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 2016-17

INDEX

First Year Engineering:

Sr. No.	Subject Code	Subject Name	Count
1	FEL101	Basic Workshop Practice-I	1
2	FEC102	Applied Physics-I	1
3	FEC103	Applied Chemistry -I	1
4	FEC104	Engineering Mechanics	1
5	FEC105	Basic Electrical Engineering	1
6	FEC106	Environmental studies	1
7	FEL201	Basic Workshop Practice-II	1
8	FEC202	Applied Physics-II	1
9	FEC203	Applied Chemistry -II	1
10	FEC204	Engineering Drawing	1
11	FEC205	Structured Programming Approach	1
12	FEC206	Communication Skills	1
		Total	12

AC 14/7/2016, Item No. 4.64

UNIVERSITY OF MUMBAI

Bachelor of Engineering

First Year Engineering (Semester I & II), Revised course
(REV- 2016) from Academic Year 2016 – 17,
(Common for All Branches of Engineering)

(As per **Choice Based Credit and Grading System**
with effect from the academic year 2016–2017)

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 First Year of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2017-2018, for Third Year Final Year Engineering in the academic years 2018-2019, 2019-2020, respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Program Structure for
First Year Engineering (Semester I & II)
Mumbai University
(With Effect from 2016-2017)

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC101	**Applied Mathematics-I**	04	-	01	04	-	01	**05**
FEC102	**Applied Physics-I**	03	01	-	03	0.5	-	**3.5**
FEC103	**Applied Chemistry -I**	03	01	-	03	0.5	-	**3.5**
FEC104	**Engineering Mechanics**	05	02	-	05	01	-	**06**
FEC105	**Basic Electrical Engineering**	04	02	-	04	01	-	**05**
FEC106	**Environmental studies**	02	-	-	02	-	-	**02**
FEL101	**Basic Workshop Practice-I**	-	04	-	-	02	-	**02**
Total		**21**	**10**	**01**	**21**	**05**	**01**	**27**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg					
FEC101	**Applied Mathematics-I**	20	20	20	80	25	-	-	**125**
FEC102	**Applied Physics-I**	15	15	15	60	25	-	-	**100**
FEC103	**Applied Chemistry –I**	15	15	15	60	25	-	-	**100**
FEC104	**Engineering Mechanics**	20	20	20	80	25	-	25	**150**
FEC105	**Basic Electrical Engineering**	20	20	20	80	25	-	25	**150**
FEC106	**Environmental studies**	15	15	15	60	-	-	-	**75**
FEL101	**Basic Workshop Practice-I**	-	-	-	-	50	-	-	**50**
Total				**105**	**420**	**175**		**50**	**750**

Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC201	**Applied Mathematics-II**	04	-	01	04	-	01	**05**
FEC202	**Applied Physics-II**	03	01	-	03	0.5	-	**3.5**
FEC203	**Applied Chemistry -II**	03	01	-	03	0.5	-	**3.5**
FEC204	**Engineering Drawing**	03	04	-	03	02	-	**05**
FEC205	**Structured Programming Approach**	04	02	-	04	01	-	**05**
FEC206	**Communication Skills**	02	02	-	02	01	-	**03**
FEL201	**Basic Workshop Practice-II**	-	04	-	-	02	-	**02**
Total		**19**	**14**	**01**	**19**	**07**	**01**	**27**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg					
FEC201	**Applied Mathematics-II**	20	20	20	80	25	-	-	**125**
FEC202	**Applied Physics-II**	15	15	15	60	25	-	-	**100**
FEC203	**Applied Chemistry -II**	15	15	15	60	25	-	-	**100**
FEC204	**Engineering Drawing**	15	15	15	60	25	50	-	**150**
FEC205	**Structured Programming Approach**	20	20	20	80	25	25	-	**150**
FEC206	**Communication Skills**	10	10	10	40	25	-	-	**75**
FEL201	**Basic Workshop Practice-II**	-	-	-	-	50	-	-	**50**
Total				**95**	**380**	**200**	**75**	**-**	**750**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC101	**Applied Mathematics-I**	04	-	01	04	-	01	**05**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC101	**Applied Mathematics-I**	20	20	20	80	25	-	-	**125**

Objectives

1. To provide students with sound foundation in applied mathematics to solve real life problems in industry.
2. To provide hands on experience in using Scilab software to handle real life problems.

Outcomes: Learner will be able to…

1. Apply the concepts of complex numbers to the engineering problems.
2. Apply the knowledge of nth order derivatives of standard functions to engineering problems.
3. Apply the principles of basic operations of matrices to the engineering problems.
4. Apply the basic principles of partial differentiation to engineering problems.
5. Apply concepts of partial differentiation (maxima and minima, Jacobian), expansion of functions as an application of successive differentiation.
6. Apply SCILAB programming techniques to model problems based on solution of simultaneous linear algebraic equations.

Module	Detailed Contents	Hrs.
01	**Complex Numbers** **Pre-requisite**: Review of Complex Numbers-Algebra of Complex Number, Different representations of a Complex number and other definitions, D'Moivre's Theorem. 1.1. Powers and Roots of Exponential and Trigonometric Functions. 1.2. Expansion of $\sin^n \theta$, $\cos^n \theta$ in terms of sines and cosines of multiples of θ and Expansion of $\sin n\theta$, $\cos n\theta$ in powers of $\sin\theta$, $\cos\theta$ 1.3. Circular functions of complex number and Hyperbolic functions. Inverse Circular and Inverse Hyperbolic functions. Separation of real and imaginary parts of all types of Functions.	**3** **2** **4**
02	**Logarithm of Complex Numbers , Successive Differentiation** 2.1 Logarithmic functions, Separation of real and Imaginary parts of Logarithmic Functions. 2.2 Successive differentiation: nth derivative of standard functions. Leibnitz's Theorem (without proof) and problems	**4** **4**
03	**Matrices** **Pre-requisite**: Inverse of a matrix, addition, multiplication and transpose of a matrix Types of Matrices (symmetric, skew- symmetric, Hermitian, Skew Hermitian, Unitary, Orthogonal Matrices and properties of Matrices). Rank of a Matrix using Echelon forms, reduction to normal form, PAQ in normal form, system of homogeneous and non – homogeneous equations, their consistency and solutions. Linear dependent and independent vectors. Application of inverse of a matrix to coding theory.	**9**
04	**Partial Differentiation** 4.1 Partial Differentiation: Partial derivatives of first and higher order. Total differentials, differentiation of composite and implicit functions.	**6**

	4.2. Euler's Theorem on Homogeneous functions with two and three independent variables (with proof).Deductions from Euler's Theorem	**3**
05	**Applications of Partial Differentiation , Expansion of Functions** 5.1 Maxima and Minima of a function of two independent variables, Jacobian. 5.2 Taylor's Theorem (Statement only) and Taylor's series, Maclaurin's series (Statement only).Expansion of e^x , sin(x), cos(x), tan(x), sinh(x), cosh(x), tanh(x), log(1+x), $sin^{-1}(x)$,$cos^{-1}(x)$,$tan^{-1}(x)$, Binomial series.	**4** **4**
06	**Indeterminate forms, Numerical Solutions of Transcendental Equations and System of Linear Equations** 6.1 Indeterminate forms, L- Hospital Rule, problems involving series. 6.2 Solution of Transcendental Equations: Solution by Newton Raphson method and Regula –Falsi Equation. 6.3 Solution of system of linear algebraic equations, by (1) Gauss Elimination Method, (2) Gauss Jacobi Iteration Method, (3) Gauss Seidal Iteration Method. (Scilab programming for above methods is to be taught during lecture hours)	**2** **4** **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) Guass Elimination Method (ii) Guass Seidal Iteration method (iii) Gauss Jacobi Iteration Method (iv) Newton Raphson Method (v) Regula –Falsi method (vi) Maxima and Minima of functions of two variables

The distribution of Term Work marks will be as follows -

1. Attendance (Theory and Tutorial) : 05 marks
2. Class Tutorials on entire syllabus : 10 marks
3. SciLab Tutorials : 10 marks

<u>Assessment</u>:

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 Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
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 randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

References:

1. A text book of Applied Mathematics, P.N.Wartikar and J.N.Wartikar, Vol – I and –II by Pune VidyarthiGraha.
2. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
3. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
4. Matrices, Shanti Narayan.S. Chand publication
5. Numerical Methods, Dr. P. Kandasamy , S. Chand Publication
6. Howard Anton and Christ Rorres. Elementary Linear Algebra Application Version. 6th edition. John Wiley & Sons, INC.
7. Eisenberg, Murray. Hill Ciphers and Modular Linear Algebra. 3 Nov 1999 (accessed November - 2 December 2001)
8. <http://www.math.umass.edu/~murray/Hillciph.pdf>

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC102	Applied Physics – I	03	01	--	03	0.5	--	**3.5**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC102	Applied Physics – I	15	15	15	60	25	--	--	**100**

Objectives

1. To impart knowledge of basic concepts in applied physics.
2. To provide the knowledge and methodology necessary for solving problems in the field of engineering.

Outcomes: Learner will be able to…

1. Apply the concepts of crystallography and to use XRD techniques for analysis of crystal structure .
2. Apply the knowledge of Quantum mechanics to uncertainty principle and motion of free particle.
3. To comprehend the basic concepts of semiconductor physics and apply the same to electronic devices.
4. Apply the knowledge of superconductivity to SQUID and Magnetic levitation.
5. Apply the reasons for Acoustic defects and use this in the proper design of a Hall/Auditorium.
6. Use the knowledge of Piezoelectric and Magnetostriction effect for production of ultrasonic waves and its application in various fields.

