beers Lamberts law <input type="checkbox"/> Visible and UV Spectrophotometry; Principles, Instrumentation and applications	08
05	Radio isotopic techniques: <input type="checkbox"/> Use of radioisotopes in life sciences, radioactive labelling, principle and application of tracer techniques <input type="checkbox"/> Detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger-Muller and Scintillation counters, Autoradiography <input type="checkbox"/> Applications	08

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Wilson K and Goulding K.H., A biologist's guide to Principles and Techniques of Practical Biochemistry.
2. Willard and Merrit, Instrumental Methods and Analysis
3. Ewing GW, Instrumental Methods of Chemical analysis.
4. Robert. M. Silverstein et al, Spectrometric identification of Organic Compounds, 7th Edition, 1981.
5. Vogel's, Text Book of Quantitative Chemical Analysis, 6th Edition, 2004.
6. John A. Adamovic, Chromatographic Analysis of Pharmaceuticals, 2nd Edition.
7. Raymond P. W. Scott, Techniques and Practice of Chromatography –Vol. 70.
8. Sethi P.D, Dilip Charegaonkar, Chromatography –2nd Edition.
9. Niessen W. M. A., Van Der Greef J, Liquid Chromatography– Mass Spectrometry, Vol. 58.
10. Kalsi. P.K, Spectroscopy of Organic Compounds.
11. Hanes, Gel Electrophoresis of Proteins- A Practical Approach,
12. Hamilton R. J. and Sewell P. A, Introduction to High Performance Liquid Chromatography
13. Gordon M. Message, Practical aspects of Gas Chromatography and Mass Spectrometry, John Wiley and Sons, New York. 1984
14. Chapman J.M and G. Ayrey, The use of radioactive isotopes in the life sciences, George Allen and Unwin Ltd., London.
15. Biophysical chemistry by Upadhyay, Upadhyay and Nath, Himalaya publication house.

Course Code	Course/Subject Name	Credits
BTC405	Immunology and Immunotechnology	4

Prerequisites:

- Knowledge of anatomy and physiology of human body
- Knowledge of blood components and blood cells
- Knowledge of lymphatic system
- Knowledge of principle of immune response and vaccine
- Knowledge of history and basic terminology in immunology

Objectives

- To learn about various basic terminology in immunology
- To have knowledge of immune system in detail
- To describe the interaction of antigens and antibodies in antibody mediated and cell-mediated immune responses.
- To make familiar with the techniques involved in antigen and antibody reactions
- To understand the concepts and principle of immunoassay techniques in routine diagnosis, research
- To learn principle and types of vaccines

Outcomes:

- Student can define innate and adaptive immunity
- Student can define the characteristics of antigens
- Student can define the characteristics of antibodies
- Student can describe cellular cooperation in antibody and cell mediated immune responses
- Student can define antigen antibody interaction
- Student can describe Production of Monoclonal Antibodies and Recombinant Vaccines.

Module	Contents	Contact Hours
01	Introduction to immune system	06
	<input type="checkbox"/> Innate and adaptive immunity	
	<input type="checkbox"/> Cells and organs of the immune system	
	<input type="checkbox"/> Primary and secondary immune responses;	
	<input type="checkbox"/> Cell mediated and humoral response	
02	Antigens & Antibodies	04
	<input type="checkbox"/> Antigens	
	<input type="checkbox"/> Antibodies and T cell receptors: Antigen, Structure and function of immunoglobulin,	
	<input type="checkbox"/> B and T cell receptors	
03	Generation and regulation of immune responses	08
	<input type="checkbox"/> Antigen processing and presentation	
	<input type="checkbox"/> MHC-restriction; Cytokines	
	<input type="checkbox"/> T Cell Maturation, activation and Differentiation B Cell	
	Generation, activation and differentiation	

	<input type="checkbox"/> Clonal selection and immunological memory	
	<input type="checkbox"/> Complement system, classical, alternative and MBL pathway	
	<input type="checkbox"/> Cell mediated cytotoxic responses	
	<input type="checkbox"/> Regulation of immune responses; Immunological tolerance	
04	Antigen-antibody Reactions	07
	<input type="checkbox"/> Strength of Antigen-Antibody Reactions	
	<input type="checkbox"/> In Vivo Antigen-Antibody Reactions, In Vitro Antigen-Antibody Reactions	
	<input type="checkbox"/> Precipitation (In Fluid and In Gel Immuno electrophoresis),	
	<input type="checkbox"/> Agglutination (Heamagglutination, Bacterial agglutination, Passive agglutination and Agglutination Inhibition).	
	<input type="checkbox"/> Radio immuno Assay (RIA)	
	<input type="checkbox"/> Enzyme Linked Immunosorbant Assay (ELISA),	
	<input type="checkbox"/> Western Blot	
	<input type="checkbox"/> • Immune Fluorescence	
	<input type="checkbox"/> Immunoprecipitation	
05	Disorders of Human Immune System	06
	Primary and secondary immunodeficiency; Autoimmune disorders; Hypersensitive reactions; Cytokine related diseases	
06	Production of Monoclonal Antibodies and Recombinant Vaccines.	05
	<input type="checkbox"/> Monoclonal antibody, polyclonal antibody. Production of	
	Monoclonal antibodies - Definition, production, applications.	
	<input type="checkbox"/> Vaccines - Definition, recombinant vector vaccines, DNA vaccines ,Multivalent subunit vaccines, minicell vaccines, conjugate vaccines	

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks

Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.

- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Essential Immunology: Ivan Roitt.
2. Kuby Immunology: Golds by, Kindt and Osborne.
3. Immunology: Roitt, Brostoff, Mole.
4. Introductory Immunology : Huw Davies

Course Code	Course/Subject Name	Credits
BTC406	Unit Operation - II	3

Pre-requisites:

- An understanding of differential equations and basic physical concepts, units and dimensions

Course Objectives:

- To study the basics of Heat and Mass Transfer
- To develop understanding about the application of Heat and Mass transfer in Bio processing.
- To calculate the size of heat transfer equipments, for a known quantity of raw material.
- To apply energy balance.
- To understand the role of diffusion, drying & distillation in the processes. To apply material balance.
- To design equipments in which heat & mass transfer occurs.

Course outcomes:

- The student will be able to understand basic application of various unit operations & unit processes to industrial & theoretical problems
- They will have a clear understanding of the theories of Heat and Mass transfer which are used for modeling.
- They will be able to do design the fermenter and Bioreactors using the models developed.

Module	Contents	Contact Hours
01	Introduction: Various modes of heat transfer Viz. Conduction, Convection and Radiation.	07
	Conduction: Fouriers law, Steady state unidirectional heat flow through single and multiple layer slabs, Cylinders and spheres for constant and variable thermal conductivity.	
	Insulation: Properties of insulation materials, Types of insulation, Critical and Optimum thickness of insulation	
	Extended Surfaces: Fins – Types of fins, Derivation of fin efficiency for longitudinal fins, Fin effectiveness. Elementary treatment of unsteady state heat conduction. Problems	
02	Convection: Individual and overall heat transfer coefficient, LMTD, LMTD correction factor.	08
	Dimensionless numbers, - Dimensional analysis, Empirical correlation for forced and natural convection.	
	Analogy between momentum and heat transfer – Reynolds, Coulburn and Prandtl analogies. Problems	
	Heat Transfer with Phase Change: Boiling phenomena, Nucleate and film boiling, Condensation – Film and Drop wise condensation, Nusselts equations.	
03	Radiation: Properties and definitions, Absorptivity, Reflectivity, Emissive power and intensity of radiation, Black body radiation,	08

	Gray body radiation,	
	Stefen – Boltzmann law, Wien’s displacement law, Kirchoffs law, View factors, Radiation between surfaces- different shapes, Radiation involving gases and vapours, Radiation shields.	
	Heat Transfer Equipment: Double pipe heat exchangers, Shell and tube heat exchangers – Types of shell and tube heat exchangers, Condenser – types of condensers. Design of heat exchanger.	
	Evaporators: Types of evaporators, performance of tubular evaporator – Evaporator capacity, Evaporator economy, Multiple effect evaporator	
04	Diffusion: Molecular diffusion in fluids, Diffusion coefficient, Flick’s Law of diffusion, Dependence of diffusion coefficient on temperature, pressure and composition, Diffusion in multi-component gas mixtures. Diffusion in solids: Molecular, Knudsen & surface diffusion Inter- phase mass transfer, Mass transfer coefficients ,Diffusion between phases , Equilibrium solubility of gases in liquids, Mass Transfer theories, Mass transfer in fluidized beds , flow past solids and boundary layers, Simultaneous heat and mass transfer.	07
05	Mass Transfer in Bioprocess Operations: Role of Diffusion in Bio processing, Oxygen Uptake in Cell Culture, Factors affecting cellular oxygen demand, oxygen transfer from gas bubble to cell, oxygen transfer in fermenters, sparging stirring and medium properties, anti foaming agents, temperature, gas pressure and oxygen partial pressure, presence of cells, measuring dissolved oxygen concentration, estimating oxygen solubility, effect of oxygen partial pressure, effect of temperature, effect of solutes, mass transfer correlations, measurement of kLa, oxygen balance method, dynamic method, sulphite oxidation method, oxygen transfer in large vessels.	05

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Robert E Treybal, Mass Transfer Operations, McGraw Hill Third Edition
2. Diffusion: Mass Transfer in Fluid System (Cambridge series in Chemical Engineering) by E.L.Cussler”

3. McCabe & Smith, Unit Operations in Chemical Engineering, 6th Edition, McGraw Hall, 2001.
4. Coulson and Richardson, Chemical Engineering Vol I, 4th Edition, Pergmon Press, 1998.
5. Press, 1998.
6. Badger & Banchero, Introduction to Chemical Engineering, TMH 6th Reprint, 1998.
7. Doran P.M, Bioprocess Engineering Principles, Academic Press
8. Bailey G.E and Ollis D.F, Bioprocess Engineering Fundamentals McGraw Hill
9. Shuler M.L and Kargi F, Bioprocess Engineering- Basic Concepts, Pearson Education
10. Blanch H.W and Clark D.S, Biochemical Engineering Marcel Dekker Inc.

Course Code	Course/Subject Name	Credits
BTL401	Fermentation Technology Lab	1.5

List of Experiments Suggested:

- Alcohol production by baker's yeast
- Isolation and preservation of microorganism of commercial importance
- Cell immobilization technique by immobilizing yeast cells in calcium alginate beads.
- Production of citric acid by A.niger
- Hydrolysis of sucrose by immobilized yeast cells
- Determination of cell mass by different methods (dry weight method, density method and haemocytometer method)
- Estimation of carbohydrates from fermentation media.
- Production of amylase
- Isolation of auxotrophic mutants of industrially important microorganisms
- Study of substrate utilization kinetics of the organism
- Study the set up of various types of bioreactors
- Introduction to fermentor.

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL402	Analytical Methods In Biotechnology Lab	1.5

List of Experiments Suggested:

- Chromatography of amino acids and sugars
- Agarose gel electrophoresis
- SDS-PAGE, Native PAGE
- Iso-electric Focussing
- Centrifugation
- Density gradient Centrifugation
- Affinity chromatography
- Ion exchange chromatography
- Gel filtration chromatography
- UV-Visible spectrophotometer
- Thin Layer Chromatography
- Paper Chromatography

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL403	Unit Operations - II Lab	1

List of Experiments Suggested:

- Plate type H.E
- Natural convection
- Forced convection
- Critical Heat flux
- Emissivity
- Heat transfer through composite wall
- Shell & Tube H.E
- k of insulating material
- Vapor-liquid equilibrium
- Diffusivity of a liquid
- Diffusion through porous solids
- Determination of Mass transfer coefficients in Gas Liquid system by evaporation
- Determination of Mass transfer coefficients in Liquid Liquid system.

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
T.E. Semester V (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
BTC501	Bioinformatics	4	-	-	4	-	-	4
BTC502	Genetic Engineering	4	-	-	4	-	-	4
BTC503	Thermodynamics and Biochemical Engineering	3	-	1	3	-	1	4
BTC504	Bioreactor Analysis and Technology	3	-	1	3	-	1	4
BTC505	Business Communication and Ethics	2	-	2	-	-	2	2
BTE501X	Elective I	3	-	1	3	-	1	4
BTL501	Bioinformatics Lab	-	2	-	-	1	-	1
BTL502	Genetic Engineering Lab	-	3	-	-	1.5	-	1.5
BTL503	Lab I	-	3	-	-	1.5	-	1.5
Total		17	12	3	17	6	3	26

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC501	Bioinformatics	20	20	20	80	3	-	-	100	
BTC502	Genetic Engineering	20	20	20	80	3	-	-	100	
BTC503	Thermodynamics and Biochemical Engineering	20	20	20	80	3	25	-	125	
BTC504	Bioreactor Analysis and Technology	20	20	20	80	3	25	-	125	
BTC505	Business Communication and Ethics	-	-	-	-	-	50	-	50	
BTE501X	Department Elective I	20	20	20	80	3	25	-	125	
BTL501	Bioinformatics Lab	-	-	-	-	2	-	25	25	
BTL502	Genetic Engineering Lab	-	-	-	-	3	-	25	25	
BTL503	Lab I	-	-	-	-	3	-	25	25	
Total				100	400	-	125	75	700	

Department Elective I (Sem V)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Biosensors and Diagnosis (BTE5011)	1. Biophysics (BTE5012) 2. Biostatistics (BTE5013)	1. Pharmaceutical Technology (BTE5014)

Course Code	Course/Subject Name	Credits
BTC501	Bioinformatics	4

Pre-requisites:

- Basic knowledge of computers, Biochemistry: Structures of DNA, RNA & Proteins.

Course Objectives:

- To develop skills of the Students in the area of Bioinformatics particularly to make them to learn all the techniques used with biological data.
- To study various databases of DNA & Proteins along with current bioinformatics concepts & their implementation.
- To help students easily handle proteins by studying in detail about protein structure.
- To become knowledgeable about the storage, retrieval, sharing and use of biological data, information, and tools.

Course outcomes:

By learning this course the students will be able to :

- Cast a molecular biology problem as a bioinformatics problem.
- Select relevant tools, optimize their settings and build pipelines to solve the set problem.
- Easily extract the required data from a given set of data & similarly be able to store it.
- Use conventional softwares and web-based applications.
- Analyze processed data with the support of analytical and visualization tools.

Module	Contents	Contact Hours
01	Introduction to bioinformatics: Types of biological data, Sequencing Methods: DNA (Maxim Gilbert Method, Sangers Method) & Protein (MS-MSAnalysis), Genomic Sequencing, ESTs and SNPs, Applications of bioinformatics.	06
02	Types of databases: Based on storage techniques(Flat, Relational, Object Oriented); Based on data (Primary, Secondary , Specialized) Search engines: Entrez& SRS Sequence databases: NCBI, EMBL, DDBJ Structural Databases: PDB Protein Databases: PIR, SWISS PROT Other Databases: KEGG, TrEMBL, EBI.	08
03	Alignment: Global Alignment, Local Alignment Pair Wise Sequence Alignment: Dot Matrix Alignment. Dynamic programming Methods: Needleman Wunch Algorithm, Smith Waterman Algorithm. Heuristic Method: BLAST, FASTA Amino Acid Substitution Matrices: PAM, BLOSSUM Multiple Alignment: CLUSTAL WPhylogenetic Analysis	10
04	Visualization: Methods for representing biological data, Rasmol, Swiss PDB, 3D Structure Viewers.	04
05	Proteins: Structure, Classification, Classification databases. Protein Structure prediction: Primary Structure Prediction,	07

	Secondary Structure Prediction, Tertiary Structure Prediction, Homology Modelling, Chao-Fasman Algorithm, Neural Networks, Ab-Initio Modelling, Fold recognition (Threading)	
06	Interactions: Protein ligand interactions, Torsionangle, Ramchandran plot, Protein folding & Chaperones. Cartesian coordinates	10

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Oreilly , Developing bioinformatics computer skills, Shroff publishers, 1st Indian edition
2. David mount, Bioinformatics sequence and genome analysis, CBS publishers, 2nd edition
3. N. Gautam , Bioinformatics databases & algorithm, Narosa publication
4. S. Ignacimuthu S.J, Basic bioinformatics, Narosa publications
5. T. K. Attwood, Introduction to bioinformatics, Pearson education, 8th reprint
6. S. C. Rastogi, Bioinformatics concepts, skills & applications, CBS publishers, 1st edition

Course Code	Course/Subject Name	Credits
BTC502	Genetic Engineering	4

Pre-requisites:

- Knowledge of Biochemistry, Microbiology, Molecular Biology, Genetics.