Module	Detailed Contents	Hrs.
01	**CRYSTAL STRUCTURE** Introduction to crystallography; Study of characteristics of unit cell of Diamond, ZnS, NaCl and HCP; Miller indices of crystallographic planes & directions; interplanar spacing; X-ray diffraction and Bragg's law; Determination of Crystal structure using Bragg's diffractometer; Frenkel and Schotkey crystal defects; Ionic crystal legancy (3,4,6,8); Liquid crystal phases.	07
02	**QUANTUM MECHANICS** Introduction, Wave particle duality; de Broglie wavelength; experimental verification of de Broglie theory; properties of matter waves; wave packet, phase velocity and group velocity; Wave function; Physical interpretation of wave function; Heisenberg's uncertainty principle; Electron diffraction experiment and Gama ray microscope experiment; Applications of uncertainty principle; Schrodinger's time dependent wave equation; time independent wave equation; Motion of free particle; Particle trapped in one dimensional infinite potential well.	09
03	**SEMICONDUCTOR PHYSICS** Splitting of energy levels for band formation; Classification of semiconductors(direct & indirect band gap, elemental and compound); Conductivity, mobility, current density **(**drift & diffusion) in semiconductors(n type and p type); Fermi Dirac distribution function; Fermi energy level in intrinsic & extrinsic semiconductors; effect of impurity concentration and temperature on fermi level; Fermi Level diagram for p-n junction(unbiased, forward bais, reverse bias); Breakdown mechanism (zener&avalanchy), Hall Effect	14

	Applications of semiconductors: Rectifier diode, LED, Zener diode, Photo diode, Photovoltaic cell, BJT, FET, SCR., MOSFET	
04	**SUPERCONDUCTIVITY** Introduction, Meissner Effect; Type I and Type II superconductors; BCS Theory (concept of Cooper pair); Josephson effect Applications of superconductors- SQUID, MAGLEV	**03**
05	**ACOUSTICS** Conditions of good acoustics; Reflection of sound(reverberation and echo); absorption of sound; absorption coefficient; Sabine's formula; Acoustic Design of a hall; Common Acoustic defects and acoustic materials	**03**
06	**ULTRASONICS** Ultrasonic Wave generation; Magnetostriction Oscillator; Piezoelectric Oscillator; Applications of ultrasonic: Eco sounding; NDT; ultrasonic cleaning(cavitation); ultrasonic sensors; Industrial applications of ultrasonic(soldering, welding, cutting, drilling)	**03**

Suggested Experiments: (Any five)

1. Study of Diamond, ZnS, NaCl crystal structure.
2. Study of HCP structure.
3. Study of Miller Indices, Plane and direction.
4. Study of Hall Effect.
5. Determination of energy band gap of semiconductor.
6. Study of Ultrasonic Distance Meter.
7. Study of I / V characteristics of Zener diode.
8. Determination of 'h' using Photo cell.
9. Study of I / V characteristics of semiconductor diode

The distribution of Term Work marks will be as follows –

1. Attendance (Theory and Practical) : 05 marks
2. Assignments : 10 marks
3. Laboratory work (Experiments and Journal) : 10 marks

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 15 marks.
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 3 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. In question paper weightage of each module will be proportional to number of respective
1. lecture hrs as mentioned in the syllabus.

References:

1. A text book of Engineering Physics-Avadhanulu&Kshirsagar, S.Chand
2. Applied Solid State Physics –Ranikant, Wiley India
3. Solid State Electronic Devices- B. G. Streetman, Prentice Hall Publisher
4. Physics of Semiconductor Devices- S. M. Sze, John Wiley & sons publisher
6. Modern Engineering Physics – Vasudeva, S.Chand
7. Concepts of Modern Physics- ArtherBeiser, Tata McGraw Hill
8. Engineering Physics- V. Rajendran, Tata McGraw Hill
9. Introduction to Solid State Physics- C. Kittle, John Wiley & Sons publisher
10. Engineering Physics-H. K. Malik, McGraw Hill

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC103	**Applied Chemistry – I**	03	01	--	03	0.5	--	**3.5**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC103	**Applied Chemistry – I**	15	15	15	60	25	--	--	**100**

Objectives

1. To provide necessary background in applied chemistry relevant to chemical industries.
2. To provide exposure in conducting experiments and interpret and report the results in professional format.

Outcomes: Learner will be able to…

1. Apply the knowledge of types of hardness of water and its estimation.
2. Apply the knowledge of various softening and disinfecting methods.
3. Apply the knowledge of various polymers, their synthesis, properties and uses along with their fabrication techniques.
4. Apply the knowledge of thermodynamics in studying different chemical systems in equilibrium obeying Gibb's phase rule.
5. Apply the knowledge of lubricants, types, properties and mechanisms to avoid frictional resistance.
6. Demonstrate the knowledge of Portland cement and carbon nanomaterials.

Module	Detailed Contents	Hrs.
01	**Water** Impurities in water, Hardness of water, Determination of Hardness of water by EDTA method and problems, Softening of water by Hot and Cold lime Soda method and numerical problems. Zeolite process and numerical problems. Ion Exchange process and numerical problems. Potable water standard as per BIS w.r.t. i) pH, ii) Alkalinity, iii) TDS, iv) Hardness; Drinking water or Municipal water -Treatments removal of microorganisms by adding Bleaching powder, Chlorination (no breakpoint chlorination), Disinfection by Ozone, Electrodialysis, Reverse osmosis, and Ultra filtration. BOD, COD- definition & significance, sewage treatment (only activated sludge process), Numerical problems related to COD.	**12**
02	**Polymers** Introduction to polymers, Classification, Types of polymerization, Thermoplastic and Thermosetting plastic; Compounding of plastic, Fabrication of plastic by Compression, Injection, Transfer and Extrusion moulding. Preparation, properties and uses of Phenol formaldehyde, PMMA, Kevlar. Effect of heat on the polymers (Glass transition temperature), Viscoelasticity. Conducting polymers, Engineering Plastics, Polymers in medicine and surgery. Rubbers : Natural rubber- latex, Drawbacks of natural rubber, Vulcanization of rubber, Preparation, properties and uses of Buna-S, Silicone and Polyurethane rubber.	**12**
03	**Lubricants** Introduction, Definition, Mechanism of lubrication, Classification of lubricants, Solid lubricants (graphite & Molybdenum disulphide), Semisolid lubricants, Liquid lubricants, Additives in blended Oils. Important properties of lubricants - Definition and significance of - Viscosity, Viscosity index, Flash and fire points, Cloud and pour points, Oiliness,	**07**

	Emulsification, Acid value and numerical problems, Saponification value and numerical problems.	
04	**Phase Rule** Gibb's Phase Rule, Terms involved with examples, One Component System (Water), Reduced Phase Rule, Two Component System (Pb- Ag), Advantages and Limitations of Phase Rule.	**04**
05	**Important Engineering Materials** Cement – Manufacture of Portland Cement, Chemical Composition and Constitution of Portland Cement, Setting and Hardening of Portland Cement, Concrete, RCC and Decay. Nanomaterials, preparation (Laser and CVD) method, properties and uses of CNTS, Fullerene - properties and uses.	**05**

Suggested Experiments:

1) To determine total, temporary and permanent hardness of water sample.
2) Removal of hardness using ion exchange column.
3) To determine acid value of a lubricating oil.
4) To determine free acid pH of different solutions using pHmeter
5) To determine metal ion concentration using colorimeter.
6) To determine flash point and fire point of a lubricating oil
7) To determine Chloride content of water by Mohr's Method.
8) To determine melting point and /or glass transition temperature of a polymer
9) Molecular weight determination of polymers by Oswald Viscometer.
10) To determine the percentage of lime in cement.
11) Hardening and setting of cement using Vicat's apparatus
12) Determination of Viscosity of oil by Redwood Viscometer.

Term Work shall consist of minimum five experiments. The distribution of marks for term work shall be as follows:

1 Attendance (Practical and Theory) : 05 marks
2 Laboratory Work (Experiments and journal) : 10 marks
3 Assignments and Viva on practical's : 10 marks

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 15 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 3 marks will be asked.
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.

References:

1. Engineering Chemistry - Jain& Jain (DhanpatRai)
2. Engineering Chemistry – Dara&Dara (S Chand)
3. Engineering Chemistry - Wiley India (ISBN – 9788126519880)
4. A Text Book of Engineering Chemistry – Shashi Chawla (DhanpatRai)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC104	Engineering Mechanics	05	02	-	05	01	-	**06**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC104	Engineering Mechanics	20	20	20	80	25	--	25	**150**

Objectives

1. To acquaint the concept of equilibrium in two and three dimensional system.
2. To study and analyse motion of moving bodies.

Outcomes: Learner will be able to…

1. Illustrate the concept of force, moment and apply the same along with the concept of equilibrium in two and three dimensional systems with the help of FBD.
2. Demonstrate the understanding of Centroid and its significance and locate the same.
3. Correlate real life application to specific type of friction and estimate required force to overcome friction.
4. Establish relation between velocity and acceleration of a particle and analyse the motion by plotting the relation
5. Illustrate different types of motions and establish Kinematic relations for a rigid body
6. Analyse body in motion using force and acceleration, work-energy, impulse-momentum principles

Module	Detailed Contents	Hrs.
01	**1.1 System of Coplanar Forces:** Resultant of concurrent forces, parallel forces, non-concurrent Non-parallel system of forces, Moment of force about a point, Couples, Varignon's Theorem. Force couple system. Distributed Forces in plane. **1.2 Centroid** for plane Laminas.	**05** **04**
02	**2.1Equilibrium of System of Coplanar Forces**: Condition of equilibrium for concurrent forces, parallel forces and non-concurrent non-parallel general forces and Couples. **2.2Types of support**: Loads, Beams, Determination of reactions at supports for various types of loads on beams.(Excluding problems on internal hinges) **2.3Analysis of plane trusses**: By using Method of joints and Method of sections. (Excluding pin jointed frames).	**06** **03** **05**
03	**3.1 Forces in space**: **Resultant of Non-coplanar Force Systems:** Resultant of concurrent force system, parallel force system and non-concurrent non-parallel force system. **Equilibrium of Non-coplanar Force Systems:** Equilibrium of Concurrent force system, parallel force system and non-concurrent non-parallel force system. **3.2 Friction**: Introduction to Laws of friction, Cone of friction, Equilibrium of bodies on inclined plane, Application to problems involving wedges, ladders. **1.3 Principle of virtual work:** Applications on equilibrium mechanisms, pin jointed frames.	**05** **07** **04**

04	**4.1 Kinematics of a Particle**: -Rectilinear motion, Velocity & acceleration in terms of rectangular co-ordinate system, Motion along plane curved path, Tangential& Normal component of acceleration, Motion curves (a-t, v-t, s-t curves), Projectile motion.	**10**
05	**5.1 Kinematics of a Rigid Body** :- Introduction to general plane motion, Instantaneous center of rotation for the velocity, velocity diagrams for bodies in plane motion.	**06**
06	**6.1 Kinetics of a Particle: Force and Acceleration: -**Introduction to basic concepts, D'Alemberts Principle, Equations of dynamic equilibrium, Newton's second law of motion. **6.2 Kinetics of a Particle: Work and Energy:** Principle of work and energy, Law of conservation of energy. **6.3 Kinetics of a Particle: Impulse and Momentum:** Principle of linear impulse and momentum. Law of conservation of momentum. Impact and collision.	**04** **03** **03**

List of Experiments:-

1. Polygon law of coplanar forces.
2. Non-concurrent non-parallel (General).
3. Bell crank lever.
4. Support reaction for beam.
5. Inclined plane (to determine coefficient of friction).
6. Collision of elastic bodies (Law of conservation of momentum).
7. Kinematics of particles
8. Kinetics of particles

Any other experiment based on above syllabus.

Term work:-

Term work shall consist of minimum six experiments (at least one experiments on Dynamics), assignments consisting numerical based on above syllabus, at least 3 numerical from each module.

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

1. Attendance (Theory and Practical) : 05 marks
2. Laboratory work (Experiment/ programs and journal) : 10 marks
3. Assignments : 10 marks

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 Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
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 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.

Oral Examination: - Oral examination will be based on entire syllabus

References:

1. Engineering Mechanics by R. C. Hibbeler.2
2. Engineering Mechanics by Beer &Johnston, Tata McGraw Hill
3. Engineering Mechanics by F. L. Singer, Harper& Raw Publication
4. Engineering Mechanics by Macklin & Nelson, Tata McGraw Hill
5. Engineering Mechanics by Shaum Series,
6. Engineering Mechanics by A K Tayal, Umesh Publication.
7. Engineering Mechanics by Kumar, Tata McGraw Hill
8. Engineering Mechanics (Statics) by Meriam and Kraige, Wiley Bools
9. Engineering Mechanics (Dynamics) by Meriam and Kraige, Wiley Bools

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC105	**Basic Electrical Engineering**	04	02	-	04	01	-	**05**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC105	**Basic Electrical Engineering**	20	20	20	80	25	--	25	**150**

Objectives
1. To provide knowledge on fundamentals of D.C. circuits and its applications.
2. To impart knowledge on fundamentals of 1-Φ A.C. circuits and its applications.
3. To inculcate knowledge on the basic operation and the performance of 1-Φ transformer.
4. To impart knowledge on fundamentals of 3-Φ A.C. circuits and its applications.
5. To provide knowledge on fundamentals of DC machines.

Outcomes: Learner will be able to…
1. To evaluate D.C. circuits using network theorems.
2. To evaluate 1-Φ AC circuits.
3. To illustrate constructional features and operation of 1-Φ transformer.
4. To evaluate 3-Φ AC circuits.
5. To illustrate working principle of DC machines.
6. To conduct experiments on D.C. circuits and AC circuits.

Module	Detailed Contents	Hrs.
01	**DC Circuits(Only Independent Sources):** Kirchhoff 's laws, Ideal and practical voltage and current source, Mesh and Nodal analysis, Super node and Super mesh analysis, Source transformation, Star-delta transformation, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, (Source transformation not allowed for Superposition theorem, Mesh and Nodal analysis).	**18**
02	**AC Circuits:** Generation of alternating voltage and currents, RMS and Average value, form factor, crest factor, AC through resistance, inductance and capacitance, R-L, R-C and R-L-C series and parallel circuits, phasor diagrams, power and power factor, series and parallel resonance, Q factor and bandwidth.	**12**
03	**Three Phase Circuits:** Three phase voltage and current generation, star and delta connections(balanced load only), relationship between phase and line currents and voltages, Phasor diagrams, Basic principle of wattmeter, measurement of power by one and two wattmeter methods.	**06**
04	**Single Phase Transformer:** Construction, working principle, emf equation, ideal and practical transformer, transformer on no load and on load, phasor diagrams, equivalent circuit, OC and SC test, regulation and efficiency.	**12**
05	**DC Machines:** Principle of operation of DC motors and DC generators, construction and classification of DC machines, emf equation.	**04**

Term work:

Term work consists of performing minimum 06 practical mentioned as below.

Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.

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

Attendance (Theory and Practical)	: 05 marks
Laboratory work (Experiment/journal)	: 10 marks
Assignments	: 10 marks

List of laboratory experiments (Minimum Six):

1. Mesh and Nodal analysis.
2. Verification of Superposition Theorem.
3. Verification Thevenin's Theorem.
4. Study of R-L series and R-C series circuit.
5. R-L-C series resonance circuit
6. R-L-C parallel resonance circuit.
7. Relationship between phase and line currents and voltages in three phase system (star & delta)
8. Power and phase measurement in three phase system by one wattmeter method.
9. Power and phase measurement in three phase system by two wattmeter method.
10. OC and SC test on single phase transformer

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 Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
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 3 marks will be asked.
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. V. N. Mittal and Arvind Mittal "Basic Electrical Engineering" Tata McGraw Hill, (Revised
2. Edition)
3. Electrical Engineering Fundamentals" by Vincent Del Toro, PHI Second edition, 2011
4. Edward Hughes: Electrical and Electrical Technology, Pearson Education (Tenth edition)
5. D P Kothari and I J Nagrath "Theory and Problems of Basic Electrical Engineering", PHI 13 thedition 2011.

Reference Books:

1. B.L.Theraja "Electrical Engineering " Vol-I and II,
2. S.N.Singh, "Basic Electrical Engineering" PHI , 2011Book name and author

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC106	**Environmental Studies**	02	--	--	02	--	--	**02**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC106	**Environmental Studies**	15	15	15	60	--	--	--	**75**

Objectives

1. Creating the awareness about environmental problems among students.
2. Imparting basic knowledge about the environment and its allied problems.
3. Developing an attitude of concern for the environment.
4. Motivating students to participate in environment protection and environment improvement.
5. Acquiring skills to help the concerned individuals in identifying and solving environmental problems.

Outcomes: Learner will be able to…

1. Illustrate Depleting Nature of Environmental Resources, Global Environmental Crisis, Ecosystem concept.
2. Adapt to 3R (Reuse, Recovery, Recycle).
3. Study different control measures related to Environmental Pollution.
4. Illustrate and analyse various Case Studies related to Environmental Legislation.
5. Demonstrate the working of Renewable energy sources & Equipments.
6. Illustrate the Techniques of Disaster Management and Green Building.

Module	Detailed Contents	Hrs.
01	**Overview of Environmental Aspects:** • Definition, Scope and Importance of Environmental Study • Need for Public awareness of environmental education • Introduction to depletion of natural resources: Soil, Water, Minerals and Forests. • Global crisis related to – Population, water, sanitation & Land. **Ecosystem:** • Study of ecosystems : Forest, desert and aquatic (in brief). • Energy flow in Ecosystem, overview of Food Chain, Food Web and Ecological Pyramid. • Concept of ecological succession and its impact on human beings (in brief). **Case Study on Chipko Movement (Uttarakhand, India), (began in 1973).**	**4**
02	**Aspects of Sustainable Development:** • Concept and Definition of Sustainable Development. • Social, Economical and Environmental aspects of sustainable development. • Control measures: 3R (Reuse, Recovery, Recycle), • Resource utilization as per the carrying capacity (in brief). **Case Study on Narmada BachaoAndolan (Gujarat, India, in the mid and late 1980s).**	**2**

03	**Types of Pollution:** • Water pollution: Sources of water pollution and Treatment of Domestic and industrial waste water (with flow-diagram of the treatment), • Land Pollution: Solid waste, Solid waste management by land filling, composting and incineration • Air pollution: Sources of air pollution, Consequences of air pollution :- Greenhouse effect (Explanation with schematic diagram), Photochemical Smog (Explanation with chemical reaction). Cleaning of gaseous effluents to reduce air contaminants namely dust particle or particulate matters by using:- (i) Electrostatic precipitators (ii) Venturi scrubber (Schematic diagram and working). • Noise pollution: Sources, effects, threshold limit for different areas and control methods. • E-Pollution: Definition, Sources and effects. • Nuclear pollution: Sources and effects. **Case study on Water Pollution of Ganga River.** **Case study on London smog (U. K.)(December, 1952).** **Case Study of Fukushima Disaster (March, 2011).**	**8**
04	**Pollution Control Legislation:** • Functions and powers of Central and State Pollution Control Board. • Environmental Clearance, Consent and Authorization Mechanism. **Case Study of Dombivali MIDC- Boiler Blast Tragedy (Thane, Maharashtra, India), (May, 2016).**	**3**
05	**Renewable Sources of Energy:** • Importance of renewable sources of energy. • Principle and working with schematic diagram of :- (i) Solar Energy: (a) Flat plate collector and (b) Photovoltaic cell. (ii) Wind Energy: Wind Turbines. (iii) Hydropower: Hydropower generation from water reservoir of the dam. (iv) Geothermal Energy: Utilisation of underground sources of steam for power generation.	**4**
06	**Technological Advances to overcome Environmental problems:** • Concept of Green Buildings, • Various indoor air pollutants and their effects on health. • Carbon Credit: Introduction and general concept. • Disaster Management: Techniques of Disaster Management to cope up with (i) Earthquake and (ii) Flood. **Case Study on Earthquake in Latur (Maharashtra, India), (September,1993).** **Case Study on Cloudburst and Landslides at Kedarnath (Uttarakhand, India), (June, 2013).**	**5**

Assessment:

Internal Assessment Test:

1. Each test will be of 15 marks.
2. At least one question will be based on case study. Candidate is expected to explain the salient features of the incident and suggest preventive measures.

End Semester Theory Examination:

1. Question paper will comprise of total six question, each carrying 15 marks.
2. Total four questions need to be solved.
3. Question Number One will be compulsory and it will be based on entire syllabus wherein sub-questions of 2 to 3 marks will be asked.
4. Remaining questions i.e. Q.2 to Q.6 will be mixed in nature and will be divided in three parts (a), (b) & (c) and they will belong to different modules.
5. In question paper, weight of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Environmental Studies by Benny Joseph, TataMcGraw Hill.
2. Environmental Studies by R.Rajagopalan, Oxford University Press.
3. Environmental Studies by. AnanditaBasak, Pearson Education.
4. Essentials of Environmental Studies by Kurian Joseph &Nagendran, Pearson Education.
5. Fundamentals of Environmental Studies by Varadbal G. Mhatre, Himalaya Publication House.
6. Perspective of Environmental Studies, by Kaushik and Kaushik,New Age International.
7. Renewable Energy by Godfrey Boyle, Oxford Publications.
8. Textbook of Environmental Studies by Dave and Katewa, Cengage Learning.
9. Textbook of Environmental studies by ErachBharucha, University Press.
10. Environmental pollution control engineering by C.S. Rao, New Age International (P) Limited Publishers.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEL101	**Basic Workshop Practice - I**	--	04	--	--	02	--	**02**

Course Code	Course Name	Examination Scheme								
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEL101	**Basic Workshop Practice - I**	--	--	--	--	50	--	--	**50**