Course Objectives:

- Give insight into the functioning of Recombinant DNA molecules, their constructions, analysis and fine tuning.
- To engineer such molecules for making of difficult bio-molecules.
- This course also gives various ideas and approaches by different schools of thoughts.

Course outcomes:

By learning this course the students will be able to:

- Understand how recombinant molecules are created analysed with respect to DNA, RNA, and Protein.
- They also will be familiar with the problems they could encounter and how to trouble shoot them.
- They will be able to monitor both in-vitro and in-vivo activity.
- They will be able to suggest more rational approach to solve problem of a living system at a molecular level.

Module	Contents	Contact Hours
01	Basics of genetic material: DNA structure, topology, Super helical and relaxed molecules. Plasmids- Basic features classification, size and copy number, conjugation & compatibility. Total cell DNA preparation, different methods of plasmid DNA preparation.	06
02	Enzymes for Recombinant Technology: Cutting enzymes- Restriction Endonucleases (Classification, blunt end, sticky end, mode of action).Introduction to other enzymes-DNA polymerases, Reverse Transcriptase, Polynucleotide Kinase, Terminal Transferase, Alkaline Phosphatase,S1-Nuclease, Bal-31, DNA Ligase.	07
03	Cloning vectors: Vectors used for Gene-cloning: Plasmids (e.g pUC type, conjugative, Ti etc.), Phages (Lambda and M13 type), Cosmids and Phagemids.	07
04	Library construction and recombinant gene expression: Library construction (Genomic and C-DNA type) and Screening for the clone. Foreign gene expression in E. coli, Fusion proteins	06
05	DNA transfer in to cells: Transformation and Transfection, Membrane Fusion and Electroporation, Gene-Gun and Micro-injection	05

06	DNA and Protein Analysis: DNA: Southern and Northern Hybridization. PCR Amplification, DNA Sequence Analysis (e.g Sangers Method), Automated Sequencing, RFLP and RAPD. Protein: Western Blotting, ELISA and its variations	08
07	Antisense and RNA interference Technology and their applications. R-DNA in medicine, e.g. Insulin and Blood clotting factor VIII.	06

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Molecular Biology of the Cell: Alberts et al.5th. Ed. Garland Publications.
2. Genes VIII: Benjamin Levine, Oxford University Press.
3. Principle of Gene Manipulations (2004): S.B. Primrose, R.M. Twyman & R. W. Old. Sixth edition. Blackwell Science.
4. Gene Cloning and DNA analysis: An Introduction.(2006).T. A. Brown. Blackwell Publishing.

Course Code	Course/Subject Name	Credits
BTC503	Thermodynamics and Biochemical Engineering	4

Pre-requisites:

- Knowledge of phase rule, knowledge of differentiation & Integration

Course Objectives:

- To study the basic concepts of the energy flow in and out of the system.
- To apply the thermodynamic principles to the biochemical reactions.
- To check the feasibility of the reaction.

Course outcomes:

- The student will be able to check the feasibility of a reaction.

Module	Contents	Contact Hours
01	Basic Concepts: System, Surrounding & Processes, Closed and Open systems, State and Properties, Intensive & Extensive Properties, State and Path functions, Equilibrium state and Phase rule, Zeroth law of Thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes.	02
02	Laws of Thermodynamics: General statement of First law of Thermodynamics, First law for Cyclic Process, Non-Flow Process, Flow process, Heat capacity. General statements of the second law, Concept of entropy, The Carnot principle, Calculation of entropy changes, Clausius inequality, Entropy and Irreversibility. Third law of Thermodynamics.	05
03	PVT Behaviour: PVT behaviour of pure fluids, equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic and polytrophic processes. Equations of state for real gases: Van-der Waals equation, Redlich- Kwong equation, Peng-Robinson equation, virial equation.	04
04	Biochemical Energetics: Coupled reactions and energy rich compounds, Reaction Stoichiometry, criteria of biochemical reaction equilibrium, equilibrium constant and standard free energy change, effect of temperature, pressure on free energy change, effect of temperature, pressure on equilibrium constants and other factors affecting equilibrium conversion. Le Chateliers principle, liquid phase reactions, heterogeneous bioreaction equilibria, phase rule for reacting systems.	05
05	Properties of Pure Fluids: Principles of corresponding states, Generalized compressibility charts. Reference properties, energy	06

	properties, Derived properties, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, modified equations for internal energy (U) & enthalpy (H), Effect of temperature on U, H & Entropy (S), Relationships between C_p & C_v , Gibbs-Helmholtz equation.	
06	Fugacity and Activity: Fugacity: Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, Fugacities of solids and liquids, Activity: Effect of temperature and pressure on activity. Departure functions and generalized charts, thermodynamic diagram types of diagrams and construction of thermodynamic diagrams.	04
07	Properties of Solutions: Partial molar properties- Partial molar properties of solutions, determination of partial molar properties, chemical potential effect of temperature and pressure, Lewis randall rule, Raoult's law for ideal solutions, Henry's law and dilute solutions ideal behavior of real solutions and Henry's law, Activity in solutions, Activity coefficients effect of temperature and pressure, Gibbs - Duhem equation, Property changes of mixing, excess properties, excess Gibbs free energy.	06
08	Phase Equilibria: Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions - azeotropes, VLE at low pressures activity coefficient equation, bubble point and dew point equilibria, Consistency test for VLE data using slope of Incurves, using partial pressure data, calculation of activity coefficients using Gibbs-Duhem equation, Liquid-Liquid Equilibrium diagrams binary liquid Equilibrium diagrams.	04

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub

questions can be asked.

- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Smith, J.M., Van Ness, H.C., and Abbott, M.M. Introduction to Chemical Engineering Thermodynamics, McGraw Hill, Inc..
2. Kyle, B.G., Chemical and Process Thermodynamics, Prentice Hall, Inc.
3. Hougen, O.A., Watson, K.M., and Ragatz, R.A., Chemical Process Principles Part II, John Wiley & Sons, (CBS Publishers & Distributors, New Delhi).
4. YVC Rao, "An Introduction to Thermodynamics", University Press, Second Edition.
5. K V Narayanan, "Textbook of Chemical Engineering Thermodynamics", PHI Learning Second Edition.

Course Code	Course/Subject Name	Credits
BTC504	Bioreactor Analysis and Technology	04

Pre-requisites:

- Knowledge of chemical reaction kinetics, Knowledge of differentiation and integration

Course Objectives:

- To understand the basic concepts of Bioreactor design.
- To select the relevant principles and data for practical process engineering purposes.

Course outcomes:

- Student will be able to understand the different types of ideal and non-ideal reactors.
- Student will be able to design the reactors required for a particular processes.

Module	Contents	Contact Hours
01	Basic Reaction Kinetics: Reaction thermodynamics, order and molecularity of reaction, homogeneous and heterogeneous reactions, elementary and non-elementary reactions, reaction yield, reaction rate, calculation of reaction rates from experimental data, general reaction kinetics for biological system, production kinetics in cell culture, kinetics of substrate uptake in cell culture, growth kinetics with plasmid instability	06
02	Ideal Reactors: Constant volume and variable reactors, batch operation of a well-mixed enzyme and cell culture reactor, fed batch operation of a well-mixed enzyme and cell culture reactor, continuous operation of well mixed enzyme and cell culture reactor, continuous operation of plug flow enzyme and cell culture reactor, autocatalytic reactions, recycle reactors-plug flow reactor and continuous stirred tank reactor, comparison between major modes of reactor operation.	07
03	Multiple Reactors and Reaction Systems: Continuous stirred tank reactors of equal size in series, continuous stirred tank reactors of unequal size in series, finding conversion in given system, determining the best system for a given conversion, plug flow reactors in series and parallel, reactors of different types in series. Simple reactions, step wise reactions, parallel reactions, series reactions, maximizing R in batch reactor, plug flow reactor and continuous stirred tank reactor, reactor choice for series reactions and series parallel reactions, concepts of reversible reactions.	07
04	Heterogeneous Reactions:	06

	Heterogeneous reactions in Bioprocessing, Concentration gradients and reaction rates in solid catalysts, Internal mass transfer and reactions, steady state mass balance (spherical geometry), Concentration profile for first order kinetics, Concentration profile for zero order kinetics, Concentration profile for Michaelis- Menten kinetics, Effectiveness factor and Thiele Modulus, External mass transfer	
05	Deviations from ideal reactors: Concept of nonideality, reasons of non ideality, RTD studies, F curve, C curve, E curve, diagnosis of ills of flow reactors, modelling of nonideal behaviour-dispersion model, tanks in series model.	05
06	Working principle of unconventional reactors: Selection criterion for bioreactors, Bubble column, Airlift reactor, Fluidizedbed reactor, perfusion reactors, membrane reactors	04

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. D.G. Rao, Introduction to Biochemical Engg, Tata McGraw Hill Edu. Pvt. Ltd., Second edition.
2. P.M. Doran, Bioprocesses Engg. Principles, Academic Press, London, Second edition.
3. E.H. Perry 7 D.W. Green, Perrys Chemical Engineering Handbook, Seventh edition.
4. Octave Levenspiel, Chemical Reaction Engineering, John Wiley Publication, Third Edn
5. H Scott Fogler "Elements of Chemical Reaction engineering" Prentice Hall, 2006

Course Code	Course/Subject Name	Credits
BTC505	Business Communication and Ethics	2

Prerequisites:

- Students should have basic knowledge of English and general engineering.

Course Objectives

- To inculcate in students professional and ethical attitude, effective communication skills, teamwork, multidisciplinary approach, and an ability to understand Engineers' social responsibilities
- To provide students with an academic environment where they will be aware of the excellence, leadership and lifelong learning needed for a successful professional career
- To inculcate professional ethics and codes of professional practice
- To prepare students for successful careers that meets the global Industrial and Corporate requirement

Course Outcomes:

- Students will be able to
- Communicate effectively in both oral and written form and equip to demonstrate knowledge of professional and ethical responsibilities.
- participate and succeed in campus placements and competitive examinations like GATE, TOFEL
- Possess entrepreneurial approach and ability for life-long learning
- Have education necessary for understanding the impact of engineering solutions on Society, and demonstrate awareness of contemporary issues Detailed Syllabus.
- Design a technical document using precise language, suitable vocabulary and apt style.
- Develop the life skills/ interpersonal skills to progress professionally by building stronger relationships.
- Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
- Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
- Deliver formal presentations effectively implementing the verbal and non-verbal skills.

Module	Contents	Contact Hours
1	Report Writing Objectives of Report Writing Language and Style in a report Types : Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports (Memo, Letter, Short and Long Report)	05
2	Technical Writing Technical Paper Writing (IEEE Format) Proposal Writing	03

3	Introduction to Interpersonal Skills Emotional Intelligence Leadership and Motivation Team Building Assertiveness Conflict Resolution and Negotiation Skills Time Management Decision Making	09
4	Meetings and Documentation Strategies for conducting effective meetings Notice, Agenda and Minutes of a meeting Business meeting etiquettes	02
5	Introduction to Corporate Ethics Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.) Introduction to Intellectual Property Rights Ethical codes of conduct in business and corporate activities(Personal ethics, conflicting values, choosing a moral response and making ethical decisions)	02
6	Employment Skills Group Discussion Resume Writing Interview Skills Presentation Skills Statement of Purpose	07

Term Work

The term work shall be comprised of the neatly written Journal comprising below mentioned assignments.

Assignment 1- Interpersonal Skills (Group activity Role play)

Assignment 2- Interpersonal Skills (Documentation in the form of soft copy or hard copy)

Assignment 3- Cover Letter Resume

Assignment 4- Report Writing

Assignment 5- Technical Proposal (document of the proposal)

Assignment 6- Technical Paper Writing

Assignment 7 -Meetings Documentation (Notice, Agenda, Minutes of Mock Meetings)

Assignment 6- Corporate Ethics (Case study, Role play)

Assignment 8- Printout of the PowerPoint presentation

Term-work Marks: 50 Marks

The marks of term-work shall be judiciously awarded depending upon the quality of the term work including that of the report on experiments assignments. The final certification acceptance of Term work warrants the satisfactory the appropriate completion of the assignments, presentation, book report, group discussion and internal oral the minimum passing marks to be obtained by the students. The following weightage of marks shall be given for different components of the term work.

Attendance : 05 Marks

Assignments : 20 Marks

Internal Oral: 25 Marks comprising of:

 Presentation of the Project Report: 10 Marks

 Book Report (one copy per group): 05 Marks

 Group discussion: 10 Marks

References

1. Fred Luthans, "Organizational Behavior", McGraw Hill, edition
2. Lesiker and Petit, "Report Writing for Business", McGraw Hill, edition
3. Huckin and Olsen, "Technical Writing and Professional Communication", McGraw Hill
4. Wallace and Masters, "Personal Development for Life and Work", Thomson Learning, 12th edition
5. Heta Murphy, "Effective Business Communication", McGraw Hill, edition
6. Sharma R.C. and Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw-Hill Education
7. Ghosh, B. N., "Managing Soft Skills for Personality Development", Tata McGraw Hill. Lehman,
8. Dufrene, Sinha, "BCOM", Cengage Learning, 2nd edition
9. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
10. Dr. Alex, K., "Soft Skills", S Chand and Company
11. Subramaniam, R., "Professional Ethics" Oxford University Press.
12. Robbins Stephens P., "Organizational Behavior", Pearson Education
13. <https://grad.ucla.edu/asis/agep/advspstem.pdf>

Course Code	Course/Subject Name	Credits
BTE5011	Department Elective I – Biosensors and Diagnostics	4

Pre-requisites:

- Biochemistry, Analytical methods in Biotechnology, Principles of basic instruments used in a Biotechnology laboratory.

Course Objectives:

The objectives of this course is that the students will be able to:

- Explain the role of biological macromolecules as recognition elements & biosensors.
- Describe the biomedical aspects of these sensors.
- Analyse the interplay between materials, components and systems in the field of bio sensing.
- Design an advanced biosensor for medical applications, using the current state of the art of biosensors.
- Describe what challenges are shared among and what challenges are unique to the major biosensor application areas.

Course outcomes:

By learning this course the students will be able to :

- Apply the principles of engineering to the development of bioanalytical devices and the design of biosensors
- Explain the principles of linking cell components and biological pathways with energy transduction, sensing and detection.
- Differentiate among various biosensor systems.
- Design a biosensor in response to agricultural, bioenvironmental, food safety, and biosecurity applications.
- Apply engineering and biological approaches to solve problems in diagnosis of diseases, such as diabetes, cancer or detection of other analytes/ biomarkers.

Module	Contents	Contact Hours
01	Biosensors: Principles, Characteristics of Ideal Biosensors, Basic measuring procedure, Components of biosensors, Advantages & Limitations	08
02	Bio catalysis based biosensors, Bioaffinity based biosensors & Microorganisms based biosensors, Biologically active material and analyte. Types of membranes used in biosensor constructions.	09
03	Various types of transducers, Principles and applications Calorimetric, Optical, Potentiometric/ Amperometric, Conductrometric/ resistometric.	05
04	Piezoelectric, Semiconductor, Impedimetric, Mechanical and molecular electronics based transducers, Chemiluminiscene-based biosensors.	05
05	Biosensors in clinical chemistry, Medicine and health care, Biosensors for veterinary, Agriculture and food, Low cost biosensor for industrial processes for online monitoring,	08

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment**Internal**

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References:

1. Roger, K.R. and Gerlach, C.L. 199. Update on environmental for biosensors. *Env. Sci. Technol* 33 500A - 506A.
2. Bilitewski, U. Turner, A.P.F. 2000 *Biosensors for environmental monitoring* Harwood, Amsterdam.
3. Moses, V and Cape, R.E. 1991, *Biotechnology the science and business*, Harwood, Academic Publisher London
4. Rogers, K.R. and Mascini, M. 2001. *Biosensors for analytical monitoring* EPA biosensors group.
5. Aboul - Enein, H. V., Stefan, R. and Van Staden, (1999) *Chemiluminiscence - based biosensors - An overview* *crit Rev. Anal. Chem.* 29, 323-331.
6. Pearson, J.E. Gill, A., and Vadgama, P. (2000) *Analytical aspects of biosensors*, *Ann Clin Biochem* 37, 119-145.
7. *Biosensors: Fundamentals and applications*, Oxford, U.K: Oxford University Press by Turner, A.P.F., Karube, I. & Wilson, GS.

Course Code	Course/Subject Name	Credits
BTE5012	Department Elective I – Biophysics	4

Pre-requisites:

- Knowledge of Chemistry, Physics, Atomic physics, Biochemistry, Molecular Biology.

Course Objectives:

- The objective of this course is to give insight into the structure of various macro-molecules, their constructions, analysis and interactions.

Course outcomes:

By learning this course the students will be able to:

- Understand how molecules are created and studied.
- They will be able to monitor both in-vitro and in-vivo activity and interactions.

Module	Contents	Contact Hours
01	Introduction to Biophysical Techniques: Electron Microscopy, Atomic Force Microscopy, X ray Crystallography, NMR Spectroscopy, Infrared Spectroscopy, Circular Dichroism	10
02	Nucleic Acid interactions: Carrier RNA, Interactions between DNA & protein, Zinc finger proteins, various nucleic acid binding proteins, Nuclear transport.	06
03	Membrane Structure & Properties: The principles governing the structures of biological membrane, Two-dimensional fluids, Assembly of membrane components.	06
04	Protein Structural study: Intra and inter-molecular forces, helix-coil transitions and protein folding in a thermodynamical context, Secondary Motifs, Tertiary Architecture and Quaternary Organization, crystallization, diffraction theory.	07
05	Lipids & their Interaction: Details of Lipid Structures, Lipoproteins and Glycolipids. High density (HDL) and low density (LDL) lipoprotein. Disorder caused by saturated fat and cholesterol, Arteriosclerosis.	06

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

**Assessment
Internal**

-
- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Cantor R, Samuel P. R. (1985). Biophysical Chemistry. W. H. Freeman & Co.
2. Vasantha Pattabhi, N. Gautham. Biophysics. Narosa Publishing House Ltd.
3. Van Holde Johnson and Ho. (2006) Principles of Physical Biochemistry. Second Edition, Pearson Prentice Hall.
4. Igor N. Serdyuk, Nathan R. Zaccari, & Joseph Zac. Methods in Molecular Biophysics: Structure, dynamics and Function. Cambridge University Press.
5. Physical Biochemistry: Principles and applications by David Sheehan, Jon Wiley & Sons.

Course Code	Course/Subject Name	Credits
BTE5013	Department Elective I – Biostatistics	4

Pre-requisites:

- Knowledge of basic statistical methods

Course Objectives:

- To understand statistics - basic theory, philosophy and application of statistics
- To Understand why biologists need a background in statistics in conducting research
- To help students know the role of statistics as a tool for scientists

Course outcomes:

By learning this course the students will be able to:

- Identify and implement statistical techniques and models for analysis of biological data.
- To enable them interpret research.

Module	Contents	Contact Hours
01	Descriptive statistics and Probability: Frequency distribution, Measures of Central tendency, Measures of Dispersion, Basic probability and Bayes theorem.	03
02	Probability and sampling distributions; Discrete probability distributions; Continuous probability distributions- Binomial, Poisson and normal distributions; Sampling Distributions- sample mean, difference between two sample means, Sample proportions, difference between two sample proportions.	08
03	Estimation; t-distribution; Confidence intervals for- population mean, difference between two population means, population proportion, difference between two population proportions, Variance of normally distributed population, ratio of variances of two normally distributed populations. Determination of sample size for estimating mean and proportions.	05
04	Hypothesis Testing: Hypothesis testing for - population mean, difference between two population means, population proportion, difference between two population proportions, population variance, ratio of two population variances, Type I and II error and Power of test	05
05	Analysis of Variance: Completely randomized design, Randomized complete block design, repeated measures design, factorial experiment. Regression and Correlation: Simple linear regression, correlation model, correlation coefficient, multiple regression, multiple correlation	09
06	Chi square distribution and analysis of frequency, Chi-square distribution properties, Test of goodness of fit, independence and homogeneity	05

List of Tutorials:

- Descriptive statistics and probability
- Discrete probability distributions
- Continuous probability distributions
- Sampling distributions
- Estimation
- Hypothesis testing
- Analysis of Variance
- Regression and correlation
- Chi square distribution and analysis of frequency

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment**Internal**

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Textbooks

1. Biostatistics - A foundation for analysis in health sciences by Wayne W. Daniel, Seventh edition, Wiley India
2. Fundamentals of Mathematical statistics by S.C.Gupta and V.K. Kapoor, second edition, Sultan Chand Publishers
3. Probability and statistics for engineers by J. Ravichandran, Wiley India
4. Biostatistics- How it works by Steve Selvin, Pearson Education
5. An introduction to Biostatistics by Sunder Rao and J. Richard, third edition, Prentice Hall of India
6. Probability and Statistics by Schaum's series

Course Code	Course/Subject Name	Credits
BTE5014	Department Elective I – Pharmaceutical Technology	4

Pre-requisites:

- Knowledge about biochemistry and biochemical pathways in biological systems.
- Knowledge about cell biology and metabolism

Course Objectives:

- To understand the basic aspects of pharmacokinetics and pharmacodynamics.
- To give an insight about the pre-clinical and clinical trials and different classes of drugs.

Course outcomes:

- Students will be able to tell factors affecting the bioavailability and stability of dosage form. They also know the parameters for the disposition, absorption and Michaelis-Menton constants for non-linear kinetics.
- Students will know the fabrication, design, evaluation and application of drug delivery systems.

Module	Contents	Contact Hours
01	Introduction To Pharmaceuticals: History & Definition of Drugs. Sources of Drugs - Plant, Animals, Microbes and Minerals. Drug targets, Intermolecular bonding forces. Classification of Drugs. Naming of Drugs and medicines	04
02	Pharmacodynamics and Pharmaco kinetics: Molecules acting as drug targets: Enzymes, Receptors, Nucleic acid Drug Absorption, Distribution, Metabolism and Excretion (ADME). Modes of drug administration Drug dosing (half-life, steady state concentration, drug tolerance, Bioavailability). Drug delivery system	08
03	Finalstages of drug development-trials: Preclinical and clinical trials, Patenting and regulatory affairs	04
04	Medicinal Chemistry: Antibacterial, Anticancer, Antiviral drugs, Opioid analgesics	12
05	Biopharmaceuticals: Production of Therapeutic Proteins, Hormones, Nucleic acids, Role of Biopharmaceuticals in treatment of various health disorders	06

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

-
- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Biopharmaceuticals: Biochemistry & Biotechnology, Gary Walsh (1998), John Wiley & Sons Ltd.
2. Medicinal Chemistry by Graham L. Patrick, Oxford University Press
3. Remington's Pharmaceutical sciences, (Mark Publications & Company eston PA) 1980.
4. Medicinal Chemistry: an introduction by Gareth Thomas, Wiley Publications
5. Theory & Practice of Industrial Pharmacy, (3rd ed.) Leon Lachman, Lea & Febiger (1986)

Course Code	Course/Subject Name	Credits
BTL501	Bioinformatics Lab	1

Concept of Experiments:

Ten experiments must be performed

- Access & use of different databases using NCBI metadatabase.
- To study use of ORF finder to find the correct reading frame.
- To study the characteristics of protein using PROT SCALE.
- To study prediction of coding sequence (CDS) of a gene using NCBI & Genemark and compare the results for percentage accuracy.
- To access & use different online gene & protein alignment softwares.
- Protein structure visualization using 'RASMOL' graphical user interface.
- Protein structure visualization using 'RASMOL' command line interface.
- Secondary structure prediction for amino acid sequences of a given protein.
- Homology modelling of protein using SWISS-PDB modeller.
- To study chemical structure of drugs using Chems sketch & Marvin sketch.
- To find & study phylogenetic relationships among different given species using CLUSTAL OMEGA.
- To study multiple sequence alignment (MSA) tools & compare the results.
- To study BLOCKS using Interpro.
- To study EXPASY tool for protein structure analysis.
- To find and study gene using MAP-VIEWER.

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments

Course Code	Course/Subject Name	Credits
BTL502	Genetic Engineering Lab	1.5

Concept of Experiments:

Ten experiments must be performed

- Isolation of Genomic DNA
- Purification and quantification of isolated DNA.
- Separation of DNA by Agarose gel electrophoresis.
- PCR analysis of DNA fragments by agarose gel electrophoresis
- Making the bacterial cells competent
- Transformation of E.coli.
- Isolation of plasmid DNA by boiling lysis method.
- Isolation plasmid DNA by Alkaline lysis method.
- Southern blotting
- Southern Hybridization
- In vitro DNA ligation
- RFLP technique
- Protein Analysis by SDS-PAGE
- Bacterial conjugation
- Bacterial survival against UV irradiation and mutagenesis
- Isolation of mutants, e.g.auxotrophs, by chemical mutagenesis. (Acridineorange/Ethydium bromide)
- β -galactosidase activity of lac⁺ & lac⁻ mutant of E.coli.
- Primary screening of antibiotic producers from soil

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments

Course Code	Course/Subject Name	Credits
BTL503	Lab I	1.5

Concept of Experiments:

Ten experiments must be performed

- Physical method of microbial control.
- Chemical method of microbial control.
- Isolation of bioluminescent organisms.
- Diauxic growth curve of E.Coli.
- Biochemical characterization of microbes (IMVIC test, Catalase, Oxidase test).
- Detection of Amino acid producer from soil.
- Acid fast staining for mycobacteria.
- Study of air microflora & determination of sedimentation rate.
- Blood film preparation and identification of cells.
- Antibiotic susceptibility test.
- E Test
- Blood group typing using haemagglutination tests.
- To detect the antigen/antibody using Enzyme Linked Immuno Sorbent Assay (ELISA)
- To test the pattern of antigen-antibody interaction through Ouchterlony double diffusion assay
- RID
- Lymphoid organs and their microscopic organization
- Separation of mononuclear cells by Ficoll-Hypaque
- VDRL test (Demonstration)
- Immunodiagnosics (demonstration using commercial kits)
- Determination of MIC of antibacterial drugs.
- Identification of AgAb complex by Slide agglutination test

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
T.E. Semester VI (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
BTC601	Food Technology	3	-	1	3	-	1	4
BTC602	Cell & Tissue Culture	4	-	-	4	-	-	4
BTC603	Enzyme Engineering	4	-	-	4	-	-	4
BTC604	IPR, Bioethics and Bio safety	3	-	1	3	-	1	4
BTC605	Process Control & Instrumentation	3	-	1	3	-	1	4
BTE602X	Elective-II	3	-	1	3	-	1	4
BTL601	Lab-II	-	3	-	-	1.5	-	1.5
BTL602	Lab-III	-	3	-	-	1.5	-	1.5
Total		20	6	4	20	3	4	27

Course code	Course Name	Examination Scheme								
		Theory				Term Work	Pract/ Oral	Oral	Total	
		Internal Assessment		End Sem Exam	Exam Duration (in hrs)					
		Test 1	Test 2			Avg				
BTC601	Food Technology	20	20	20	80	3	25	-	-	125
BTC602	Cell & Tissue Culture	20	20	20	80	3	-	-	-	100
BTC603	Enzyme Engineering	20	20	20	80	3	-	-	-	100
BTC604	IPR, Bioethics and Bio safety	20	20	20	80	3	25	-	-	125
BTC605	Process Control & Instrumentation	20	20	20	80	3	25	-	-	125
BTE602X	Elective-II	20	20	20	80	3	25	-	-	125
BTL601	Lab-II	-	-	-	-	3	-	25	-	25
BTL602	Lab-III	-	-	-	-	3	-	25	-	25
Total				120	480	-	100	50	--	750

Department Elective II (Sem VI)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Computational Fluid Dynamics (BTE6021)	1. Protein Engineering (BTE6022) 2. Cancer Biology (BTE6023)	1. Green technology (BTE6024)

Course Code	Course/Subject Name	Credits
BTC601	Food Technology	4

Pre-requisites:

- Basic concepts of Microbiology and Fermentation Technology

Course Objectives:

- To impart knowledge of various areas related to Food science and technology
- To enable the students to understand food composition and its physiochemical, nutritional and microbiological aspects
- To familiarize the students about the processing and preservation techniques of Food products

Course outcomes:

- Students will know the principles of preservation.
- Students will understand the principles of food processing techniques and will be able to apply these principles to specific food commodities.

Module	Contents	Contact Hours
01	Introduction to food technology, Constituents of food, contribution to texture, flavour and organoleptic properties of food; food additives coloring agents, emulsifiers, preservatives, flavours, vitamins, organic acids and their functions; enzymes in food processing	06
02	Sources and activity of microorganisms associated with food; Factors affecting the growth and survival of micro-organisms in foods-intrinsic and extrinsic; Food borne diseases, infections and intoxications, food spoil agecauses. Microbial food- yeasts, bacteria and production of new protein foods - SCP, mushroom, algal proteins	07
03	Microbial fermentation and production of food and beverages using microorganisms. Pickling, Sauerkraut, vinegar, bread. Dairyproduct-Yogurt, cheese production by microbial and enzymatic (proteases) method. Alcoholic beverages-Beer (deoxygenating and desugaring by glucose oxidase of beer, beer mashing and chill proofing), Wine (red, white, sparkling)	07
04	Fermentation methods for preserving foods, Preparation of various food additives like coloring agents, emulsifiers, vitamins, flavours and organic acids	05
05	Post Harvest technology for food crops. Food preservation-high temperature methods, low temperature methods, irradiation, high pressure method and chemical preservatives. Production of Fruit juices and types of Fruit juices	05
06	Food Packaging methods: Materials used for food packaging of various food products like cheese, eggs, bread, alcoholic beverages, milk and juices	05

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which

are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Frazier, Food Microbiology, TI-IM Publications.
2. Heller, Genetic Engineering of Food: Detection of Genetic Modifications- Wiley Publications.
3. Le.A. et.al., Microorganism & Fermentations- N.Y. Chemical
4. Rehm, Biotechnology Set Wiley Publications
5. M. R. Adams and M. O. Moss, Food Microbiology, Royal society of chemistry
6. James M. Jay, Modern food microbiology, An Aspen Publications
7. Prescott and Dunn, Industrial Microbiology, CBS Publications.

Course Code	Course/Subject Name	Credits
BTC602	Cell and Tissue Culture	4

Pre-requisites:

- Basic knowledge of Cell Biology, Microbiology and Plant and Animal Physiology

Course Objectives:

- To examine and analyse practical and theoretical principles of cell culture
- To explain the conditions under which cells can be cultured outside the body.
- To explain the advantages and limitations of cell culture in biomedical research and applications.

Course outcomes:

By learning this course the students will be able to:

- Plan experiments using cultured cells.
- Carry out cell culture, and associated laboratory techniques.
- Carry out the most common analysis techniques associated with cell culture.
- Perform adequate statistical processing of data generated by cell culture.
- Present and analyse literature which covers cell culture.

Module	Contents	Contact Hours
01	Plant tissue culture Introduction: Internal organization of plant, Plant Tissue Culture Media, Plant growth hormones, Concept of Totipotency, Study of various types of Organ Culture, Organogenesis, Micropropagation	08
02	Plant Cell Culture And its Applications: Plant Cell Suspension Culture, Single Cell Culture, Somatic Embryogenesis, Artificial Seeds, Protoplast Culture & Somatic Hybridization, Scale-up and Automation of Plant Cell Culture	08
03	Transformation of Plants: Agrobacterium mediated Gene transfer, Chemical Methods, Virus Mediated Gene Transfer, Transgenic Plants, Applications of Plant Biotechnology for Production of Quality Oil, Industrial Enzymes and Plantibodies	06
04	Introduction to Animal Cell Culture: Advantages and limitations of Animal Tissue Culture, Laboratory Design & Layout of ATC laboratory, Equipments and Materials of a Tissue Culture Laboratory, Media Preparation and Sterilization techniques,	08
05	Primary and secondary cell Culture: Establishment and maintenance of primary cell cultures of adherent and non-adherent cell lines, Establishment and maintenance of secondary and continuous cell cultures.	05
06	Characterization of cell lines: Cell morphology, Chromosome preparation and analysis, karyotyping, chromosome banding, Chromosome painting, Spectral karyotyping (SKY). DNA analysis- DNA	05

	hybridization, DNA fingerprinting	
07	Application of cell culture: Vaccine production, Antibody Engineering and large scale production of pharmaceutical products, Production of cytokines and therapeutic recombinant glycoproteins.	05

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Plant Tissue Culture: Theory and Practice :Theory and Practice By S.S. Bhojwani, M.K. Razdan; Elsevier Publishers
2. Plant Tissue Culture by Kalyan Kumar De; Published by New Central Book Agency, 1997
3. Plant Tissue and Cell Culture; Volume11 of Botanical monographs, by Herbert Edward Street; Publisher: University of California Press, 1973
4. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications By R. Ian Freshney; Wiley Publishers
5. Animal Cell Culture (Introduction to Biotechniques): Sara j.Morgan, David C. Darling; Published by BIOS Scientific Publishers Ltd., 1993
6. Principles and Practice of Animal Tissue Culture – Sudha Gangal.
7. Basic Cell Culture Vol. 290 Protocols by Cheryl D Helgason, Cindy L Miller. Humanan Press.2005.
8. Basic Cell Culture 2nd Edition by JM Davis Oxford University Press.2002.
9. Biotechnology by B. D. Singh: Expanding horizons. Kalyani Publishing. 2008.
10. Animal Cell Culture & Technology by M. Butler, Published by Taylor & Francis publishers.