	Detailed Contents	Hrs.
Note:	The syllabus and the Term- work to be done during semester I and Semester II is given together. Individual Instructor for the course is to design the jobs for practice and demonstration and spread the work over entire two semesters. The objective is to impart training to help the students develop engineering skill sets. This exercise also aims in inculcating respect for physical work and hard labor in addition to some amount of value addition by getting exposed to interdisciplinary engineering domains. The two compulsory trades (Trade 1 – Fitting and Trade 2 – Carpentry) shall be offered in separate semesters. Select any four trade topics (two per semester) out of the topic at trade 3 to 11. Demonstrations and hands on experience to be provided during the periods allotted for the same. Report on the demonstration including suitable sketches is also to be included in the term – work	
Trade 1	**Fitting (compulsory)** • Use and setting of fitting tools for chipping, cutting, filing, marking, center punching, drilling, tapping. • Term work to include one job involving following operations : filing to size, one simple male- female joint, drilling and tapping	**30**
Trade 2	**Carpentry (compulsory)** • Use and setting of hand tools like hacksaws, jack planes, chisels and gauges for construction of various joints, wood tuning and modern wood turning methods. • Term work to include one carpentry job involving a joint and report on demonstration of a job involving wood turning	**30**
Trade 3	**Forging (Smithy)** • At least one workshop practice job (Lifting hook and handle) is to be demonstrated.	**15**
Trade 4	**Welding** • Edge preparation for welding jobs. Arc welding for different job like, Lap welding of two plates, butt welding of plates with simple cover, arc welding to join plates at right angles.	**15**
Trade 5	**Machine Shop** • At least one turning job is to be demonstrated.	**15**
Trade 6	**Electrical board wiring** • House wiring, staircase wiring, wiring diagram for fluorescent tube light, Godown wiring and three phase wiring for electrical motors.	**15**
Trade 7	**PCB Laboratory Exercises** Layout drawing, Positive and negative film making, PCB etching and drilling, Tinning and soldering technique.	**15**
Trade 8	**Sheet metal working and Brazing** • Use of sheet metal, working hand tools, cutting , bending , spot welding	**15**

Trade 9	**Plumbing** • Use of plumbing tools, spanners, wrenches, threading dies, demonstration of preparation of a domestic line involving fixing of a water tap and use of coupling, elbow, tee, and union etc.	**15**
Trade 10	**Masonry** • Use of masons tools like trowels, hammer, spirit level, square, plumb line and pins etc. demonstration of mortar making, single and one and half brick masonry , English and Flemish bonds, block masonry, pointing and plastering.	**15**
Trade 11	**Hardware and Networking:** • Dismantling of a Personal Computer (PC), Identification of Components of a PC such as power supply, motherboard, processor, hard disk, memory (RAM, ROM), CMOS battery, CD drive, monitor, keyboard, mouse, printer, scanner, pen drives, disk drives etc. • Assembling of PC, Installation of Operating System (Any one) and Device drivers, Boot-up sequence. Installation of application software (at least one) • Basic troubleshooting and maintenance • Identification of network components: LAN card, wireless card, switch, hub, router, different types of network cables (straight cables, crossover cables, rollover cables) Basic networking and crimping. **NOTE**: Hands on experience to be given in a group of not more than four students.	**15**

Term work:

Term work shall consist of respective reports and jobs of the trades selected the distribution of marks for term work shall be as follows.

1 Laboratory work (Job and Journal) : 40 marks
2 Attendance (Practical and Theory) : 10 marks

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC201	**Applied Mathematics-II**	04	--	01	04	--	01	**05**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC201	**Applied Mathematics-II**	20	20	20	80	25	--	--	**125**

Objectives

1. To provide students with sound foundation in applied mathematics to solve real life problems in industry.
2. To provide hands on experience in using Scilab software to handle real life problems.

Outcomes: Learner will be able to…

1. Apply the concepts of First Order and first degree Differential equation to the engineering problems.
2. Apply the concepts of Higher Order Linear Differential equation to the engineering problems.
3. Apply concepts of Beta and Gamma function to the engineering Problems.
4. Apply SCILAB programming techniques to solve differential equation to model complex engineering activities.
5. Apply concepts of Double integral of different coordinate systems to the engineering problems.
6. Apply concepts of triple integral of different coordinate systems to the engineering problems.

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. 1.2 Linear differential equations (Review), equation reducible to linear form, Bernoulli's equation. 1.3: Simple application of differential equation of first order and first degree to electrical and Mechanical Engineering problem (no formulation of differential equation)	**4** **3** **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), cos (ax+b), x^n, e^{ax}V, xV. 2.2. Cauchy's homogeneous linear differential equation and Legendre's differential equation, Method of variation of parameters.	**6** **3**
03	**Numerical solution of ordinary differential equations of first order and first degree, Beta and Gamma Function** 3.1. (a)Taylor's series method (b)Euler's method (c) Modified Euler method (d) Runga-Kutta fourth order formula (SciLab programming is to be taught during lecture hours) 3.2 .Beta and Gamma functions and its properties.	**4** **4**
04	**Differentiation under Integral sign, Numerical Integration and Rectification** 4.1. Differentiation under integral sign with constant limits of integration. 4.2. Numerical integration- by (a) Trapezoidal (b) Simpson's 1/3rd (c) Simpson's 3/8th rule (all with proof). (Scilab programming on (a) (b) (c) (d) is to be taught during lecture hours) 4.3. Rectification of plane curves.	**2** **3** **3**

05	**Double Integration** 5.1. Double integration-definition, Evaluation of Double Integrals. 5.2. Change the order of integration, Evaluation of double integrals by changing the order of integration and changing to polar form.	**2** **7**
06	**Triple Integration and Applications of Multiple Integrals.** 6.1. Triple integration definition and evaluation (Cartesian, cylindrical and spherical polar coordinates). 6.2. Application of double integrals to compute Area, Mass, Volume. Application of triple integral to compute volume.	**3** **6**

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 practical.
2. Students must be encouraged to write Scilab Programs in tutorial class only. Each Student to write atleast 4 Scilab tutorials (including print out) and at least 6 class tutorials on entire syllabus.
3. SciLab Tutorials will be based on (i)Curve Tracing (ii) Taylor's series method, Euler's method Modified Euler method, RungaKutta fourth order formula (iii) Ordinary Differential Equation and (iv) Trapezoidal Simpson's 1/3rd and Simpson's 3/8th rule.

The distribution of Term Work marks will be as follows -

Attendance (Theory and Tutorial): 05 marks
Class Tutorials on entire Syllabus: 10 marks
SciLab Tutorials : 10 marks

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 Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 3 to 4 marks will be asked.
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.

References:

1. A text book of Applied Mathematics, P.N.Wartikar and J.N.Wartikar, Vol – I and –II by Pune VidyarthiGraha.
2. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
3. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
4. Numerical methods by Dr. P. Kandasamy ,S.Chand Publications

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC202	**Applied Physics – II**	03	01	--	03	0.5	--	**3.5**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC202	**Applied Physics – II**	15	15	15	60	25	--	--	**100**

Objectives

1. To impart knowledge of basic concepts in applied physics.
2. To provide the knowledge and methodology necessary for solving problems in the field of engineering.

Outcomes: Learner will be able to…

1. Comprehend principles of interference and diffraction.
2. Illustrate the principle,construction and working of various LASERs and its applications.
3. Identify various applications of optical fibres.
4. Comprehend the concepts of electrodynamics and Maxwell's equations and their use in telecommunication systems.
5. Apply the concepts of electromagnetism in focusing systems and CRO.
6. Comprehend the significance of nanoscience and nanotechnology,its applications.

Module	Detailed Contents	Hrs.
01	**INTERFERENCE AND DIFFRACTION OF LIGHT** Interference by division of amplitude and by division of wave front; Interference in thin film of constant thickness due to reflected and transmitted light; origin of colours in thin film; Wedge shaped film(angle of wedge and thickness measurement); Newton's rings Applications of interference - Determination of thickness of very thin wire or foil; determination of refractive index of liquid; wavelength of incident light; radius of curvature of lens; testing of surface flatness; Anti-reflecting films and Highly reflecting film. Diffraction of Light –Fraunhoffer diffraction at single slit, Fraunhoffer diffraction at double slit, Diffraction Grating, Resolving power of a grating, dispersive power of a grating Application of Diffraction - Determination of wavelength of light with a plane transmission grating	**14**
02	**LASERS** Quantum processes as absorption, spontaneous emission and stimulated emission; metastable states, population inversion, pumping, resonance cavity, Einsteins's equations; Helium Neon laser; Nd:YAG laser; Semiconductor laser, Applications of laser- Holography (construction and reconstruction of holograms) and industrial applications(cutting, welding etc), Applications in medical field	**04**
03	**FIBRE OPTICS** Total internal reflection; Numerical Aperture; critical angle; angle of acceptance; Vnumber; number of modes of propagation; types of optical fiber; Losses in optical fibre(Attenuation and dispersion) Applications of optical fibre - Fibre optic communication system; sensors (Pressure, temperature, smoke, water level), applications in medical field	**04**

04	**ELECTRODYNAMICS** Cartesian, Cylindrical and Spherical Coordinate system, Scaler and Vector field, Physical significance of gradient, curl and divergence, Determination of Maxwell's four equations. Applications-design of antenna, wave guide, satellite communication etc.	**08**
05	**CHARGE PARTICLE IN ELECTRIC AND MAGNETIC FIELDS** Fundamentals of Electromagnetism, Motion of electron in electric field (parallel ,perpendicular, with some angle); Motion of electron in magnetic field (Longitudinal and Transverse); Magnetic deflection; Motion of electron in crossed field; Velocity Selector; Velocity Filter, Electron refraction; Bethe's law; Electrostatic focusing; Magnetostatic focusing; Cathode ray tube (CRT);Cathod ray Oscilloscope (CRO) Application of CRO: Voltage (dc,ac), frequency, phase measurement.	**05**
06	**NANOSCIENCE AND NANOTECHNOLOGY** Introduction to nano-science and nanotechnology, Surface to volume ratio, Two main approaches in nanotechnology -Bottom up technique and top down technique; Important tools in nanotechnology such as Scanning Electron Microscope, Transmission Electron Microscope, Atomic Force Microscope. Nano materials: Methods to synthesize nanomaterials (Ball milling, Sputtering, Vapour deposition, solgel), properties and applications of nanomaterials.	**04**

Suggested Experiments: (Any five)

1. Determination of radius of curvature of a lens using Newton's ring set up
2. Determination of diameter of wire/hair or thickness of paper using Wedge shape film method.
3. Determination of wavelength using Diffracion grating. (Hg/ Ne source)
4. Determination of number of lines on the grating surface using LASER Sourse.
5. Determination of Numerical Aperture of an optical fibre.
6. Determination of wavelength using Diffracion grating. (Laser source)
7. Use of CRO for measurement of frequency and amplitude.
8. Use of CRO for measurement of phase angle.
9. Study of divergence of laser beam
10. Determination of width of a slit using single slit diffraction experiment (laser source)

The distribution of Term Work marks will be as follows –

4. Attendance (Theory and Practical) : 05 marks
5. Assignments : 10 marks
6. Laboratory work (Experiments and Journal) : 10 marks

<u>Assessment</u>:

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 15 marks.
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 3marks will be asked.
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.