Course Code	Course/Subject Name	Credits
BTC603	Enzyme Engineering	4

Pre-requisites:

- Knowledge of Biochemistry, Microbiology & Molecular Biology.

Course Objectives:

The objectives of this course are to:

- Give insight into the functioning of Enzyme molecules (Biological Catalyst), their constructions, Structure, interactions with other cellular molecules, and the process of catalysis.
- Students will learn to use such molecules for making of difficult bio-molecules.
- They will also be able to understand Industrial uses and applications of Enzymes.

Course outcomes:

By learning this course the students will be able to:

- Understand how Enzymes are created as functional bio-catalysts, analysed with respect to their efficiencies, their lability, and ways to make them durable.
- They also will be familiar with the problems they could encounter and how to trouble shoot them.
- They will be able to monitor both in-vitro and in-vivo activity.

Module	Contents	Contact Hours
01	Enzymes as Biological Catalysts, Chemical nature & Structure of Enzymes, Properties of enzymes, Enzyme Units, Nomenclature & Classification, Catalytic and Allosteric site, Models of Enzyme-substrate interactions, Activation Energy and catalysis, Effect of pH, Temperature and Salts on Enzyme activity	08
02	Enzyme Kinetics: Henri & Michaelis-Menten Equation & its significance, Briggs Haldane modification, Line weaver-Burke, Eadie-Hofstee & Hanes plot, Problems. Enzyme Inhibition: Irreversible & Reversible (Competitive, Uncompetitive, Noncompetitive, Mixed, Partial), Substrate Inhibition, Allosteric Inhibition.	11
03	Enzyme Assay: Kinetic determination of catalytic activity, Coupled kinetic assay, Radioimmunoassay. Instrumental techniques for Enzymatic Analysis: Manometry, Spectrophotometry, Spectrofluorimetry, Electrochemical methods (Potentiometric & Conductometry) Enthalpimetry, Radiochemical methods, Dry reagent techniques.	06
04	Working with Enzyme: Isolation & Extraction of Enzymes from various sources and locations in cell. Purification of Enzymes: Preliminary purification, further purification using chromatography & electrophoresis Criteria of Purity: Specific Activity, Electrophoresis, And	08

	Ultracentrifugation. Immobilization of Enzyme for repeat use.	
05	Solid-liquid reactors for enzymes: Types of heterogeneous reactors and its design criteria (CSTR, PFR, PBR, FBR etc.), Operational problems, Decline and loss of enzyme efficiency, Remedies.	07
06	Application of Enzyme in Industries: Food, Leather, Beverage, Detergents, Pharmaceuticals and Medicines, Analytical/ Diagnostics and Biosensors, Therapeutics.	05

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Enzymes-Palmer; T, (Affiliated East West Press Pvt. Ltd.), 2004.
2. Biochemistry- Stryer, Berg, 6th Edition, (W.H. Freeman and Co.), 2007.
3. Biochemistry-Metzler; DE, 2nd Edn., (Academic press) 2001.
4. Lehninger Principles of biochemistry-Nesson, Cox, 4th Edn., (W.H. Freeman and Co.), 2005.
5. Biochemistry Voet & Voet; J, 3rd Edn. (John Wiley and sons Inc.), 2004.
6. Outlines of Biochemistry-Conn; E, Stumpf, 5th Edn. (Tata-McGraw Hill), 1988.
7. Enzyme Biotechnology- Tripathi; G, (ABD Publishers), 2003.
8. Enzyme Technology, M.F. Chaplin and C. Bucke. Cambridge University Press
9. Industrial Enzymes & their applications, H. Uhlig, (John Wiley and Sons Inc.)

Course Code	Course/Subject Name	Credits
BTC604	IPR, Bioethics and Biosafety	4

Pre-requisites:

- Knowledge of materials to be classified as biohazard, knowledge about current scenario of biotechnological issues.

Course Objectives:

- To understand the laws governing biotechnology and related field at national and international level.
- To gain knowledge about safety precautions necessary during biotechnological work.
- To understand the ethical perspective of handling biomaterials

Course outcomes:

- To be aware of rules and regulations setup at international level for various biotechnology related work so that any further research can be formulated accordingly.
- To know the social and legal state of the society with respect to genetically engineered products or other outcomes of biotechnology.
- Work according to the safety precautions set up by international bodies while handling bio hazardous material.

Module	Contents	Contact Hours
01	Introduction to Intellectual Property: Concept of Intellectual Property, Kinds of Intellectual Property: Patents, Copyrights, Designs, Trademarks, Geographical Indication. Infringement of IPR, its protection and remedies. Licensing and its types.	10
02	International Scenario: Introduction to the leading international instruments concerning intellectual property rights: The Berne Convention, GATT, WTO, Indian Patent Act, Universal Copyright Convention, The Paris Convention, TRIPS, The World Intellectual Property Rights Organization (WIPO), Budapest treaty	05
03	Patents: Requirement of patentable novelty, inventive step, prior art Classifying products as patentable and non-patentable Procedure for applying for patent, Patent Infringement and related case studies, Biological Patentability.	06
04	IPR and Biotechnology: Biopiracy and Bioprospecting, Farmers Rights and Plant breeders rights, Biodiversity, CBD	04
05	Biosafety: Good Lab Practices, Introduction to Biological Safety Cabinets, Primary Containment for Biohazards, Biosafety Levels, GMOs, LMOs and their environmental impact, Roles of Institutional Bio safety Committees: RCGM, GEAC etc. for GMO applications in food and agriculture, Risk analysis,	06

	assessment and management.	
06	Bioethics: Bioethical issues related to Healthcare & medicine, Food& agriculture, Genetic engineering. The Human Genome Project and Genetic Testing, Environmental problems.	04

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. IPR, Bio safety and Bioethics by Deepa Goel and Shomini Parasha
2. Intellectual property rights by Dr. Reddy

Course Code	Course/Subject Name	Credits
BTC605	Process Control and Instrumentation	4

Pre-requisites:

- Knowledge of Laplace Transforms, Knowledge of differentiation and Integration

Course Objectives:

- To understand the basic concepts of process parameter control
- To understand the closed loop and open loop control system
- To carry out the stability analysis for a given process

Course outcomes:

- Student will be able to design the process control of a parameter.
- Student will be able to carry out the stability analysis for a process.

Module	Contents	Contact Hours
01	Instrumentation: Instrumentation principles, Introduction to temperature and liquid level measurements, measurement of important physico-chemical and biochemical parameters, methods of on-line and off-line biomass estimation, flow injection analysis for measurement of substrates, products and other metabolites.	05
02	First order systems: Process characteristics, Laplace transforms, first order systems examples, mercury in glass thermometer, liquid level system, linearization, response of first order system for step, pulse, impulse and sinusoidal changes in input, conceptual numericals.	05
03	First order systems in series: Interacting and non-interacting systems and their dynamic response to step, pulse and impulse inputs; conceptual numericals.	04
04	Second order systems: Second order systems with transfer functions (spring-damper, control valve, U-tube manometer), response of second order system to step, pulse/ impulse and sinusoidal input Overdamped, underdamped and critically damped condition of second order system, transportation lag.	05
05	Controllers and final control elements: Actuators, Positioners, Valve body, Valve plugs, Characteristics of final control elements, controllers two position control, proportional control, derivative control, integral control, P-I (proportional- integral) control, P-D (proportional-derivative) control, P-I-D (proportional-integral- derivative) control, conceptual numericals.	05
06	Closed loop control systems: Block diagrams for servo and regulatory problems. Transient response of first and second order processes for set point	04

	changes and load changes with proportional and PI controllers, conceptual numericals.	
07	Controller design and stability: Criteria for stability, Routh test; Root locus analysis, Introduction to frequency response, Qualitative discussion about Bode criteria and Nyquist criteria, Controller tuning-Gain & Phase margin; Conceptual numerical on Routh test, Root locus and Bode plot.	05
08	Bioprocesses dynamics and control: Dynamics and control of bioreactors & sterilizers. On-line data analysis for state and parameter estimation, techniques for biochemical processes, Complex control strategies such as feed forward, cascade, adapter, supervisory, multivariable controls and their application for optimum controls.	03

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Coughnanowr, Process Systems Analysis and Control.
2. Stephanopoulos, G., Chemical Process Control, Prentice Hall of India., 1990.
3. Richardson, J. F., Peacock, D. G., Coulson & Richardson's Chemical Engineering, Vo. 3., ed. 3., Asian Books Pvt. Ltd, New Delhi, 1994.
4. William L. Luyben, Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill International Edition. 1990.
5. B.Wayne Bequette Process Control Modeling, Design and Simulation, Prentice Hall of India Pvt. Ltd.

Course Code	Course/Subject Name	Credits
BTE6021	Department Elective II- Computational Fluid Dynamics	4

Pre-requisites:

- Linear Algebra
- Partial Differential Equations
- Scilab or Python

Course Objectives:

- To understand the formulation of CFD problems
- To discretize the problems
- To solve the set of equations in simple cases using Scilab routines.
- To understand and use software in CFD

Course Outcomes:

- The student will be able to obtain flow profiles for some simple applications using Scilab.
- The student will be able to use appropriate software for solving realistic problems.

Module	Contents	Contact Hours
1	Module: Introduction Contents: Advantages of Computational Fluid Dynamics Typical Practical Applications Equation Structure Overview of CFD	02
2	Module: Preliminary Computational Techniques Contents: Discretisation Approximation to Derivatives Accuracy of the Discretisation Process Wave Representation Finite Difference Method	04
3	Module: Theoretical Background Contents: Convergence Consistency Stability Solution Accuracy Computational Efficiency	06
4	Module: Weighted Residual Methods Contents: General Formulation Least Squares, Galerkin and Subdomain Formulations. Weak form of Galerkin Method	08
5	Module: Finite Element Method Contents: Piece-wise Continuous Trial Functions One Dimensional Linear and Quadratic Elements	08

	One Dimensional Heat Transfer Tri-diagonal Matrix Algorithm	
6	Module: Two Dimensional Elements Quadrilateral Elements Steady State Heat Transfer in Two Dimensions Alternating Direction Implicit Method Potential Flow in Two Dimensions	08
7	Module: Finite Volume Method One Dimensional Diffusion Two Dimensional Diffusion Diffusion With Convection and The Upwind Scheme	06
8	Module: Pressure Velocity Coupling in Steady Flows The Staggered Grid The Momentum Equation The Simple Algorithm	06

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Books

1. C.A.J. Fletcher; Computational Techniques for Fluid Dynamics 1; Springer-Verlag Berlin Heidelberg GmbH
2. P. Seshu; Textbook of Finite Element Analysis; PHI Learning Private Limited, New Delhi
3. H.K. Versteeg and W. Malalasekera; An Introduction To Computational Fluid Dynamics; Longman Scientific & Technical

References

1. John D. Anderson; Computational Fluid Dynamics; McGraw Hill Education Private Limited

Course Code	Course/Subject Name	Credits
BTE6022	Department Elective II- Protein Engineering	4

Pre-requisites:

- Knowledge of Biochemistry, Recombinant DNA Technology and Enzyme Engineering

Course Objectives:

- Imparting knowledge about structure function relationships of proteins
- Studying the problem of protein folding and methods of characterization folded proteins
- Aspects of Protein Engineering in the industry

Course outcomes:

- At the end the student would have learned:
- Structure and Function relationship in proteins and its application in designing proteins
- Process of engineering proteins to increase its value by assisting folding, purification
- Protein engineering of therapeutic proteins, industrially important enzymes and antibodies.

Module	Contents	Contact Hours
01	Primary, Secondary, Tertiary and Quaternary Structure of Proteins, Bonds that stabilize a protein molecule, Ramchandran Plot. Protein folding pathways and Energy Status of a Protein Molecule, Protein Degradation in the cell	06
02	Techniques involved in studying protein structure: Methods of protein crystallization. Methods to study the quaternary structures of proteins: X-ray Crystallography, NMR Spectroscopy. MALDI-TOF, ESI-MS	07
03	Structure Function Relationships in Proteins: Helix-turn-Helix motif in DNA binding and homeo domain protein, Zinc fingers, Leucine zippers. Membrane proteins: General characteristics, Transmembrane segments, bacteriorhodopsin and Photosynthetic reaction center	06
04	Concepts of designing a new Protein Molecule: Chemical synthesis of peptides. Target molecules for Protein Engineering. The protein cycle and steps involved in Engineering a new Protein. De novo protein design	06
05	Applications of Protein Engineering: Protein Engineering to enhance the solubility and assist	10

	folding of expressed proteins. Protein Engineering to assist purification of expressed proteins. Role in Vaccine Development. Engineering blood clotting factors: factor VIII. Engineering enzymes: tyrosyl- t RNA synthase. Engineering therapeutic hormones: insulin. Engineering humanized antibodies	
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Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Lilia Arbenghina; Protein Engineering in Industrial Biotechnology; Harwood Academic Publishers
2. Creghton TE; Proteins Function, A Practical Approach; Freeman WH, Second Ed, 1993
3. Branden C. And Tooze J.; Introduction to Protein Structure; Second Edition, Garland Publishing, NY, USA, 1999
4. Moody PCE, and A.J. Wilkinson; Protein Engineering; IRL Press, Oxford, 1990
5. Walsh.G; Protein Biotechnology and Biochemistry; 2nd ed.; Wiley Publications
6. Klaus Demobowsky, Novel Therapeutic Proteins; Wiley Publications
7. Voet D. and Voet G.; Biochemistry' Third Edn. John Wiley and Sons, 2001

Course Code	Course/Subject Name	Credits
BTE6023	Elective II- Cancer Biology	4

Pre-requisites:

- Knowledge of Biochemistry, Cell biology, Immunology, Molecular biology, Genetic Engineering

Course Objectives:

- Studying cellular and molecular mechanisms that are deregulated in cancerous cells.
- Contribution of Genetic mutation in the development of cancer
- Environmental factors influencing susceptibility of cancer
- Treatment modalities i.e traditional chemotherapies and novel targeted therapeutic approaches
- Genetic Engineering technologies to understand cancer prevention, diagnosis, and treatment

Course outcomes:

- By the end of the course, students should be able to describe the:
- Process of tumorigenesis at the molecular and cellular level.
- Cell cycle regulatory mechanisms in normal and tumor cells
- Role of oncogenes and tumor suppressor genes and their genetic alterations in cancer formation.
- Importance of apoptosis in normal and tumor cells
- Tumorigenesis, angiogenesis, and metastasis.

Module	Contents	Contact Hours
01	Control of Cell proliferation, Cell Cycle and Cell Death: Process of Cell cycle, tumor suppressor genes, Cell cycle control and pRb tumor suppressor. Apoptosis and p53 tumor suppressor gene. Introduction to different forms of cancers.	06
02	Mutagens, carcinogens, and mutations: Chemical Carcinogenesis, Metabolism of Carcinogenesis, targets of Chemical Carcinogenesis, Physical carcinogens - X-Ray radiation – Mechanism of radiation Carcinogenesis. DNA repair mechanisms – DNA repair defects and their relationship to cancer. Gene mutations and deregulation in cell signal pathway	08
03	Oncogenes, growth factors, receptors and cancer: Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Role of growth factors and receptors in carcinogenesis, RAS, NFkB, Wnt signaling in cancer.	08
04	Tumor Invasion and Metastasis: Metastatic cascade, Basement membrane disruption, Three step theory of invasion, Proteinases and tumour cell invasion. Multi-step tumorigenesis and the evolution of cancer.	07

05	Cancer treatment modalities: Different forms of therapy- Chemotherapy, Radiation Therapy, Immunotherapy, commonly used cancer diagnostic and prognostic molecular markers, Novel targeted therapeutic approaches.	06
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Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. King R.J.B., "Cancer Biology", Addison Wesley Longmann Ltd, U.K., 1996.
2. Ruddon. R.W, "Cancer Biology", Oxford University Press, Oxford, 1995, 2007.
3. Robert Allan Weinberg, "The Biology of Cancer", Volume 2, Garland Science, 2007.

Course Code	Course/Subject Name	Credits
BTE6024	Department Elective II- Green Technology	4

Pre-requisites:

- Basics of physics, chemistry, biochemistry, and microbiology

Course Objectives:

- Green Technologies is a highly interdisciplinary degree program that emphasizes green systems and the environment, energy technology and efficiency, and sustainability and society. The objective of this course is to:
- Seek opportunities for alternative sourcing, conservation, efficiency and repurposing through an understanding of product life cycles from origins to recycling or inevitable disposal.
- To design products, processes and complex infrastructure systems to promote sustainable attributes of importance to the environment and the global community.
- To combine technical and scientific skills with an understanding of the environment, renewable energy management, waste utilization, resource management and land based industries who can contribute to the national and global development.

Course outcomes:

- To understand the principles of green chemistry and engineering.
- To design processes those are benign and environmentally viable.
- To design processes and products those are safe and hazard free.
- To learn to modify chemical processes making hazardous products and make them green safe and economically acceptable by using biotechnology.

Module	Contents	Contact Hours
01	Fundamentals of Green Chemistry and Technology- Principles of Green Chemistry and technology, green chemistry metrics (atom economy, atom efficiency, E-factor, and other green chemistry metrics)	05
02	Catalysis- Introduction to catalysis, Catalytic cycle, TON, TOF, bio-catalysis	03
03	Industrial Safety and Hazard analysis- Introduction to ISO standards, hazard identification, life cycle analysis, and safety aspects related to transport, handling and storage of hazardous chemicals. green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity- WEHAB (eco-restoration/ phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies , global warming; greenhouse gas emissions, impacts, mitigation and adaptation	10
04	Green processes- Microwave assisted reactions, ultra-sonication assisted reactions, ionic liquids as solvent, water as a reaction medium, solvent free reactions, supercritical solvents, safe product and process design, case studies	04
05	Advances in separation process- Adsorption, Distillation,	04

	filtration, membrane separation, precipitation, crystallization	
06	Green Biotechnology- Green concepts in biotechnology, organic synthesis using supported microbes and enzymes in biopharmaceuticals/ bio refineries, bioreactor designs, downstream processing.	04
07	Green Nanotechnology - Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste Management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology	05

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Green Chemistry – An introductory text - M. Lancaster, RSC
2. Industrial catalysis – optimizing catalysts and processes – R J Wijngarden Wiley - VCH
3. Safety and Reliability of Industrial Products, Systems and Structures C. Guedes Soares (Eds), CRC Press
4. Green separation processes- C. A. M. Afonso, J. G. Crespo (Ed)- Wiley VCH
5. Industrial biotechnology- sustainable growth and economic success- Wilm Soetaert Reic J Wandamme- Wiley VCH
6. Energy, Ecology and the Environment, Academic Press Inc, B. R Wilson & W J Jones, 2005

Course Code	Course/Subject Name	Credits
BTL601	Lab-II	1.5

Concept for Experiments

A minimum of TEN experiments must be performed

- Maintenance of aseptic condition in PTC Lab
- Medium Preparations
- Callus induction and Regenerations
- Callus propagation
- Organogenesis
- Haploid Culture
- Embryo Culture
- Somatic Embryogenesis
- Suspension Culture
- Anther culture for production of haploid plants
- In vitro seed germination
- Inoculate the tissue culture raised shoots on suitable medium for in vitro rooting
- Hardening and acclimatization of in vitro raised rooted shoots
- Hairy root induction by *Agrobacterium tumefaciens*
- seed anti-mitotic assay
- Meristem culture for obtaining Virus free plants
- Effect of plant growth regulators on callus induction : effect of hormone variation
- Encapsulate the shoot buds, seeds to demonstrate the production of synthetic seeds
- Sterilization procedures and media preparation for Animal Cell cultures
- Establishment of Primary cell culture from chick embryo
- Animal cell culture: viable cell counting by Haemocytometer

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL602	Lab-III	1.5

Concept for Experiments

A minimum of TEN experiments must be performed

- Isolation of enzyme from a plant source
- Isolation of enzyme from an animal source
- Isolation of intracellular enzyme
- Determination of specific activity of enzyme
- Determination of the optimum pH & temperature of enzyme
- Determine the stability of enzyme
- Immobilization of enzyme
- Determination of kinetic parameters (K_m and V_{max})
- Purification of enzymes
- Studies of various enzyme reactors
- Bacteriological testing of milk (MBRT)
- Estimation of Calcium by EDTA method
- Isolation and separation of chloroplast by sucrose density gradient centrifugation
- Production of Grape wine and its biochemical analysis
- Determination of starch and sugar in plant tissue
- Clarification of fruit juices
- Study of pectinase activity
- Primary screening of Amylase producing bacteria and fungi from soil

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
B.E. Semester VII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC701	Bioseparation & Downstream Processing Technology-I	4	-	1	4	-	1	5
BTC702	Bioprocess Modelling and Simulation	4	-	1	4	-	1	5
BTC703	Agriculture Biotechnology	3	-	1	3	-	1	4
BTE703X	Department Elective III	3	-	1	3	-	1	4
ILO701X	Institute Level optional Subject I	3	-	-	3	-	-	3
BTP701	Project A	-	-	6	-	-	3	3
BTL701	Lab - IV	-	3	-	-	1.5	-	1.5
BTL702	Lab - V	-	3	-	-	1.5	-	1.5
	Total	17	6	10	17	3	7	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC701	Bioseparation & Downstream Processing Technology-I	20	20	20	80	3	25	-	-	125
BTC702	Bioprocess Modelling and Simulation	20	20	20	80	3	25	-	-	125
BTC703	Agriculture Biotechnology	20	20	20	80	3	25	-	-	125
BTE703X	Department Elective III	20	20	20	80	3	25	-	-	125
ILO701X	Institute Level optional Subject I	20	20	20	80	3	-	-	-	100
BTP701	Project A	-	-	-	-	-	100		50	150
BTL701	Lab - IV	-	-	-	-	-	-	25	-	25
BTL702	Lab - V	-	-	-	-	-	-	25	-	25
	Total			100	400	-	200	50	50	800

Department Elective III (Sem VII)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Stem Cell & Tissue Engineering (BTE7031)	1. Operation research in Biotechnology (BTE7032) 2. Project Management (BTE7033)	1. Nanotechnology (BTE7034)

Institute Level Optional Subject I (Sem VII)		
1. Product Lifecycle Management (ILO7011)	4. Design of Experiments (ILO7014)	7. Disaster Management and Mitigation Measures (ILO7017)
2. Reliability Engineering (ILO7012)	5. Operation Research (ILO7015)	8. Energy Audit and Management (ILO7018)
3. Management Information System (ILO7013)	6. Cyber Security and Laws (ILO7016)	9. Development Engineering (ILO7019)

Course Code	Course/Subject Name	Credits
BTC701	Bio separation and Downstream Processing Technology-I	5

Pre-requisites:

- Basics of Bioprocesses and Unit Operations
- Basic knowledge of mass balance
- Concepts of molecular diffusion and diffusion coefficients

Course Objectives:

- To cover the fundamentals, and design concepts of various downstream purification steps (unit operations) involved in a biochemical process.

Course outcomes:

- Students will be able to describe theory, principle, design, application and possible integrations of unit operations in bioprocessing.

Module	Contents	Contact Hours
01	Introduction to By-products and Bio separation: Range and characteristics of bio products, Characteristics of Fermentation Broth, Selection of unit operation with due consideration of physical, chemical and biochemical aspect of biomolecules. Stages of Downstream Processing	04
02	Product release and recovery processes: Fundamental principles of obtaining the product from cell cultures: intracellular vs. extracellular product. Cell disruption-Physical, Chemical and Enzymatic methods of cell disruption, Mechanical Cell disruption methods: High pressure Cell Homogenizer, Bead Mill, Sonication	05
03	Primary Separation: Removal of insolubles and Biomass (and particulate debris) separation techniques, Flocculation and sedimentation, Centrifugation-Ultracentrifugation, Gradient centrifugation, Filtration: Theory of Filtration, Pre-treatment of Fermentation Broth, Filter Media and Equipment, Conventional and Cross-flow Filtration, Continuous Filtration, Filter cake resistance, specific cake resistance, Washing and dewatering of filter cakes	09
04	Gas Absorption: Solubility of gases in liquids, Effect of temperature and pressure on solubility, Ideal and Non-ideal solutions, Choice of solvent for gas absorption, absorption factor, stripping factor, minimum gas liq ratio, Single stage gas absorption-Cross Current, Co- current, Countercurrent, Multistage Counter current Operation, Absorption with Chemical Reactions, Related problems	10
05	Liquid-Liquid Separation Process: Introduction to Liquid-Liquid Extraction, Choice of Solvent for Liquid-Liquid Extraction, Binodal solubility curve,	10

	<p>Single Stage Operation, Equipments for liquid-liquid extraction.</p> <p>Types of extraction processes: Reactive extraction, Aqueous two phase systems, Reverse micellar extraction, Liquid-liquid and solid-liquid extraction, Supercritical fluid Extraction.</p> <p>Design of extraction equipment. Different types of extractors and designing of extractors.</p> <p>Distillation: Simple, Steam and Equilibrium distillation, Fractionation, McCabe Thiele method, azeotropes, numericals</p>	
06	<p>Leaching and Precipitation:</p> <p>Leaching: Representation of equilibria, single stage leaching, and multistage cross current leaching, multistage counter current leaching, equipments for leaching.</p> <p>Precipitation: Protein Precipitation methods: Isoelectric precipitation, Salting out, Organic solvent addition, Non-ionic polymers, Polyelectrolyte Addition, Selective denaturation of unwanted proteins, Large scale precipitation, Applications</p>	07

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Treybal R.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.
2. McCabe W. L.and Smith J.C., Unit operation in chemical engineering, 5Ed., McGraw Hill New York 1993.
3. Geankoplis C.J., Transport processes and unit operations, Prentice Hall, New Delhi 1997.
4. Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, Oxford University Press
5. B.Shivshankar, Bioseparations: Principles and Techniques, Eastern Economy

- Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012
6. Bioseparation & bioprocessing (2nd Ed.) 2-Volume set, Ed SUBRAMANIAN Ganapathy, Wiley-VCH, (09-2007)
 7. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley Interscience Publication, 1988.
 8. J.E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill, Inc., 1986.
 9. R. K. Scopes, Berlin, Protein Purification: Principles and Practice, Springer, 1982.
 10. Scopes Ak, Protein Purification, IRL Press, 1993
 11. Biotechnology: Bioprocessing, Rhem and Reed, Vol. 3, 1993
 12. Separation and purification techniques in biotechnology, Fredreich Dechow, 1989
 13. Asenjo J.A. and J.Hong (Eds), Separation Processes in Biotechnolgy, Taylor and Francis
 14. T. Schepler et al, Biotreatment, Downstream Processing and Modeling (Advances in Biochemical Engineering /Biotechnology, Vol 56) by Springer Verlag

Course Code	Course/Subject Name	Credits
BTC702	Bioprocess Modelling and Simulation	5

Pre-requisites:

- Knowledge of Fundamental Laws of Physics
- Knowledge of basic Mathematics
- Knowledge of Reactors and its types
- Knowledge of production of various fermentation products

Course Objectives:

- To understand the mathematical models in Biochemical Engineering systems
- To learn about different aspects of modelling in Bioprocess system
- To learn various techniques to solve and simulate various bioprocess models

Course outcomes:

- Students will be able to formulate model for biochemical System.
- Students will be able to solve Biochemical models

Module	Contents	Contact Hours
01	Basic Modelling Principles: Introduction, definition of Modelling and simulation, different types of models, application of mathematical modelling. Fundamental laws: continuity equation, energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics with examples	08
02	Mathematical Models for Biochemical Engineering Systems: Batch Reactor, CSTR isothermal with cooling/heating jacket or coil, Continuous Stirred Tank Bioreactor, Fed Batch reactor, Batch distillation	08
03	Numerical Methods: Solution of linear algebraic equations by Cramer's rule, Gauss elimination, Gauss sie del iterative method. Solution of Non algebraic equations by Bisection method, Newton Raphson, Secant Method. Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Euler's method, Runge Kutta method, Basic data analysis-curve fitting	10
04	Modelling approaches for Biological systems Growth kinetic Models - structured and unstructured systems; Compartment models; Deterministic and stochastic approaches for modelling structured systems. Thermal death kinetics models, Stochastic Model for thermal sterilization of medium.	10
05	Modelling for activated sludge process, Model for anaerobic digestion, Model for lactic acid fermentation, antibiotic production, Ethanol fermentation	09

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. J.E. Bailey and D.F. Ollis, Biochemical Engg Fundamentals, 1986, McGraw Hill Book Company
2. Said S.E.H. Elnashaie, Parag Garhyan, Conservation Equations and Modeling of Chemical and Biochemical Processes, 2003, Marcel Dekker
3. B. Wayne Bequette, Process Dynamics: Modeling, Analysis and Simulation, 1998, Prentice Hall
4. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002
5. Process Modelling, Simulation and Control for Chemical Engineers, by William Luyben, McGraw Hill, Second Edition.
6. Numerical Methods and Modelling for Chemical Engineers, Davis M.E., Wiley, New York 1984
7. Numerical Methods for Engineers, Santosh Kumar Gupta, Tata McGraw hill, 1995
8. Numerical Methods, M. K. Jain, S. R. K. Iyengar, and R. K. Jain Sixth Edition. New Age International Publishers, New Delhi, 2012
9. Introduction to Chemical Engineering Computing by Bruce A. Finlayson Wiley- International, 2005.

Course Code	Course/Subject Name	Credits
BTC703	Agriculture Biotechnology	4

Pre-requisites:

- Knowledge about plant tissue culture methods and applications.
- Knowledge about genetic engineering methods for e.g. gene transfer techniques, plant vectors and basics of transgenic plants.
- Knowledge about traditionally used herbicides, pesticides, its advantages and drawbacks
- Knowledge about ethical and biosafety issues and intellectual property rules associated with plants

Course Objectives:

- To understand basic plant biology and breeding methods.
- To gain knowledge about transgenic plant analysis, principle behind generation of herbicide and pest tolerant plants.
- To understand the stress condition in plants and methods to overcome it.
- To design methods for crop improvement.
- To analyse applications based on molecular farming.

Course outcomes:

- Students will be able to:
- Apply the transgenic methods to develop better quality crops.
- Understand the advantages and drawbacks of engineered plants and modify them accordingly.
- Harness the plants for improved quality biomaterials.