References:

1. A text book of Engineering Physics-Avadhanulu&Kshirsagar, S.Chand
2. Fundamentals of Optics by Jenkins and White, McGraw-Hill
3. Optics - Ajay Ghatak, Tata McGraw Hill
4. Concepts of Modern Physics- ArtherBeiser, Tata Mcgraw Hill
5. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
6. Engineering Physics-D. K. Bhattacharya, Oxford
7. Concepts of Modern Physics- ArtherBeiser, Tata Mcgraw Hill
8. Classical Electodyamics – J. D. Jackson, Wiley
9. Introduction to Electrodynamics- D. J. Griffiths, Pearson publication
10. Intoduction to Nanotechnology- Charles P. Poole, Jr., Frank J. Owens, Wiley India edition
11. Nano: The Essential – T. Pradeep, Mcgraw-Hill Education

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC203	Applied Chemistry – II	03	01	--	03	0.5	--	**3.5**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC203	Applied Chemistry – II	15	15	15	60	25	--	--	**100**

Objectives

1. To provide necessary background in applied chemistry relevant to chemical industries.
2. To provide exposure in conducting experiments and interpret and report the results in professional format.

Outcomes: Learner will be able to…

1. Identify types of corrosion and factors affecting it related to problems affecting all industries.
2. Identify different types of corrosion control methods to study corrosion control in various industries.
3. Apply the knowledge of different types of fuels, including their production and refining methods and combustion mechanisms.
4. Illustrate composition and properties of different types of alloys and the process of powder metallurgy
5. Illustrate princpales of green chemistry.
6. Illustrate properties and applications of different types of composite materials.

Module	Detailed Contents	Hrs.
01	**Corrosion:** Introduction: Types 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 Electrochemical Corrosion- Galvanic cell corrosion, Concentration cell corrosion (differential aeration), Pitting corrosion, Intergranular corrosion, Stress corrosion. Factors affecting the rate of corrosion- Nature of metal, position of metal in galvanic series, potential difference, overvoltage, relative area of anodic and cathodic parts, purity of metal, nature of the corrosion product, temperature, moisture, influence of pH, concentration of the electrolytes. Methods to decrease the rate of corrosion- Material selection, Proper designing, Use of inhibitors, Cathodic protection- i) Sacrificial anodic protection ii) Impressed current method, Anodic protection method, Metallic coatings- hot dipping- galvanizing and tinning, metal cladding, metal spraying, Electroplating, Cementation. Organic coatings – Paints (only constituents and their functions).	**11**
02	**Alloys** Introduction, purpose of making alloys, Ferrous alloys, plain carbon steel, heat resisting steels, stainless steels (corrosion resistant steels), effect of the alloying element- Ni, Cr, Co, Mn, Mo,W and V; Non-Ferrous alloys- Composition, properties and uses of- Alloys of Aluminium- i) Duralumin ii) Magnalium. Alloys of Cu- (I) Brasses-i) Commercial brass ii) German silver, (II) Bronzes- i) Gun metal ii) High phosphorous bronze. Alloys of Pb- i) Wood's metal ii)	**07**

	Tinmann's solder. Powder Metallurgy- Introduction, (1)Methods of powder metal formation- i) Mechanical pulverization ii) Atomization iii) Chemical reduction iv) Electrolytic process v) Decomposition (2) Mixing and blending. (3) Sintering (4) Compacting- i) Cold pressing ii) Powder injection moulding (iii) Hot compaction. Applications of powder metallurgy. Shape Memory Alloys- Definition, properties and Uses.	
03	**Fuels** Definition, classification of fuels-solid, liquid and gaseous. Calorific value- Definition, Gross or Higher calorific value & Net or lower calorific value, units of heat (no conversions), Dulong's formula & numerical for calculations of Gross and Net calorific values. Characteristics of a good fuel. Solid fuels- Analysis of coal- Proximate and Ultimate Analysis with Significance and numericals. Liquid fuels- Crude petroleum oil, its composition and classification and mining (in brief). Refining of crude oil- i) Separation of water ii) Separation of 'S' & iii) Fractional Distillation with diagram and composition and uses table. Cracking- Definition, Types of cracking- I) Thermal cracking – (i) Liquid phase thermal cracking (ii) Vapour phase thermal cracking. II) Catalytic cracking- (i) Fixed-bed catalytic cracking (ii) Moving-bed catalytic cracking. Advantages of Catalytic cracking. Petrol- Refining of petrol, unleaded petrol (use of MTBE), Catalytic converter, Power alcohol, Knocking, Octane number, Cetane number, Antiknocking agents. Combustion- Calculations for requirement of only oxygen and air (by weight and by volume only) for given solid & gaseous fuels. Biodiesel- Method to obtain Biodiesel from vegetable oils (Trans-esterification), advantage and disadvantages of biodiesel. Fuel cell- Definition, types and applications.	**12**
04	**Composite Materials** Introduction, Constitution- i) Matrix phase ii) Dispersed phase. Characteristic properties of composite materials. Classification- (A) Particle - reinforced composites- i) Large – particle reinforced composites ii) Dispersion – strengthened composites. (B) Fiber – reinforced composites- i) Continuous – aligned ii) Discontinuous – aligned (short)- (a) aligned (b) randomly oriented (C) Structural Composites- i) Laminates (ii) Sandwich Panels.	**04**
05	**Green Chemistry** Introduction, Twelve Principles of Green chemistry, numerical on atom economy, Conventional and green synthesis of Adipic acid, Indigo, Ibuprofen and Carbaryl. Green solvents (water,supercritical CO_2) and products from natural materials.	**06**

Suggested Experiments: (Any five)

1. Estimation of Zn- Complexometric titration.
2. Estimation of Ni- Complexometric titration.
3. Estimation of Al- Complexometic titration.
4. Flue gas analysis using Orsat's apparatus.
5. Estimation of Fe from plain carbon steel
6. Estimation of Ni by gravimetric method.
7. Estimation of Sniodometrically.
8. Preparation of Biodiesel from edible oil.
9. Estimation of Cu- Iodometrically.
10. Estimation of percentage moisture in coal.
11. Estimation of percentage ash in coal.
12. To estimate the emf of Cu-Zn system by potentiometry.
13. Demonstration of Electroplating.

Term work

Term Work shall consist of minimum five experiments. The distribution of marks for term work shall be as follows:

1. Attendance (Practical and Theory) : 05 marks
2. Laboratory Work (Experiments and journal) : 10 marks
3. Assignments and Viva on practicals : 10 marks

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 15 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 3 marks will be asked.
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.

References:

1. Engineering Chemistry - Jain &Jain (DhanpatRai)
2. Engineering Chemistry – Dara & Dara (S Chand)
3. Engineering Chemistry - Wiley India (ISBN – 9788126519880)
4. A Text Book of Engineering Chemistry - ShashiChawla (DhanpatRai)
5. A Text Book of Green Chemistry – V.K. Ahluwalia (Springer)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC204	**Engineering Drawing**	03	04	--	03	02	--	**05**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC204	**Engineering Drawing**	15	15	15	60	25	50	--	**150**

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.
4. 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.
2. Apply the basic principles of projections in converting 3D view to 2D drawing.
3. Read a given drawing.
4. Visualize an object from the given two views.
5. Use CAD tool to draw different views of a 3D object.
6. Use CAD tool to draw an object in 3D.

Module	Detailed Contents	Hrs.
01	**Introduction to Engineering Drawing:-** Types of Lines, Dimensioning Systems as per IS conventions. **Engineering Curves:-** Basic construction of Cycloid, Involutes and Helix (of cylinder) only. ** **Introduction to Auto CAD:-** Basic Drawing and Editing Commands. Knowledge of setting up layers, Dimensioning, Hatching, plotting and Printing.	**3**
02	**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**. **@Projection of Planes:-** Triangular, Square, Rectangular, Pentagonal, Hexagonal and Circular planes inclined to either HP or VP only. (Exclude composite planes)	**6**
03	**Projection of Solids:-** (Prism, Pyramid, Cylinder, Tetrahedron, Hexahedron and 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 **Section of Solids:-** Section of Prism, Pyramid, Cylinder, Tetrahedron, Hexahedron & Cone cut by plane perpendicular to at least one reference plane.(Exclude Curved Section Plane). Use change of position or Auxiliary plane method **Development of Lateral Surfaces of Sectioned Solids:-** Lateral surface development of Prism, Pyramid, Tetrahedron, Hexahedron, Cylinder, Cone **with section plane** inclined to HP or VP only. (Exclude DLS of a solid with a hole in it and Reverse Development). (Exclude Reverse Development)	**14**
04	**Orthographic and Sectional 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. • ****Drawing of orthographic projections using Auto CAD.**	**12**

05	**<u>Isometric Views</u>:-** Isometric View/Drawing of blocks of plain and cylindrical surfaces using plain/natural scale only. (Exclude Spherical surfaces). • ****Drawing of Isometric views using Auto CAD.** • **@Reading of Orthographic Projections. [Only for Practical Exam (AutoCAD) and Term Work]** • ****Orthographic Reading using Auto CAD.** ****<u>Introduction to 3D in AutoCAD</u>** Working in 3-dimensions, Viewing 3D Objects, Basic wireframe models, Extruding, simple revolved objects. Boolean operations.	10

****Should be covered during Auto CAD practical sessions.**
@ Should be covered only in Term work. (i.e. Questions will not be asked for the End semester Examination).

TERM WORK:

<u>Component – 1</u>

Drawing Sheet – 1: Projection of Solids (3 Problems)
Drawing Sheet – 2: Section of Solids and Development of lateral surfaces (2 Problems)
Drawing Sheet – 3: Orthographic Projection without section (2 Problems)
Drawing Sheet – 4: Orthographic Projection with section (2 Problems)
Drawing Sheet – 5: Isometric Views (3 Problems)

<u>Component -2</u>

<u>One A-3 size sketch book consisting of:-</u>

1) Two problems each from Engineering Curves, Projection of Lines, Planes and Solids. One problem from Section of solids without DLS and one problem from section of solids with DLS of that sectioned Solid.
2) Two problems from Orthographic Projections (with Section), One problem on Reading of Orthographic projections and Two problems on Isometric views.

<u>Component-3</u>

Printouts **(preferably on A3 size sheet)** of each from:

1. Orthographic Projections with Section – 3 problems.
2. Isometric Views – 4 problems
3. Reading of Orthographic Projections – 1 problem.

Note:- 2 hrs /week Auto CAD Practical is essential for completing the Auto CAD Drawings and take required printouts.