Module	Contents	Contact Hours
01	Agricultural Microbiology: Microbial groups in soil, Plant and Microbe interactions. Plant pathogens, Biological nitrogen fixation, Microflora of Rhizosphere and Phyllo sphere microflora, microbes in composting, Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial insecticides, Microbial agents for control of Plant diseases	05
02	Plant Breeding: Historical milestones in plant breeding, Aims and objectives of plant breeding, Significance of plant breeding in crop development. Concepts in plant breeding – Simple versus Complex Inheritance, Mating Systems, Varieties, and Pure Lines. Methods of Plant Breeding. Plant Hormone Signal Transduction - Auxin and GA Signaling, Cytokinin and Ethylene Signaling	05
03	Transgenic Plants: Transgenic Plant Analysis: screening on selection media, PCR, Intact Transgene Integration characterization, Real time PCR, Transgene expression, western blot analysis.	05

	Regulations and Biosafety. Field Testing of Transgenic Plants- Environmental Risk Assessment (ERA) process, e.g. the case of Bt Maize, Agronomic Performance, Risk analysis. Clean-gene technology.	
04	Genetic manipulation of herbicide tolerance: The use of herbicides in modern agriculture, types of compounds used as herbicides, Strategies for engineering herbicide tolerance - Glyphosate tolerance, Phosphinothricin, Prospects for plant detoxification systems, Commercialization of herbicide-tolerant plants to date, The environmental impact of herbicide-tolerant crops, Development of Superweeds.	03
05	Biotic and Abiotic stress: Abiotic stress: Acclimatization and crop adaptation to water stress, salinity stress, temperature stress, heat and cold, Photo oxidative stress, nutrient stress, heavy metal stress, metabolite engineering for abiotic stress tolerance Biotic stress: plant response to pathogens and herbivores, biochemical and molecular basis of host plant resistance, toxins of fungi and bacteria, systemic and induced resistance, pathogen derived resistance, genetic engineering for biotic stress resistance	06
06	Genetic manipulation of pest resistance: The nature and scale of insect pest damage to crops. GM strategies for insect resistance: the Bacillus thuringiensis approach. The use of Bacillus thuringiensis as a biopesticide. Bt-based genetic modification of plants. Problem of insect resistance to Bt, environmental impact of Bt crops. Copy Nature strategy	03
07	Improvement of crop yield and quality: Genetic manipulation of fruit ripening, softening, genetic modification of ethylene biosynthesis. Golden rice and Biofortified rice. Engineering plant protein composition for improved nutrition. The genetic manipulation of crop yield by enhancement of photosynthesis	04
08	Molecular farming: Farming of carbohydrates (e.g. starch, polyfructans) Metabolic engineering of Lipids (e.g. Bioplastics) Molecular farming of proteins (e.g. oleosin system: hirudin and insulin production). Medically related proteins (e.g. custom made antibodies, Edible vaccines)	04

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Plant biotechnology-The genetic manipulations of plants by Slater, A., Scott, N. and Fowler, M., Oxford University press
2. Principles of Plant Breeding by Allard R W 1960 .Kalyani Publishers, New Delhi.
3. Plant Biotechnology and Genetics: Principles, Techniques, and Applications - Edited by C. Neal Stewart, Jr.
4. Stress biology, by U.Chakraborty, Bishwanath Chakraborty, 2005. Narosa Publishing House.
5. Agricultural Microbiology by D. J. Bagyaraj, G. Rangaswami, Prentice Hall of India Pvt Ltd.

Course Code	Course/Subject Name	Credits
BTE7031	Department Elective-III: Stem Cell & Tissue Engineering	4

Pre-requisites:

- Cell Biology, Developmental Biology, Biochemistry, Molecular Biology and Genetics.

Course Objectives:

- To understand the developmental processes in a complex living system.
- To manipulate the cells to change and perform tasks in a carefully directed fashion.
- To understand the possibilities this technology offers in a medical field

Course outcomes:

- This course gives an overview about the application of stem cells for regenerative medicine.
- It explains advantages and disadvantages of stem cells as therapeutics.
- The students obtain knowledge in medical applications of biomaterials as well as about basic concepts regarding design and mechanical properties of selected natural and synthetic biomaterials
- The Tissue Engineering and Regenerative Medicine educate students in two new, interdisciplinary fields in the biomedical sciences that aim to replace damaged tissue in the human body and to stimulate the body's own regenerative processes.
- International research and development of new therapies in these areas is currently booming

Module	Contents	Contact Hours
01	Development of multicellular organisms: Universal mechanisms of animal development, Basic anatomical features, Role of proteins and regulatory DNA in development, Approaches to understand developmental processes, Cell fate, Positional value of cell, Inductive signalling, Asymmetric cell division, Positive feedback, Morphogens and their gradients, Intrinsic programming, Patterning by sequential induction	06
02	Stem cells: Definition, Properties & Types of stem cells, Maintaining population of stem cells, Transit amplifying cells. Embryonic stem cells: Properties, Pluripotent stem cells and methods of generating them. Adult stem cells and their sources.	04
03	Epidermal renewal by stem cells: The multilayered structure of epidermis, Role of stem cells and transit amplifying cells in epidermis renewal. Renewal by multipotent stem cells: Blood cell formation, Bone marrow and Hemopoietic Stem Cells, Hematopoiesis, Contact Signals From Stromal Cells. Osteogenesis: Formation of bone & cartilage from Mesenchymal Stem Cells.	05

04	Applications of stem cells in regenerative medicine: Repairing Nervous system, Liver cell proliferation and repair, Cardiac repair, Diabetes treatment, GM stem cells and Gene therapy. Ethical issues associated with stem cells	05
05	Tissue Engineering: Introduction to biomaterials and tissue engineering, Elements of biomaterials, Self-assembly and growth, Mechanical concepts in biomaterials, Different protein fibers: collagen, silk, keratin. Characterization of biomaterials, Methods for the determination of biocompatibility, Biological composite materials e.g. fibers, Hierarchical design bone, wound care and suture materials, vascular implants, biomimetic and bio-inspired materials, Basic techniques to manufacture scaffolds from raw biomaterials and different prerequisites for the biomaterials	10
06	Tissue engineering examples: Bone & Cartilage tissue engineering, skin tissue engineering, vascular tissue engineering, heart valves tissue engineering	05

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Molecular biology of Cell: Alberts et al.2014.(Chapter 22 and 23)
2. Gordana Vunjak- Novakovic, R. Ian Freshney (2006): Culture of Cells for Tissue Engineering, Wiley
3. Ulrich Meyer, Thomas Meyer, Jörg Handschel, Hans Peter Wiesmann (2009): Fundamentals of Tissue Engineering and Regenerative Medicine, Springer
4. Lanza RP, Langer R, Vacanti J. Principles of Tissue Engineering. Third edition. Academic Press. 2007

Course Code	Course/Subject Name	Credits
BTE7032	Department Elective-III: Operation Research in Biotechnology	4

Pre-requisites:

- Linear Algebra
- Computer Programming

Course Objectives:

- To understand Linear Programming and its applications to OR models.
- To understand and solve network models in OR.
- To understand Game theory and its applications.
- To study and design Queuing systems.

Course Outcomes:

- The student will be able to solve typical OR models using linear integer and dynamic programming techniques.
- The student will be able to model and solve network flow problems in OR.
- The student will be able to make decisions under various scenarios.
- The student will be able to design Queuing Systems

Module	Contents	Contact Hours
1	Module: Linear Programming Contents: Introduction Graphical Method of Solution Simplex Method Two-Phase Method Duality Dual Simplex Revised Simplex	10
2	Module: Transportation Models Contents: Examples of Transportation Models The Transportation Algorithm The Assignment Model The Trans shipment Model	06
3	Module: Network Models Contents: Scope and Definition of Network Models Minimal Spanning Tree Algorithm Shortest Route Problem Maximal Flow Model	06
4	Module: Integer and Dynamic Programming Contents: Branch and Bound Method Travelling Salesman Problem Introduction to Dynamic Programming Forward and Backward Recursion Selected Applications	06

5	Module: Deterministic Inventory Models Contents: Classic EOQ Model EOQ with Price Breaks Dynamic EOQ Models No-Setup Model Setup Model	06
6	Module: Decision Analysis and Game Theory Contents: Decision Making under Certainty Decision Making under Risk Decision Under Uncertainty Game Theory	06
7	Module: Queuing Systems Contents: Elements of a Queuing Model Role of Exponential Distribution Pure Birth and Death Models Generalized Poisson Queuing Model Measures of Performance	08

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Text Books

1. Operations Research; Hamdy A. Taha; Eighth Edition; Prentice Hall India

References

1. Hillier and Lieberman; Introduction to Operations Research

Course Code	Course/Subject Name	Credits
BTE7033	Department Elective-III: Project Management	4

Pre-requisites:

- Knowledge of Fundamentals of project

Course Objectives:

- To get acquainted with various aspects of project management.
- To study different scheduling and planning techniques used in the industry.
- To study various applications of inventory and project management with respect to the Bioprocess Industry.
- To study Life-cycle of the project.
- To develop and strengthen entrepreneurial quality in students.
- To impart basic entrepreneurial skills and understandings to run a business efficiently and effectively.

Course outcomes:

At the end of the course, learners should be able to;

- Describe the fundamental concepts in Project management
- Analyse the various scheduling and planning techniques
- Understand and apply suitable strategy for any specific project
- Apply project management principles in business situations to optimize resource utilization and time.

Module	Contents	Contact Hours
01	Introduction to Project Management: Management, Definition, Goal, Lifecycles. Project Selection Methods. Project Portfolio Process, Project Formulation. Project Manager – Roles, Responsibilities and Selection, Project Teams.	08
02	Planning and Budgeting: The Planning Process – Work Break down Structure Role of Multidisciplinary teams. Budget the Project – Methods. Estimating and Improvement. Budget uncertainty and risk management.	09
03	Scheduling and Resource allocation: GANTT Chart, PERT & CPM Networks, GERT, Crashing Project Uncertainty and Risk Management – Simulation – Gantt Charts. Algorithms for solving sequencing problems – Processing of N jobs through K machines, Assignments and transportation algorithms -Expediting a project –Resource loading and leveling. Allocating scarce resources –Goldratt’s Critical Chain.	09
04	Project control and conclusion: The Plan-Monitor-Control cycle – Data Collecting and reporting	09

	Project Control – Designing the control system. Project Evaluation, Auditing and Termination.	
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Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. John M. Nicholas, “Project management for business/Technology”, Pearson
2. Uddesh Kohli, K.K Chitkara, “Project Management Handbook”, Tata McGraw Hill
3. Samuel J. Mantel et al, “Project management”, Wiley India
4. S. Choudhury, “Project Management”, Tata McGraw Hill
5. P K Joy, “Total Project Management –The Indian context”, Macmillan
6. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001
7. S.S. Khanka, Entrepreneurial Development, S. Chand and Company Limited

Course Code	Course/Subject Name	Credits
BTE7034	Department Elective-III: Nanotechnology	4

Pre-requisites:

- Knowledge of Biophysics, Biochemistry, Molecular Biology, Immunology and Analytical Methods in Biotechnology

Course Objectives:

- To develop the skills of the student in the area of Nanotechnology and its application.
- To familiarize student with different techniques for synthesizing and characterizing of various nanoparticles.

Course outcomes:

- Students will have an in depth understanding of the components of Nanotechnology and the instruments used in Nanotechnology.
- Students will be able to apply the concepts of Nanotechnology in various fields.

Module	Contents	Contact Hours
01	Basics and Scale of Nanotechnology: Introduction, Scientific revolutions, Time and length scale in structures, Definition of a nanosystem, Dimensionality and size dependent phenomena, Surface to volume ratio-Fraction of surface atoms, surface energy and surface stress, surfaced effects, Properties at nanoscale (optical, mechanical, electronic and magnetic)	06
02	Different Classes of Nanomaterials: Classification based on dimensionality, Quantum Dots, Wells and Wires, Carbon-based nano materials (buckyballs, nanotubes, graphene), Metal based nanomaterials (nanogold, nanosilver and metal oxides), Nanocomposites, Nanopolymers, Nanoglasses, Nano ceramics, Biological nanomaterials	07
03	DNA and Protein based Nanostructures: DNA-gold particle conjugates, Polymer nanocontainers, Nanopores and nanomembranes for biochemical sensing, Micro and nanofluidic devices in biological studies, Peptide nanotubes and their applications in electronics, antibacterial agents; protein self-assembly, nanochips, nanopolymers	07
04	Nano-bioanalytics: Luminescent Quantum Dots for Biological Labeling, Nanoparticle Molecular Labels Surface Biology: Analysis of Biomolecular Structure by Atomic Force Microscopy and Molecular Pulling-Force Spectroscopy, Biofunctionalized Nanoparticles for Surface Enhanced Raman Scattering and Surface Plasmon Resonance, Bioconjugated Silica Nanoparticles for Bioanalytical Applications	06

05	Nanotechnology in Food, Medicine and Health Sciences: Nanocomposites for food packaging, nanomaterials in cosmetics, Regenerative medicine - Nanostructured collagen mimics in tissue engineering, synthesis of nanodrugs, polymeric nanoparticle for Drug and gene delivery, Micelles for drug delivery, Nanotechnology in cancer research, Preparation of nanobiomaterials-Polymeric scaffolds collagen, Elastins, Mucopolysaccharides, proteoglycans, cellulose and derivates, Dextrans, Alginates, Pectins, Chitin Toxicity and Environmental Risks of Nanomaterial	09
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Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Pradeep T., A textbook of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., 2012.
2. Hari Singh Nalwa, Nanostructured Material and Nanotechnology, Academic Press, 2002
3. Niemeyer C. M., Bionanotechnology: Concepts, Application and Perspectives Wiley VCH, 2006

Course Code	Course Name	Credits
ILO7011	Institute Level Optional Subject I- Product Life Cycle Management	03

Objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Outcomes:

Learner will be able to...

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Contact Hours
01	Introduction to Product Lifecycle Management (PLM):Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM.	10
02	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process.	09
03	Product Data Management (PDM):Product and Product Data,	05

	PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.	
04	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	05
05	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design.	05
06	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis.	05

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO7012	Institute Level Optional Subject I- Reliability Engineering	03

Objectives:

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes:

Learner will be able to...

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Contact Hours
01	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts	05

	standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
06	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Connor, “Practical Reliability Engg.” John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	Institute Level Optional Subject I- Management Information System	03

Objectives:

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

Outcomes:

Learner will be able to...

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Contact Hours
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, and Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	Institute Level Optional Subject I- Design of Experiments	03

Objectives:

- To understand the issues and principles of Design of Experiments (DOE)
- To list the guidelines for designing experiments
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes:

Learner will be able to...

- Plan data collection, to turn data into information and to make decisions that lead to appropriate action
- Apply the methods taught to real life situations
- Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Contact Hours
01	Introduction 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	Fitting Regression Models 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	Two-Level Factorial Designs and Analysis 3.1 The 2 ² Design 3.2 The 2 ³ Design 3.3 The General 2 ^k Design 3.4 A Single Replicate of the 2 ^k Design 3.5 The Addition of Center Points to the 2 ^k Design, 3.6 Blocking in the 2 ^k Factorial Design 3.7 Split-Plot Designs	07
04	Two-Level Fractional Factorial Designs and Analysis 4.1 The One-Half Fraction of the 2 ^k Design 4.2 The One-Quarter Fraction of the 2 ^k Design 4.3 The General 2 ^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	Conducting Tests 5.1 Testing Logistics	07

	5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	
06	Taguchi Approach 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss
6. Phillip J Ross, "Taguchi Technique for Quality Engineering," McGraw Hill
7. Madhav S Phadke, "Quality Engineering using Robust Design," Prentice Hall

Course Code	Course Name	Credits
ILO7015	Institute Level Optional Subject I- Operations Research	03

Objectives:

- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Outcomes:

Learner will be able to...

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems; solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Contact Hours
01	<p>Introduction to Operations Research: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research</p> <p>Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p>Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.</p> <p>Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem</p> <p>Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to</p>	14

	Decomposition algorithms.	
02	Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, Kedar Nath Ram Nath-Meerut.
5. Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO7016	Institute Level Optional Subject I- Cyber Security and Laws	03

Objectives:

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Outcomes:

Learner will be able to...

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Contact Hours
1	Introduction to Cybercrime: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
2	Cyber offenses & Cybercrime: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
3	Tools and Methods Used in Cyberline Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
4	The Concept of Cyberspace E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking, The Need for an Indian Cyber Law	8
5	Indian IT Act. Cyber Crime and Criminal Justice: Penalties, Adjudication and	6

	Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	
6	Information Security Standard compliances SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
6. Kenneth J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.
7. William Stallings, Cryptography and Network Security, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Course Code	Course Name	Credits
ILO7017	Institute Level Optional Subject I- Disaster Management and Mitigation Measures	03

Objectives:

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Outcomes:

Learner will be able to...

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structures associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Contact Hours
01	Introduction: Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration: Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with	06

	and how to proceed in due course of time, study of flowchart showing the entire process.	
04	Institutional Framework for Disaster Management in India: Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: Pre-disaster, during disaster and post-disaster measures in some events in general structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.

3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep, Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yongg – Prentice Hall (India) Publications.
8. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO7018	Institute Level Optional Subject I- Energy Audit and Management	03

Objectives:

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes:

Learner will be able to...

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Contact Hours
1	Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
2	Energy Audit Principles: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
3	Energy Management and Energy Conservation in Electrical System: Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers.	10

	Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
4	Energy Management and Energy Conservation in Thermal Systems: Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
5	Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
6	Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B. Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Institute Level Optional Subject I- Development Engineering	03

Pre-requisite:

- Interest in societal development.

Course Objective:

- To understand the characteristics of rural Society and the Scope and Nature and Constraints of rural Development.
- To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
- The objective of the course is an exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life'. The context is the work life and the personal life of modern Indian professionals.
- To understand the Nature and Type of Human Values relevant to Planning Institutions.

Course Outcome:

- Students will be able to apply knowledge for Rural Development.
- Students will be able to apply knowledge for Management Issues.
- Students will be able to apply knowledge for Initiatives and Strategies
- Students will be able to develop acumen for higher education and research.
- Students will master the art of working in group of different nature.
- Students will develop confidence to take up rural project activities independently.

Module	Contents	Contact Hours
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development.	04
2	Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	04
3	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	04
4	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies;	06

	Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-economy zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
5	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
6	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education.	04
7	Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	06
8	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rdGoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners

7. Weaver, R.C., *The Urban Complex*, Doubleday.
8. Farmer, W.P. et al, *Ethics in Planning*, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, *Journal of Planning Literature*, Vol.5, No.2, pp. 123-150.
10. Watson, V. , *Conflicting Rationalities: -- Implications for Planning Theory and Ethics*, *Planning Theory and Practice*, Vol. 4, No.4, pp.395 – 407

Course Code	Course Name	Credits
BTP701	Project-A	03
<p>Guidelines:</p> <ul style="list-style-type: none"> • Project groups: Students can form groups with not more than 3 (three). • Students should spend considerable time in applying all the concepts studied, into the Project, hence, eight hours each are allotted in project A and B to the students. • Students are advised to take up industrial/ experimental/ simulation and/or optimization based topics for their project • Students should report their guides weekly with their work. <p>Exam Guidelines</p> <p>Term Work - 100 Marks:</p> <ul style="list-style-type: none"> • Presentation – 50 Marks • Report -50 Marks <p>Oral – 50 Marks</p>		

Course Code	Course/Subject Name	Credits
BTL701	Lab IV	1.5

Concepts for experiments:

A minimum of 10 experiments must be performed based on the following concepts:

- Viscometer
- Cell disruption
- Conventional filtration
- Distribution coefficient in Liq-liq extraction
- Solid-liquid extraction of natural product and subsequent purification
- Leaching
- Protein precipitation by various methods and its recovery
- Separation of Plant Pigments using Column Chromatography
- Steam Distillation
- Simple Distillation
- Vacuum Filtration
- Extraction of Phytochemicals using different extraction methods

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL702	Lab V	1.5

Concepts for experiments:

A minimum of 10 experiments must be performed based on the following:

- Material Balance without Reaction
- Material Balance with Reaction
- Energy Balance equations
- Solving Linear equations
- Solving Non-linear algebraic equations
- Parameter Estimation in kinetics
- Modelling of Batch, Fed Batch and Continuous
- Simulation of Batch Reactor
- Simulation of Continuous Reactor
- Solving Numerical integrations
- Solving Algebraic equations
- Solving Differential Equations

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
B.E Semester VIII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	
BTC801	Environmental Biotechnology	4	-	-	4	-	-	4
BTC802	Bioseparation & Downstream Processing technology-II	4	-	-	4	-	-	4
BTC803	Bioprocess Plant & Equipment design	3	-	1	3	-	1	4
BTE804X	Department Elective IV	3	-	1	3	-	1	4
ILO802X	Institute Level optional Subject II	3	-	-	3	-	-	3
BTP801	Project B	-	-	8	-	-	6	6
BTL801	Lab - VI	-	3	-	-	1.5	-	1.5
BTL802	Lab - VII	-	3	-	-	1.5	-	1.5
	Total	17	6	10	17	3	8	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC801	Environmental Biotechnology	20	20	20	80	3	-	-	-	100
BTC802	Bioseparation & Downstream Processing technology-II	20	20	20	80	3	-	-	-	100
BTC803	Bioprocess Plant & Equipment design	20	20	20	80	3	25	-	-	125
BTE804X	Department Elective IV	20	20	20	80	3	25	-	-	125
ILO802X	Institute Level optional Subject II	20	20	20	80	3	-	-	-	100
BTP801	Project B	-	-	-	-	-	100	-	50	150
BTL801	Lab - VI	-	-	-	-	3	-	25	-	25
BTL802	Lab - VII	-	-	-	-	3	-	25	-	25
	Total			100	400	-	150	50	50	750

Department Elective IV (Sem VIII)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Non-conventional Sources of Energy (BTE8041)	1. Total Quality Management (BTE8042) 2. Entrepreneurship (BTE8043)	1. Advanced Bioinformatics (BTE8044)

Institute Level Optional Subject II (Sem VIII)		
1. Project Management (ILO8021)	4. Human Resource Management (ILO8024)	7. IPR and Patenting (ILO8027)
2. Finance Management (ILO8022)	5. Professional Ethics and CSR (ILO8025)	8. Digital Business Management (ILO8028)
3. Entrepreneurship Development and Management (ILO8023)	6. Research Methodology (ILO8026)	9. Environmental Management (ILO8029)

Course Code	Course/Subject Name	Credits
BTC801	Environmental Biotechnology	4

Pre-requisites:

- Knowledge of Biotechnological aspects and molecular genetics

Course Objectives:

- The main objective of this course is to introduce to the students the current biotechnological approaches and technologies in the use of microbes and/or other organisms and their processes to improve environmental quality, clean up contaminated environment, renew resources and generate valuable products for human society.

Course outcomes:

- Apply their knowledge of environmental science and biological systems to improve the quality of life in individual context.
- Recognize key environmental problems and to apply the operating principles and biotic systems for remediation.
- Design, improve and apply biotechnological systems and processes to meet practical needs of different environmental problems.

Module	Contents	Contact Hours
1	Introduction: Environmental Degradation, types of environmental degradation, factors affecting environmental degradation, Environmental monitoring- sampling (land, air, water), analysis- physical, chemical, biological, pollution monitoring- bio indicators, biosensors, biomarkers, pollution control aspects.	03
2	Pollution control: Atmospheric stability, atmospheric dispersion- (Gaussian plume model), air pollution control- Particulate and gaseous control, source correction methods, natural pathways of exchange of air pollutants from atmosphere to earth (wet precipitation- rain out, washout)	06
3	Water Pollution Control: Measurement of organic and inorganic pollutants, DO depletion, modelling of BOD reaction, problems on BOD, Methods of waste water treatment, Microbiology and design (activated sludge process, trickling process), Rotating Biological contactors, Fluidized bed reactors, anaerobic sludge digestion, Methanogenesis, methanogenic, acetogenic, fermentative bacteria- technical process and condition, waste water treatment using aquatic plants, heavy metal removal by hairy roots.	07
4	Soil Pollution Control: Bioremediation of contaminated soil, types of bioremediation, factors affecting bioremediation, phyto fremediation, role of genetic engineering	05

5	Solid waste management: Types of solid waste, sources, effects, methods of collection, disposal methods, potential methods of disposal, disposal of hazardous waste, Biological conversion process (aerobic, anaerobic, bioventing), biotechnology applications to hazardous waste management	06
6	Special topics in Bioremediation technology: Nanotechnology for bioremediation of heavy metals, sulphate and sulphur reducing bacteria, bioremediation of petroleum sludge using bacterial consortium and bio surfactants	04
7	Downstream Processing: Downstream processing in biological treatment process, effluent disposal and reuse, bio filtration of waste gas, treatment and purification of biogas	04
8	Effluent treatment: Need of ETP in industry, Components of ETP, general design procedure for ETP, ETP studies of industries like dairy, metal, food etc.	05
9	Environmental Legislations: Water Prevention and Control Pollution Act, Water pollution act, Air pollution and prevention act, The environment Protection Act, Forest Conservation Act, Municipal Solid Waste Rules, Biomedical Waste Rules, Hazardous Wastef Rules, Environmental Clearance, Environmental Legislation and Pollution Control Acts in India, Central Pollution Control Board, its functions and powers, Procedure to operate an industry	02
10	Environmental Standards: Need and Use of environmental standards, Agencies and Bodies setting environmental standards, classification of environmental standards, National and International Standards for waste water	03

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Environmental Biotechnology- Allen Scragg, Oxford University Press, Second edition
2. Environmental Biotechnology, 1995 S.N. Jogdand, Himalaya Publishing

- House.
3. Bioremediation, 1994 Barker, K.H. and Herson, D.S., McGraw Hill, Inc. New York
 4. Waste water Engineering, Metcalf & Eddy, Tata McGraw Hill Publication, Fourth edition
 5. Environmental Science, Richard T. Wright, PHI Pvt. Ltd., Ninth edition
 6. Environmental Pollution Health and Toxicology, S.V.S.Rana, Narosa Publishing House Pvt.Ltd., First edition

Course Code	Course/Subject Name	Credit
BTC802	Bioseparation and Downstream Processing technology-II	4

Pre-requisites:

- Basics of Bioprocesses and Unit Operations.
- Basic knowledge of mass balance.
- Concepts of molecular diffusion and diffusion coefficients.

Course Objectives:

- To cover the fundamentals, and design concepts of various downstream purification steps (unit operations) involved in a biochemical process.

Course outcomes:

- Students will be able to describe theory, principle, design, application and possible integrations of unit operations in bioprocessing

Module	Contents	Contact Hours
01	Adsorption and Ion Exchange: Introduction to Adsorption, Types of Adsorption, Adsorption Isotherms, Single Stage Adsorption, Multistage Cross Current Adsorption, Multistage Counter Current Adsorption, Equipments for Adsorption, Ion Exchange Equilibria, Ion Exchange Equipments Design and Construction of Chromatographic Columns for Bioseparations	10
02	Membrane Separation Techniques: Membrane separation processes: Reverse Osmosis, Ultrafiltration, Microfiltration, Nanofiltration, Dialysis, Electrodialysis, Gas Permeation, Pervaporation. Types of Membranes, Membrane Modules and design. Retention coefficient, Concentration Polarization, Membrane fouling Factors affecting membrane filtration. Advantages of membrane separation processes over conventional separation techniques, Industrial Applications	08
03	Equipments for Gas-Liquid Contacting applicable for Bioprocesses: Classification of equipments for gas-liquid contacting, Gas dispersed and liquid continuous phase-Sparged Vessels (Bubble Columns), Mechanically Agitated Vessels, Tray Towers, Spray Towers and Spray Chambers, Packed Towers Comparison of Packed Towers with Tray Towers.	06
04	Crystallization: Solubility curve, Super saturation, Method of obtaining supersaturation Effect of heat on size and growth of crystal, Rate of Crystal growth and Delta-L law of crystal growth, Material and energy balance for crystallizers Crystallization equipment-description	08
04	Drying: Introduction to drying, Equilibrium, Different types of moisture contents, Rate of Drying and drying curve, Batch	06

	Drying and calculation of time of drying, types of driers, Lyophilisation, Formulation Mixing and agitation: Principles of agitation, agitation equipment, Solid solid mixing equipment, Mixing effectiveness and Mixing index, Flow patterns in Agitated vessels, Impellers, Types of impellers, power consumption of impellers	
05	Case Studies of downstream processing: Baker's yeast, Ethanol, Citric acid, Penicillin, Insulin, interferon, Monoclonal antibodies, Tissue plasminogen activator, Taq polymerase	07

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Treybal R.E., Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.
2. McCabe W.L. and Smith J.C., Unit operation in chemical engineering, 5Ed. McGraw Hill New York 1993.
3. Geankoplis C.J., Transport processes and unit operations, Prentice Hall, New Delhi 1997.
4. Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, Bioseparations Science and Engineering, Oxford University Press
5. B. Shivshankar, Bioseparations: Principles and Techniques, Eastern Economy Edition, PHI Learning Pvt. Ltd., Publishing House, New Delhi, 2012
6. Bioseparation & bioprocessing (2nd Ed.) 2-Volume set, Ed SUBRAMANIAN Ganapathy, Wiley-VCH, (09-2007)
7. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations- Downstream Processing for Biotechnology, Wiley Interscience Publication, 1988.
8. J.E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill, Inc., 1986.
9. R. K. Scopes, Berlin, Protein Purification: Principles and Practice, Springer, 1982.
10. Scopes Ak, Protein Purification, IRL Press, 1993
11. Biotechnology: Bioprocessing, Rhem and Reed, Vol.3, 1993
12. Separation and purification techniques in biotechnology, Fredreich Dechow, 1989
13. Asenjo J.A. and J.Hong (Eds), Separation Processes in Biotechnology, Taylor and Francis

14. T. Schepler et al, Biotreatment, Downstream Processing and Modeling (Advances in Biochemical Engineering /Biotechnology, Vol 56) by Springer Verlag
15. Nooralbettu Krishna Prasad, Downstream Process Technology, PHI Learning, Pvt. Ltd., Eastern Economy Edition.

Course Code	Course/Subject Name	Credits
BTC803	Bioprocess Plant & Equipment Design	4

Pre-requisites:

- Process Calculation
- Unit operation I and II

Course Objectives:

- To impart basic concepts of mechanical and process design of process plant.
- To impart design principles for bioreactor.

Course outcomes:

- This course makes the students to learn the methods and practices followed in the design of Bioprocess equipments.
- This course makes the students to draw the designed equipments to scale.
- The course imparts advanced knowledge on bioreactor design for efficient utilization of the principles in bioprocess technology

Module	Contents	Contact Hours
1	Material of construction for process and bioprocess plants. Mechanical design of process equipment. Design of cylindrical and spherical vessel under internal and external pressure. Selection and design of enclosures- flat plate, formed heads, torispherical and hemispherical heads, standard flanges and nozzles- classification of flanges, flange thickness calculation, gasket selection and design, bolt selection and calculation (Numerical problems are not needed for design of flanges, gasket and nozzles) Design of heat exchange equipments for upstream and downstream operations in bioprocessing industries: Heat exchangers process design (TEMA and IS 4503 standards) of double pipe, single pipe and multipass shell and tube heat exchangers.	06
2	Introduction to Indian Standards for storage tanks and their use in design of process vessel. Storage vessels for volatile and non-volatile liquids including unfired pressure vessels. Design of supports- Bracket, leg, saddle and skirt support and fixed roof and open roof tanks.	06
3	Introduction to general design information for Bioprocess plants: Development of flowsheet, piping and instrumentation diagram and its description. General design consideration, optimum design	06
4	Design of Distillation column: Detailed design and drawing of perforated plate distillation column. Absorption columns: Detailed design and drawing of perforated plate and packed towers.	06
5	Design of fermenters: Design considerations for maintaining sterility of process streams and process equipments. Design of mechanically	06

	agitated fermenters and non- mechanically agitated (bubble column and air lift) fermenters.	
6	Design of various types of evaporators employed in bioprocess operation: Evaporators-Standard vertical tube evaporator, single and multiple effect evaporators and forced circulation evaporator. Thermal sterilization systems in fermentation processes: batch and continuous thermal sterilizers.	06

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Sinnott, R.K., Coulson & Richardson's 'Chemical Engineering', Volume 6, 3rd Edn., Butterworth Heinemann, New Delhi, 1999.
2. Perry, R.H., et al., Perry's' Chemical Engineers Handbook', 7th Edn., McGraw Hill, New York, 1997.
3. Joshi, M.V., and Mahajani, V.V., "Process Equipment Design", 3rd Edn., Macmillan India Limited, New Delhi, 1996.
4. Bownell, L.E., and Young, E.M., 'Process Equipment Design', Wiley Eastern, 1968.
5. Peters and Timmerhause, 'Plant Design and Economics for Chemical Engineers'
6. S.B.Thakore, B.I.Bhatt, "Introduction to Process Engineering and Design", McGraw Hill Companies
7. Michael L Schuler and Fikret Kargi, 'Bioprocess Engineering' Printice Hall of India Pvt. Ltd.
8. Pauline M Doran, 'Bioprocess Engineering Principles' Academic Press
9. Pressure vessel code-IS Code 2825, B.I.S., New Delhi, 1969
10. Heat Exchanger Design Code IS 4503, B.I.S., New Delhi, 1969
11. Process Equipment Design and Drawing by Kiran Ghadyalji, Nandu publication

Course Code	Course/Subject Name	Credits
BTE8041	Department Elective IV: Non-conventional Sources of Energy	4

Pre-requisites:

- Knowledge of conventional sources of energy and energy utilization.

Course Objectives:

- The main objective of this course is to introduce to the students the current approaches and technologies in the development of non-conventional sources of energy their processes to improve environmental quality and energy requirement, clean and abundant energy, renewable resources and generate cost efficient methods to harness energy for human society.

Course outcomes:

- Apply their knowledge of energy generation and its conservation to improve the quality of life in individual context.
- Recognize key energy problems and to apply the operating principles and biotic systems for remediation.
- Design, improve and apply biotechnological systems and processes to meet practical needs of different problems of energy requirement.