AUTO CAD PRACTICAL EXAMINATION: (2hrs – 50 marks):

1) Minimum 1 problem from **1 <u>OR</u> 3** of **Component-3** **<u>for 30 marks</u>.**
(All three views with at least 12 dimensions must be asked in the exam)

AND

2) Minimum 1 problem from **2** of **Component-3** **<u>for 20 marks</u>.**

Note:- Print out of the Answers have to be taken **preferably in A3 size sheets** and should be **Assessed by External examiner only**. Knowledge of concepts and accuracy of drawing should be considered during evaluation.

INTERNAL ASSESSMENT TEST: (1 hr - 15 marks)

Out of the two tests, one test must be conducted by **conventional way** and another test must be **Practical Exam** (using AutoCAD software). Average of the two tests must be considered for Internal Assessment.

END SEMESTER EXAMINATION: (3 hrs – 60 marks)

1) Question paper will comprise of 6 questions, each carrying 15 marks.
2) Any 4 questions need to be solved. **There won't be any compulsory Question.**
3) Marks of each topic should be proportional to number of hours assigned to each Module.

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.

References.

1 M.B Shah & B.C Rana, "Engineering Drawing", Pearson Publications.

2 P.J. Shah, "Engineering Graphics", S Chand Publications.

3 Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.

4 Prof. Sham Tickoo (Purdue University) &GauravVerma, "(CAD Soft Technologies) : Auto CAD 2012 (For engineers and Designers)", Dreamtech Press NewDelhi.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC205	**Structured Programming Approach**	04	02	--	04	01	--	**05**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC205	**Structured Programming Approach**	20	20	20	80	25	25	--	**150**

Objectives

1. To familirise the logic of structured programming approach.
2. To provide exposure in developing algorithm, flowchart and thereby writing efficient codes for user defined problem.

Outcomes: Learner will be able to…

1. Illustrate the basic terminology used in computer programming.
2. Illustrate the concept of data types, variables and operators using C.
3. Design and Implement control statements and looping constructs in C.
4. Apply function concept on problem statements.
5. Demonstrate the use of arrays, strings, structures and files handling in C.
6. Demonstrate the dynamics of memory by the use of pointers to construct various data structures.

Module	Topic	Detailed Contents	Hrs.
01	**Introduction to Computer, Algorithm And Flowchart**	**1.1 Basics of Computer:** Turing Model, Von Neumann Model, Basics of Positional Number System, Introduction to Operating System and component of an Operating System. **1.2 Algorithm & Flowchart :** Three construct of Algorithm and flowchart: Sequence, Decision (Selection) and Repetition	**06**
02	**Fundamentals of C-Programming**	**2.1** Character Set, Identifiers and keywords, Data types, Constants, Variables. **2.2 Operators**-Arithmetic, Relational and logical, Assignment, Unary, Conditional, Bitwise, Comma, other operators. Expression, statements, Library Functions, Preprocessor. **2.3 Data Input and Output** – getchar( ), putchar( ), scanf( ), printf( ), gets( ), puts( ), Structure of C program .	**06**
03	**Control Structures**	**3.1 Branching -** If statement, If-else Statement, Multiway decision. **3.2 Looping** – while , do-while, for **3.3 Nested control structure-** Switch statement, Continue statement Break statement, Goto statement.	**12**
04	**Functions and Parameter**	**4.1Function** -Introduction of Function, Function Main, Defining a Function, Accessing a Function, Function Prototype, Passing Arguments to a Function, Recursion. **4.2 Storage Classes** –Auto , Extern , Static, Register	**06**

05	**Arrays , String Structure and Union**	**5.1 Array**-Concepts, Declaration, Definition, Accessing array element, One-dimensional and Multidimensional array. **5.2 String-** Basic of String, Array of String , Functions in String.h **5.3 Structure-** Declaration, Initialization, structure within structure, Operation on structures, Array of Structure. **5.4 Union** - Definition , Difference between structure and union , Operations on a union	**14**
06	**Pointer and Files**	**6.1 Pointer** :Introduction, Definition and uses of Pointers, Address Operator, Pointer Variables, Dereferencing Pointer, Void Pointer, Pointer Arithmetic, Pointers to Pointers, Pointers and Array, Passing Arrays to Function, Pointers and Function, Pointers and two dimensional Array, Array of Pointers, Dynamic Memory Allocation. **6.2 File**s: Types of File, File operation- Opening, Closing, Creating, Reading, Processing File.	**08**

Laboratory Assignments:

1. Students are expected to solve and execute at least 20 programming problems based on above Syllabus.
2. Journal work should comprise of writing the problem definition, solution of problem either as algorithm and flow chart and source code in C (Advisable hand written) for all the 20 problems.

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 Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 3 to 5 marks will be asked.
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 “MASTERING C” by K.R.Venugopal and SudeepR.Prasad , Tata McGraw-Hill Publications.
2 “A Computer Science –Structure Programming Approaches using C ”, by BehrouzForouzan , Cengage Learning .
3 Schaum’s outlines “Programming with C”, by Byron S. Gottfried, Tata McGraw-Hill Publications.

Reference Books:

1 “Basics of Computer Science”, by BehrouzForouzan , Cengage Learning .
2 “Programming Techniques through C”, by M. G. Venkateshmurthy, Pearson Publication.
3 “Programming in ANSI C”, by E. Balaguruswamy, Tata McGraw-Hill Education.
4 “Programming in C”, by Pradeep Day and Manas Gosh, Oxford University Press.
5 “Let Us C”, by YashwantKanetkar, BPB Publication.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEC206	**Communication Skills**	02	02	--	02	01	--	**03**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEC206	**Communication Skills**	10	10	10	40	25	--	--	**75**

Objectives

1. To acquaint the students with appropriate language skills with the purpose of improving the existing ones – LSRW
2. To make the learners understand the importance and effective use of non-verbal communication
3. To make the learner proficient in public speaking and presentation skills
4. To guide and teach the students to utilize the principles of professional business and technical writing for effective communication in the global world
5. To make the learner capable of creating official content digitally for further communication in the corporate environment

Outcomes: Learner will be able to…

1. Understand and evaluate information they listen to and express their ideas with greater clarity
2. Speak and respond effectively along the various channels of communication in a business organization
3. Speak convincingly before an audience with the help of an expanded vocabulary and enhanced digital content
4. Read and summarize effectively
5. Communicate through result oriented writing both within and outside the organization.
6. Write a set of effective and easy to understand technical description, instructions and convey the same using global information technology

Module	Detailed Contents	Hrs.
01	Communication Theory: Concept and Meaning, Communication cycle, Objectives, Barriers to communication (linguistic and semantic, psychological, physical, mechanical, cultural), Methods of communication (verbal and non-verbal), Networks of communication (formal and informal), Language skills (listening, speaking, reading, writing), Corporate communication: Digital Content Creation.	**13**
02	Business Correspondence: Principles of Business Correspondence, Parts of a business letter, Formats (Complete block and Modified block), Types of letters: Enquiry, Reply to enquiry, Claim, Adjustment and Sales letter.	**05**
03	Grammar and Vocabulary: Common errors, Concord (subject- verb agreement), Pairs of confused words, Lexicon (Enriching vocabulary through one-word substitutes, synonyms, antonyms, etc.)	**02**

04	Summarization and Comprehension: Passages to test the analytical skills and expression	**02**
05	Technical writing : Techniques to define an object, writing instructions, language exercises based on types of expositions (description of an object, explanation of a process)	**02**
06	Information Communication Technology (ICT) enabled communication media: E-mail, Blog and Website.	**02**

The distribution of Term Work marks will be as follows -

Attendance : 05 marks

Assignments : 20 marks

List of assignments:

1. Communication theory: 02
2. Business Correspondence: 02
3. Grammar and vocabulary: 01
4. Summarization & Comprehension: 01
5. Technical writing: 01
6. ICT enabled communication media: 01

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 10 marks each. The first test should be conducted in the form of a three-minute public speech. The second test should be based on theory and application exercises as mentioned in the syllabus.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 10 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 3 to 5 marks will be asked.
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.
6. The first module (Communication Theory) will carry 40 % weightage.

References:

1. Communication in Organizations by Dalmar Fisher, Jaico Publishing House
2. Communication Skills by Meenakshi Raman & Sangeeta Sharma,
3. Oxford University Press.
4. Business Correspondence & Report-writing by R.C. Sharma& Krishna Mohan, Tata McGraw-Hill Education.
5. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.
6. Technical Writing & Professional Communication for non-native speakers of English by Thomas N. Huckin & Leslie A. Olsen, McGraw –Hill.
7. Mastering Communication by Nicky Stanton, Palgrave Master Series
8. www.buisnesscommunicationskills.com
9. www.kcitraing.com
10. www.mindtools.com
11. Journal of Business Communication

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
FEL201	**Basic Workshop Practice - II**	--	04	--	--	02	--	**02**

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Av of Test 1 & 2					
FEL201	**Basic Workshop Practice - II**	--	--	--	--	50	--	--	**50**

Detailed Syllabus is given in Basic Workshop Practice-I

Term work:

Term work shall consist of respective reports and jobs of the trades selected the distribution of marks for term work shall be as follows:

Laboratory work (Job and Journal) : 40 marks

Attendance (Practical and Theory) : 10 marks

The final certification and acceptance of term – work ensures the satisfactory performance of laboratory work.

Information Technology

Sr. No.	Subject Code	Subject Name	Count
1	SEITL302	Data Structure and Algorithm Analysis	1
2	SEITL303	Object Oriented Programming Methodology*	1
3	SEITL304	Analog and Digital Circuits	1
4	SEITL305	Database Management Systems	1
5	SEITL306	Principles of Analog and Digital Communication	1
6	SEITL402	Computer Networks	1
7	SEITL405	Web Programming	1
8	TEITL501	Computer Graphics and Virtual Reality	1
9	TEITL502	Operating Systems	1
10	TEITL503	Microcontroller and Embedded Systems	1
11	TEITL504	Advanced Database Management Systems	1
12	TEITL505	Open-Source Technologies	1
13	TEITL601	Software Engineering	1
14	TEITL602	Distributed Systems	1
15	TEITL603	System and Web Security	1
16	TEITL604	Data Mining and Business Intelligence	1
17	TEITL605	Advance Internet Technology	1
18	ITL701	Software Project 2 1 1 Management	1
19	ITL702	Cloud Computing	1
20	ITL703	Intelligent System	1
21	ITL704	Wireless Technology	1
22	ITT705	Elective -I	1
23	ITP706	Project-I	1
24	ITL801	Storage Network 2 1 1 Management and Retrieval	1
25	ITL802	Big Data Analytics	1
26	ITL803	Computer Simulation 2 1 1 and Modeling	1
27	ITL804	Elective -II	1
28	ITP805	Project - II	1
		Total	28

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Information Technology (Second Year – Sem. III & IV)

Revised course (REV- 2012)

From Academic Year 2013 -14

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

From Dean’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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the 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 philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Information Technology of University of Mumbai, happy to state here that, Program Educational Objectives were finalized in a meeting where more than 30 members from different Institutes were attended, who were either Heads or their representatives of Information Technology Department. The Program Educational Objectives finalized for undergraduate program in Information Technology are listed below;

1. To prepare Learner's with a sound foundation in the basics of engineering fundamentals.
2. To prepare Learner's to use effectively modern programming tools to solve real life problems.
3. To prepare Learner's for successful career in Indian and Multinational Organisations and to excel in Postgraduate studies
4. To encourage and motivate Learner's for entrepreneurship.
5. To inculcate professional and ethical attitude, good leadership qualities and commitment to social responsibilities in Learners.
6. To encourage Learner to use best practices and implement technologies to enhance information security and enable compliance, ensuring confidentiality, information integrity, and availability.