Module	Contents	Contact Hours
01	Introduction: Traditional energy systems: fossil fuel, firewood, coal; Fossil fuel based systems, Impact of fossil fuel based systems; renewable and non-renewable sources of energy; global and national energy crisis, Prospects of renewable energy sources.	03
02	Solar energy: Solar radiation spectrum, radiation measurements, applications (heating, cooling, drying, distillation); flat plate collectors, concentrating collectors, Solar air heaters- types, solar driers, storage of solar energy-thermal storage, solar pond, solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photovoltaics - solar cells & its applications	08
03	Wind Energy: Principle of wind energy conversion; analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind patterns and wind data; types of wind mills, components of wind mill, site selection.	03
04	Geothermal energy: Estimation and nature of geothermal energy, geothermal sources and resources: hydrothermal, geo-pressured hot dry rock, magma; Advantages, disadvantages and application of geothermal energy; prospects of geothermal energy in India.	03
05	Energy from the Ocean: Ocean Thermal Electric Conversion (OTEC) systems: open cycle, closed cycle, Hybrid cycle, prospects of OTEC in	05

	India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.	
06	Energy from Biomass: Biomass conversion principle: combustion and fermentation; Biogas generation plants: classification, advantages and disadvantages, constructional details, site selection ,digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas. Biodiesel: principle, production, efficiency, scope in India.	05
07	Fuel cells: Introduction, Design principle, operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, and application of fuel cells. Microbial Fuel cells: Principle, construction, working, efficiency and scope in India.	04
08	Hydrogen energy: Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles. Nuclear energy: nuclear reactors, fission and fusion reactions; advantages and disadvantages of nuclear energy.	04

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Non-conventional energy sources by G.D. Rai, Khanna Publishers
2. Solar Energy: Fundamentals and Applications by H.P. Garg & Jai Prakash, Tata McGraw Hill

3. Solar Engineering of Thermal Processes by Duc and Beckman, John Wiley
4. Solar Energy: Principles of Thermal Collection and Storage by S,P Sukhatme, Tata McGraw Hill
5. Non-Conventional Energy Resources, B H Khan, Tata McGraw-Hill Education, Jan-2006
6. Non-Conventional Energy Resources by S.Hasan Saeed and D.K.Sharma
7. Fuel Cells by Bockris and Srinivasan; McGraw Hill

Course Code	Course/Subject Name	Credits
BTE8042	Department Elective IV: Total Quality Management	4

Prerequisites:

- Knowledge of Basic Engineering and Science.

Course Objectives:

- To acquaint with the significance and features of TQM philosophy.
- To familiarize with various quality tools and their uses in problem solving.
- To appraise on the modern productivity improvement approaches and their interface with TQM
- To familiarize with various quality standards, quality auditing and certification methodology.
- To give and an insight into the ongoing global trends in quality approach and practices with special forms to the customer relationship

Course Outcomes:

Learner will be able to:

- Appreciate the importance of quality and its dimensions in striving for excellence
- Understand the conscious compromise between cost and quality
- Develop competency in the selection in various manufacturing and service functions
- Develop competency in the use of appropriate quality tools in various manufacturing and service functions
- Integrate quality approaches for productivity improvement.
- Acquire knowledge base and develop skills for conducting quality audits

Module	Contents	Contact Hours
1	Introduction: Definition of Quality, principles and dimensions of TQM Quality in manufacturing and service segments. Approach in implementation of TQM, barriers in implementation. Cost of quality prevention, appraisal and failure costs, hidden costs, trade-o between quality and cost.	8
2	Planning for quality and Quality improvement: Planning for quality: Need for quality policies and objective. Significance of top management commitment, strategic planning for quality. Quality improvement: Management of controllable defects, operator controllable defects, sporadic and chronic problems of operator controllable defects, sporadic and chronic problems of quality, Pareto's principle. Bench marking: Definition and significance, data collection for bench marking and its use.	8
3	Customer relations: Customers, user and consumers, product awareness, types of customers, customer perception and expectations. Quality feedback and redressal. Basic principles of reliability: quality	8

	and reliability, Product life cycle, trade-o between maintainability.	
4	Vendor relations: Vendor as a partner, vendor selection, vendor evaluation. Push Pull view of supply chain and cycle view of chain management	8
5	SQC Tool: Histograms, Pie charts, Scatter diagrams, Cause and diagram etc. Statistical Process Control: Process variability: Variables and process variation, measures of accuracy and centering, precision or spread, normal distribution Process Control: Control charts for variables (X-chart, R-chart, -chart) and attributes (np-charts, p-chart, c-charts, U-chart) Process capability: OC curve, acceptance sampling, single and double sampling producer's and consumer's risk.	8
6	Quality System: Quality standards: ISO 9001:2000 Quality management system. ^ ISO 14001:2004 Environmental management system. ISO 27001:2005 Information security management system. Quality assurance: Nature of assurance, reports on quality, measuring performance, internal audit, surveillance audit, quality certification methodology and implications Productivity improvement Tools/ Approaches/ Techniques: Principles of Six-Sigma, approaches like JIT, Lean manufacturing zero defect concept, KANBAN, QFD, FMEA, Basics of DOE and Shining concepts of quality. Productivity improvement techniques like 5S, POKAYOKE, SMED, KAIZEN and Concurrent Engineering.	8

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to

each module

References

1. Juran, J. M., Gryana, F. M., Quality planning and analysis, TMH.
2. Bester Fidd, D. H., et.al. Total quality management, Prentice Hall.
3. Erossbly, Pillip b., Quality is free, Mentor/New Americal Library.
4. Ishikawa, K., What is total quality control? The Japanese way, Prentice Hall
5. Fergenbaum, Armand V., Total quality control.
6. Logothetis, N., Managing for total quality, Prentice Hall
7. Aurora, K. C., Total Quality Management, S. K. Kataria and Sons
8. Haldar, U. K., Total Quality Management, Dhanpatrai and Co.

Course Code	Course/Subject Name	Credits
BTE8043	Department Elective IV: Entrepreneurship	4

Pre-requisites:

- Basic Knowledge of Engineering Science, Mathematics and Interest towards finance

Course Objectives:

- Meaning and concept of entrepreneurship
- Preparing a Business Plan
- Financing the New Venture
- Managing Growth in New Venture
- skills required to be an entrepreneur

Course outcomes:

- Students will be able to make decision in new venture
- Students will have creativity in Entrepreneurship.
- Students will develop skill for innovation and competition.
- Students learn leadership qualities.

Module	Contents	Contact Hours
1	Introduction to Entrepreneurship: Meaning and concept of entrepreneurship, the history of entrepreneurship development, role of entrepreneurship in economic development, agencies in entrepreneurship management and future of entrepreneurship.	04
2	The Entrepreneur: Meaning of entrepreneur, the skills required to be an entrepreneur, the entrepreneurial decision process, and role models, mentors and support system.	04
3	Business Opportunity Identification: Business ideas, methods of generating ideas, and opportunity recognition	05
4	Preparing a Business Plan: Meaning and significance of a business plan, components of a business plan, and feasibility study	05
5	Financing the New Venture: Importance of new venture financing, types of ownership securities, venture capital, types of debt securities, determining ideal debt-equity mix, and financial institutions and banks	05
6	Launching the New Venture: Choosing the legal form of new venture, protection of intellectual property, and marketing the new venture	04
7	Managing Growth in New Venture: Characteristics of high growth new ventures, strategies for growth, and building the new venture capital	04
8	Harvesting Rewards: Exit strategies for entrepreneurs, bankruptcy, and succession and harvesting strategy	04

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which

are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Entrepreneurship, Hisrich Peters Sphephard, Tata McGraw Hill
2. Fundamentals of entrepreneurship, S.K. Mohanty, Published by PHI Learning, 2010
3. Management and Entrepreneurship, By N. V. R. Naidu, T. Krishna Rao
4. Entrepreneurship in Theory and Practice: Paradoxes in Play by S. L. Nielsen, K. Klyver, M. Rostgaard Evald Published by Edward Elgar Publishing Ltd; 2012

Course Code	Course/Subject Name	Credits
BTE8044	Department Elective IV: Advanced Bioinformatics	4

Pre-requisites:

- Bioinformatics, Knowledge of protein structure.

Course Objectives:

- Study the development and implementation of tools that enables to efficiently access and manage various types of information.
- Study the development of new algorithms (mathematical formulas) and statistics used to assess relationships among members of large data sets. For example, methods to locate a gene within a sequence, predict protein structure and/or function, and cluster protein sequences into families of related sequences.
- The primary goal of bioinformatics is to increase the understanding of biological processes. What sets it apart from other approaches, however, is its focus on developing and applying computationally intensive techniques to achieve this goal.
- Help have a better knowledge of pharmaceutical biology & its relation with information technology.

Course outcomes:

By learning this course the students will be able to:

- Describe the contents and properties of the most important bio informatical databases, perform text-and sequence-based searches, and analyse and discuss the results in light of molecular biological knowledge
- Explain the major steps in pair wise and multiple sequence alignment, explain the principle for, and execute pair wise sequence alignment by dynamic programming
- Explain the major features of evolution of genes and proteins and explain how different methods can be used to construct phylogenetic trees.
- Explain the major features of methods for modelling protein structures and use programs for visualizing and analysing such structures.
- Give examples of methods for describing and analysing genes, genomes and gene expression
- To solve any biological sequence analysis problem, with choosing & modifying suitable computational model to solve it.

Module	Contents	Contact Hours
01	Introduction to concepts of molecular modelling Methods of molecular modelling: Molecular mechanics, Abinitio Quantum mechanics, Semi empirical quantum mechanics. Energy minimization of molecules: local & global energy minima.	10
02	Overview: Machine learning, Genetic algorithms, Simulated annealing Interoperability: Introduction, Its role in bioinformatics. Interexchange Languages: XML, CORBA and UMLS.	08

	Clustering algorithms.	
03	Drug discovery, Markov chains, Hidden markov models.	06
04	Drug designing: Drug optimization, Identification of pharmacophore, Optimizing access to target, Prodrugs, Endogenous compounds as drugs, Quantitative structure- activity relationship (QSAR).	05
05	Docking: Introduction, Protein protein docking, Protein Ligand docking, Applications of docking.	06

Term Work

Term work shall consist of minimum eight tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 Marks

Attendance: 05 Marks

Total: 25 Marks

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Cynthia Gibas & Per Jambeck, Developing Bioinformatics computer skills, third edition.
2. S.C. Rastogi, Bioinformatics concepts, skills & applications, first edition.
3. Dov Stekel, Microarray Bioinformatics.
4. David W. Mount, Bioinformatics sequence and genome analysis.
5. N.Claude Cohen, Molecular modeling in drug design.
6. Oreilly, Developing bioinformatics computer skills, Shroff publishers, 1st Indian edition.
7. Medicinal Chemistry by Graham L. Patrick, Oxford University Press

Course Code	Course Name	Credits
ILO8021	Institute Level Optional Subject II- Project Management	03

Objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes:

Learner will be able to...

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Contact Hours
1	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
2	Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
3	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
4	Planning Projects:	6

	Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	
5	Executing Projects: Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. 5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. 5.3 Project Contracting Project procurement management, contracting and outsourcing,	8
6	Project Leadership and Ethics: Introduction to project leadership, ethics in projects. Multicultural and virtual projects. 6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO8022	Institute Level Optional Subject II- Finance Management	03

Objectives:

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Outcomes:

Learner will be able to...

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module	Detailed Contents	Contact Hours
01	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System. Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback	10

	<p>Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)</p> <p>Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.</p>	
05	<p>Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.</p> <p>Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure</p>	05
06	<p>Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach</p>	03

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Institute Level Optional Subject II- Entrepreneurship Development and Management	03

Objectives:

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Outcomes:

Learner will be able to...

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

Module	Detailed Contents	Contact Hours
01	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	Indian Environment for Entrepreneurship: key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with	08

	large industries), exercises, e-Marketing	
06	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapher, Entrepreneurship, latest edition, The McGraw Hill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Institute Level Optional Subject II- Human Resource Management	03

Objectives:

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes:

Learner will be able to...

- Understand the concepts, aspects, techniques and practices of the human resource management.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Contact Hours
01	Introduction to HR Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	Organizational Behaviour (OB) Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); Group Behaviour and Group Dynamics: Work groups formal	7

	and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	
03	Organizational Structure & Design Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	Human resource Planning Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning. Training & Development: Identification of Training Needs, Training Methods	5
05	Emerging Trends in HR Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	HR & MIS Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries Strategic HRM Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals Labor Laws & Industrial Relations Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.

- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Stephen Robbins, Organizational Behaviour, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behaviour, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Institute Level Optional Subject II- Professional Ethics and Corporate Social Responsibility (CSR)	03

Objectives:

- To understand professional ethics in business
- To recognized corporate social responsibility

Outcomes:

Learner will be able to...

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Contact Hours
01	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Institute Level Optional Subject II- Research Methodology	03

Objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes:

Learner will be able to...

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Module	Detailed Contents	Contact Hours
01	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
03	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design	08

	f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	
05	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	Outcome of Research 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	04

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	Institute Level Optional Subject II- IPR and Patenting	03

Objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Outcomes:

- understand Intellectual Property assets
- assist individuals and organizations in capacity building
- work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Contact Hours
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and	07

	Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	
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Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dufield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO8028	Institute Level Optional Subject II - Digital Business Management	03

Objectives:

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Outcomes:

The learner will be able to

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module	Detailed content	Contact Hours
1	Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts. Difference between physical economy and digital economy. Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services). Opportunities and Challenges in Digital Business,	09
2	Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behaviour, market research and advertisement. B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals. The E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing. EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC.	06
3	Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure	06
4	Managing E-Business-Managing Knowledge, Management skills for e-business, Managing Risks in e –business. Security Threats to e-business -Security Overview, Electronic commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security,	06

	Prominent Cryptographic Applications	
5	E-Business Strategy-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition(Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization-Business plan preparation. Case Studies and presentations	08

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules
- Weightage of marks should be proportional to number of hours assigned to each module

References

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective - DOI:10.1787/9789264221796-en OECD Publishing

Course Code	Course Name	Credits
ILO8029	Institute Level Optional Subject II- Environmental Management	03

Objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Outcomes:

Learner will be able to...

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

Module	Detailed Contents	Contact Hours
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, and The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment

Internal

- Assessment consists of two tests which should be conducted at proper intervals.

End Semester theory examination

- Question paper will comprise of 6 questions each carrying 20 questions.
- Total 4 questions need to be solved
- Question no.1 will be compulsory based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules

- Weightage of marks should be proportional to number of hours assigned to each module

References

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Credits
BTP801	Project-B	06
<p>Guidelines:</p> <ul style="list-style-type: none"> • Project groups: Groups of minimum two and not more than three students can be made. • Students should spend considerable time in applying all the concepts studied, into the Project, hence, eight hours each are allotted in project A, B to the students. • Students are advised to take up industrial/ experimental/ simulation and/or optimization based topics for their project • Students should report their guides weekly with their work. <p>Exam Guidelines</p> <p>Term Work - 100 Marks:</p> <ul style="list-style-type: none"> • Presentation – 50 Marks • Report -50 Marks <p>Oral – 50 Marks</p>		

Course Code	Course/Subject Name	Credits
BTL801	Lab-VI	1.5

Concepts for experiments:

A minimum of 10 experiments must be performed from the following concept:

1. Physical property like pH, turbidity, conductivity, alkalinity determination of waste water
2. Determination of total phosphorus content of waste water
3. Determination of total Kjeldahl Nitrogen of waste water
4. Determination of BOD of waste water
5. Determination of COD of waste water
6. Determination of Oil and grease content of waste water
7. Determination of total solids, total suspended solids and total dissolved solids
8. Determination of MLSS and MLVSS
9. Determination of Sludge Volume Index
10. Estimation of metals like iron, copper in waste water
11. Determination of chloride content of waste water
12. Estimation of coliform bacteria in waste water
13. Determination of phytoplankton in waste water
14. Determination of Most Probable Number of waste water
15. Removal of heavy metals by chemical methods from waste water Adsorption

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL802	Lab-VII	1.5

Concepts for experiments:

A minimum of 10 experiments must be performed from the following Concept:

- Adsorption
- Dialysis
- Reverse Osmosis
- Batch drying
- Crystallization
- Isolation and purification of biomolecules (protein/s or enzyme) from crude source / fermentation broth
- Determination of Solar Constants
- Study of Enzyme inhibitors
- Characterization of enzymes / Determination of Molecular weight of enzymes

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight out of ten experiments.