In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

Dr. J. W. Bakal
Chairman, Board of Studies in Information Technology,
University of Mumbai, Mumbai

S. E. (Information Technology) Sem.-III

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	TW/Pract	Tut	Total
SEITC301	Applied Mathematics – III *	4		1	4		1	5
SEITC302	Data Structure and Algorithm Analysis	4			4			5
SEITC303	Object Oriented Programming Methodology*	4			4			5
SEITC304	Analog and Digital Circuits	4			4			5
SEITC305	Database Management Systems	3			3			4
SEITC306	Principles of Analog and Digital Communication.	3			3			4
SEITL302	Data Structure and Algorithm Analysis		2			1		
SEITL303	Object Oriented Programming Methodology*		2			1		
SEITL304	Analog and Digital Circuits		2			1		
SEITL305	Database Management Systems		2			1		
SEITL306	Principles of Analog and Digital Communication		2			1		
	TOTAL	22	10	1	22	5	1	28

Examination Scheme

Course Code	Course Name	Theory					Term work	Pract /Oral.	Total
		Internal Assessment			End sem exam	Exam duration (in Hrs)			
		TEST1	TEST 2	AVG.					
SEITC301	Applied Mathematics-III*	20	20	20	80	3	25	--	125
SEITC302	Data Structure & Algorithm Analysis	20	20	20	80	3	25	25	150
SEITC303	Object Oriented Programming Methodology*	20	20	20	80	3	25	25	150
SEITC304	Analog & Digital Circuits	20	20	20	80	3	25	25	150
SEITC305	Database Management Systems	20	20	20	80	3	25	25	150
SEITC306	Principles of Analog & Digital Communication.	20	20	20	80	3	25	25	150
	Total	120	120	120	480		150	125	875

*** Common with Computer Engineering.**
Tutorials will be conducted class wise and will be evaluated as term work.

S. E. (Information Technology) Sem.-IV

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Th	Pract	Tut	Th.	Pract/	Tut	Total
SEITC401	Applied Mathematics-IV*	4		1	4		1	5
SEITC402	Computer Networks	4			4			5
SEITC403	Computer Organization and Architecture	3		1	3		1	4
SEITC404	Automata Theory	3		1	3		1	4
SEITC405	Web Programming	4			4			5
SEITC406	Information Theory and Coding	4		1	4		1	5
SEITL402	Computer Networks		2			1		
SEITL405	Web Programming		2			1		
	Total	22	4	4	22	2	4	28

Examination Scheme

Course Code	Course Name	Theory					Term work	Pract/ Oral	Total
		Internal Assessment			END SEM EXAM	EXAM DURATION (in Hrs)			
		TEST1	TEST 2	AVG.					
SEITC401	Applied Mathematics-IV*	20	20	20	80	3	25	--	125
SEITC402	Computer Networks	20	20	20	80	3	25	25	150
SEITC403	Computer Organization and Architecture	20	20	20	80	3	25	25	150
SEITC404	Automata Theory	20	20	20	80	3	25	--	125
SEITC405	Web Programming	20	20	20	80	3	25	25	150
SEITC406	Information Theory and Coding	20	20	20	80	3	25	--	125
	Total	120	120	120	480		150	75	825

*** Common with Computer Engineering.**

Tutorials will be conducted class wise and will be evaluated as term work.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
SEITC301	Applied Mathematics - III*	04	--	01	04	-	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. Of Test1 and Test2					
SEITC301	Applied Mathematics -III*	20	20	20	80	25	-	-	125

Course Objective

(1) Complex Variable (2) Laplace Transform (3) Fourier Series (4) Discrete Structures (5) Z-transform

These topics involve the study of analytic function and mapping of complex function, Laplace transform, Inverse Laplace transform and application of Laplace transform to solve differential equations, finding Fourier series, Sine and cosine Fourier integral and Z-transform. These topics help them to solve many engineering problems arising in course of their further studies and also while working in the practical life situations.

Student Learning Outcomes:

Students in this course will apply the Procedure and methods to solve technical problems.

Details of the Syllabus:-

Sr.No.	Topics	Hrs
Module 01	**Complex Variable & mapping** 1.1 Functions of a complex variable, Analytic functions, Cauchy-Riemann equations in Cartesian co-ordinates, Polar co-ordinates. 1.2 Harmonic functions, Analytic method and Milne Thomson methods to find f(z), Orthogonal trajectories. 1.3 Conformal Mapping, Linear, Bilinear transformations, Cross ratio, fixed points and standard transformation such as rotation and magnification, invertion, translation.	(10)
Module 02	**Laplace Transform** 2.1 Introduction, Definition of Laplace transform, Laplace transform of constant, trigonometrical, exponential functions. 2.2 Important properties of Laplace transform: First shifting theorem, Laplace transform of $L\{t^n f(t)\}$, $L\{f(t)/t\}$, $L\left\{\frac{d^n f(t)}{dt^n}\right\}$, $L\{\int_0^t f(u)du\}$, L{f(at)} without proof. 2.3 Unit step function, Heavi side function, Dirac-delta function, Periodic function and their Laplace transforms, Second shifting theorem. 2.4 Inverse Laplace transform with Partial fraction and Convolution theorem (without proof). 2.5 Application to solve initial and boundary value problem involving ordinary differential equations with one dependent variable and constant coefficients.	(10)
Module 03	**Fourier series** 3.1 Dirichlet's conditions, Fourier series of periodic functions with period 2π and 2L. 3.2 Fourier series for even and odd functions. 3.3 Half range sine and cosine Fourier series, Parsevel's identities (without proof). 3.4Orthogonal and Ortho-normal functions, Complex form of Fourier series. 3.5 Fourier Integral Representation.	(10)
Module 04	**Vector Algebra and Calculus** 4.1 Vector Algebra: Scalar and vector product of three and four Vectors and their	(10)

	properties. 4.2 Vector Calculus: Vector differential operator ∇ , Gradient of a scalar point function, Diversions and Curl of Vector point function, $\nabla(uv)$, $\nabla.(\phi\,\bar{u}), \nabla\times(\phi\,\bar{u}), \nabla\times(\bar{u}\times\bar{v})$. 4.3 Vector Integration: Line integral; conservative vector field, Green's theorem in a plane (Without proof) 4.4 Gauss-Divergence theorem & Stokes' theorem (Without proof and no problems on verification of above theorems).	
Module **05**	**Z transform** 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 (all without proof) 5.3 Inverse Z transform: Binomial Expansion and Method of Partial fraction.	**(8)**

Term work:

Term work shall consist of minimum four SCILAB practicals and six tutorials.

SCILAB practicals : 08 marks
Tutorials : 12 marks
Attendance : 05 marks
Total : 25 marks

Recommended 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. Vector Calculus by Shanti Narayan, S Chand & Co.

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. Lapplace Treansforms by Murray R. Spiegel, Schaun's out line series-McGraw Hill Publication.
4. Vector Analysis by Murray R. Spiegel, McGraw Hill publication.

Theory Examination :

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

  Weightage of marks should be proportional to number of hours assigned to each module.

Subject code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tut.	Theory	TW/Pract	Tut	Total
SEITC302	Data Structure and Algorithm Analysis	04	02	-	04	01	-	05

Subject code	Subject Name	Examination Scheme							
		Theory Marks				TW	Pract	Oral	Total
		Internal Assessment			End Semester Exam				
SEITC302	Data Structure and Algorithm Analysis	Test1	Test2	Average of Test1 and Test2					
		20	20	20	80	25	25	-	150

Objectives:

- To teach efficient storage mechanisms of data for an easy access.
- To design and implementation of various basic and advanced data structures and algorithm analysis.
- To introduce various techniques for representation and analysis of the data in the real world.
- To develop application using data structures and algorithm and analysis.
- To teach the concept of protection and management of data.
- To improve the logical ability

Outcomes:

- Student will be able to choose appropriate data structure as applied to specified problem definition and analysis the algorithm.
- Student will be able to handle operations like searching, insertion, deletion, traversing mechanism etc. on various data structures and algorithm analysis.
- Students will be able to apply concepts learned in various domains like DBMS, compiler construction etc.
- Students will be able to use linear and non-linear data structures like stacks, queues, linked list etc.

Module	Detailed Contents	Hours
1	**Introduction:** Introduction, Mathematics Review, Exponents, Logarithms, Series, Modular Arithmetic, The P Word, A Brief Introduction to Recursion, Recursion and Induction.	3
2	**Algorithm Analysis:** Mathematical Background, Model, What to Analyze, Running Time Calculations, General Rules, Solutions for the Maximum Subsequence Sum Problem, Logarithms in the Running Time, Euclid's Algorithm, Exponentiation, Checking Your Analysis, A Grain of Salt.	4
3	**Stacks, Queues and List** Stacks, Queues, Linked Lists, Double-ended Queues. Abstract Data Type (ADT), The List ADT, Simple Array Implementation of Lists, Linked Lists, Programming Details, Common Errors, Doubly Linked Lists, Circularly Linked Lists, Examples, Cursor Implementation of Linked Lists, The Stack ADT, Implementation of Stacks, Applications, The Queue ADT, Array Implementation of Queues, Applications of Queues.	10
4	**Trees and Search Trees:** Tree, Implementation of Trees, Tree Traversals with an Application, Binary Trees, Expression Trees, the Search Tree ADT-Binary Search Trees, AVL Trees, Single Rotation, Double Rotation, Red-Black Trees, External searching in B-Trees, Tree Traversals, B-Trees	10
5	**Priority queues:** The priority queues Abstract data Type, Implementing a Priority queues with a List, Heaps, Adaptable priority queues.	6
8	**Sorting Sets, and Selection:** Insertion Sort, Shellsort, Heapsort, Quicksort, Bucket Sort, Merge Sort and radix Sort, and A Lower Bound on comparison-based Sorting and radix Sort, the complexity of some sorting algorithms, comparison of Sorting Algorithms, The Set ADT and union / file Structures	6
9	**Graphs:** The graph Abstract Data Type, Data Structures for Graphs, Graph Traversals Directed Graphs, Weighted Graphs, Shortest Paths, and Minimum spanning Trees. Applications of DFS and BSF, Shortest-Path Algorithms, Dijkstra's Algorithm, Graphs with Negative Edge Costs, Acyclic Graphs, Network Flow Problems, Minimum Spanning Tree.	9

TEXT BOOKS:

1. Mark Allien Weiss, “Data Structure and Algorithm Analysis in C”, Person.
2. Micheal Goodrict, Roberto Tamassia,”Data Structure and Algorithm in C++”, Wiley India

3. Data Structures A Psedocode Approach with C, Richard F. Gilberg & Behrouz A. Forouzan, second edition, CENGAGE Learning.
4. Data Structures Using C & C++, Rajesh K. Shukla, Wiley- India
5. Data Structures using C, Reema Thareja, Oxford University press.
6. Introduction to Data Structure and its Applications Jean-Paul Tremblay, P. G. Sorenson

REFERENCE BOOKS:

1. Ellis horowitz, Sarataj Sahni, S.Rajsekaran," Fundamentals of computer algorithm", University Press .
2. Mark Allen Weiss,"Data Structure & algorithm Analysis in C++", 3rd Edition, Pearson Education
3. Micheal Goodrict, Roberto Tamassia,"Data Structure and Algorithm in C++", Wiley India.
4. Data Structures Using C, ISRD Group, Second Edition, Tata McGraw-Hill
5. Data Structure Using C, Balagurusamy
6. C & Data Structures, Prof. P.S. Deshpande, Prof. O.G. Kakde, Dreamtech press.
7. Data Structures, Adapted by: GAV PAI, Schaum's Outlines
8. Mark Allen Weiss,"Data Structure & algorithm Analysis in C++", 3rd Edition, Pearson Education

Term Work:

Term Work shall consist of at least 12 programs based on the below list.
Note: The star (*) marks experiments are mandatory.

Linked List
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. Representation of Sparse matrix using multilinked structure. Implementation of sparse matrix multiplication. 4. Implementation of polynomials operations (addition, subtraction) using Linked List. 5. *Implementations of Linked Lists menu driven program (stack and queue) 6. Implementations of Double ended queue using Linked Lists. 7. Implementation of Priority queue program using Linked List.
Stack
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. 5. Simulation of recursion
Queue

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. 5. Implementation of Johnsons Algorithm 6. Implementation of Simulation Problem
Tree
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 Huffman code construction 5. Implementations of BST program 6. Implementation of various operations on tree like – copying tree, mirroring a tree, counting the number of nodes in the tree, counting only leaf nodes in the tree. 7. Implementations of B-tree menu driven program 8. Implementations of B+ tree program 9. Implementation of Preorder traversal of a threaded binary tree. **10.** *Implementations of AVL Tree menu driven program
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
Searching
1. Implementations of searching methods (Index Sequential, Interpolation Search) menu driven program **2.** Implementation of hashing functions with different collision resolution techniques
Graph
1. * Implementations of Graph menu driven program

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Subject code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tut.	Theory	TW/Pract	Tut	Total
SEITC303	Object Oriented Programming Methodology *	04	02	-	04	01	-	05

Subject code	Subject Name	Examination Scheme							
		Theory Marks				TW	Pract	Oral	Total
		Internal Assessment			End Semester Exam				
SEITC303	Object Oriented Programming Methodology*	Test1	Test2	Average of Test1 and Test2					
		20	20	20	80	25	25	-	150

Course Objectives

- To understand Object oriented concepts like data abstraction, encapsulation, etc.
- To solve the real world scenarios using top down approach.
- To understand various Java programming constructs.

Course Outcomes

- Students will be able to solve computational problems using basic constructs like if-else, control structures, array, strings.
- Student can understand how to model real world scenario using class diagram.
- Students will exhibit communication between 2 objects using sequence diagram.
- Students will be able to implement relationships between classes.
- Students will be able to demonstrate various collection classes.
- The students will be able to demonstrate programs on exceptions, multithreading and applets.

Detailed Syllabus:

Sr. No.	Topic	No of Hours
1	Programming Approach from proceduaral to Object Orientation OO methodologies: Grady Booch Methodology of OO development	4
2	OO Concepts: Object, Class, Encapsulation or information hiding, Inheritance, Polymorphism, Message communication, Abstraction, Reuse, Coupling and Cohesion, Sufficiency Completeness and Primitiveness, Meta class	5
3	Object Oriented Programming: Java Evolution: History, How java differs from others Overview of Java language: Introduction, Installing and implementing Java, JVM	3
4	Constants, variables and data types Operators and Expressions Revision of Branching and looping	6
5	Class Object and Method: member, method, Modifier, Selector, constructer, destructor, iterator, State of an object, Method Overloading, Inheritance, Method Overriding ,Final class, abstract class and method	6
6	Classes and Relationships : Implementation of Association and Aggegation using simple scenarios	2
7	Array, String, Vector	6
8	Interfaces : variables in Interfaces, Extending an Interface, Difference between an Abstarct class and an Interface	4
9	Multithread programming	4
10	Grouping of classes for deployment and reuse: Built-in Packages: java.lang: wrapper classes java.util: ArrayList and LinkedList Creating and using User defined packages	3
11	Managing Error and Exception	3
12	Applet programming	2

Text Books:

1. Ralph Bravaco , Shai Simoson , “Java Programing From the Group Up” ,Tata McGrawHill
2. Grady Booch, Object Oriented Analysis and Design ;

3. Jaime Nino, Frederick A. Hosch, ‘An introduction to Programming and Object Oriented
Design using Java’, Wiley Student Edition.

Reference Books:

1. Java: How to Program, 8/e, Dietal, Dietal, PHI
2. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Language ser Guide”, Pearson Education
3. Sachin Malhotra, Saurabh Chaudhary “Programming in Java”, Oxford University Press, 2010

Suggested list of Programming Assignments /Laboratory Work

Divide laboratory work into 3 parts

Part - A

Basic Java structural components and Conditional and control statements:

· To demonstrate the use of command line argument.
· To demonstrate various ways of accepting data through keyboard.
· To understand the working of an array.
· To understand string class and demonstrate its various functions.

Part - B

Perform following practical on some case study like Banking Application, Library Application etc.

· Find out classes, objects and their properties.
· Create and display objects found in above.
· Add methods to classes and implement.
· Refine above objects by adding constructors and local variables.
· Show communication between the objects by calling instance of one object from another class.
· Find relationships like inheritance, association, aggregation, composition.
· Implement above relationships.

Part - C

1. To implement user defined exceptions in Java.
2. Demonstrate the use collection classes like ArrayList/LinkedList/HashSet/TreeSet/Map.
3. To illustrate Multithreading in Java.
4. Simple programs on Applets and AWT.

TermWork:

Students will submit Term Work in the form of a journal that will include at least 15 programming assignments. Each programming assignment will consist of an algorithm or class diagram/sequence diagram (if applicable), program listing with proper documentation and snapshot of the output.

Practical Examination will be based on the term work and questions will be asked to judge understanding of the assignments at the time of the examination.

Term Work: 25 Marks (total marks) = 15 Marks (Experiment) + 5 Marks
(Assignment) + 5 (Attendance (theory + practical))

Theory `Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Subject code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tut.	Theory	TW/Pract	Tut	Total
SEITC304	Analog and Digital Circuits	04	02	-	04	01	-	05

Subject code	Subject Name	Examination Scheme							
		Theory Marks				TW	Pract	Oral	Total
		Internal Assessment			End Semester Exam				
SEITC304	Analog and Digital Circuits	Test1	Test2	Average of Test1 and Test2					
		20	20	20	80	25	--	25	150

Course Objective:

1) To provide concepts that underpins the disciplines of Analog circuits, digital electronics and Microprocessor systems.
2) To provide the concept of various components
3) To provide basic knowledge of designing Analog and digital circuits

Course outcomes:

1) Knowledge and Awareness of various components.
2) Design of stable analog circuits.
3) Circuit simulation.
4) Binary and hexadecimal calculations and conversions.
5) Design of combinational and sequential circuits.
6) Translate real world problems into digital logic formulations.
7) Awareness in Design of digital systems and concepts of Microprocessor and Microcontroller systems.

Detailed Syllabus:

Module	Detailed Contents	Hours
1	Voltage Regulator and components: Zener diode. Series and Shunt Regulator. Regulator ICs 78XX, IC 79XX.Light Emitting diode(LED), Schottky diode, Varactor diode, power diode, Photodiodes, Liquid-crystal Displays, Solar cells, Thermistor.	06
2	Biasing of BJT: DC operating point, BJT characteristics & parameters,	08

	all biasing circuits, analysis of above circuits and their design, variation of operation point and its stability. Differential Amplifier, constant current source, current mirror. Introduction to FET and comparison with BJT.	
3	Operational Amplifiers and linear applications: Block diagram representation, Ideal Op-amp, Equivalent circuit, Open-loop configuration, Transfer characteristics. Op-amp with negative feedback, Frequency response. Op-amp IC 741 specifications. Basic op-amp applications: Adder, Scalar, Subtractor, Difference amplifier, I-V converter, V-I converters, Integrator, Differentiator, Instrumentation amplifier using 2 and 3 op-amp stages. IC 555 Timer, Astable, and Monostable Multivibrator.	10
4	Number Systems and Codes: Binary, Octal, Decimal and Hexadecimal number Systems and their conversion, Binary Addition and Subtraction , Gray Code, BCD Code, Excess-3 code, ASCII Code.	04
5	Boolean Algebra and Logic Gates: Theorems and Properties of Boolean Algebra, Standard SOP and POS form, Reduction of Boolean functions using Algebric method, K -map method (2,3,4 Variable). Basic Digital Circuits: NOT,AND,OR,NAND,NOR,EX-OR,EX-NOR Gates.	04
6	Combinational Logic Design: Introduction, Half and Full Adder, Half and Full Subtractor, Four Bit Binary Adder, One digit BCD Adder, code conversion, Multiplexers and Demultiplexers, Decoders, 4-bit Magnitude Comparator IC 7485 and ALU IC74181.	06
7	Sequential Logic Design: Flip Flops: SR, D, JK, JK Master Slave and T Flip Flop, Truth Tables and Excitation Tables, Flip-flop conversion. Counters: Design of Asynchronous and Synchronous Counters, Modulo Counters, UP- DOWN counter .IC 74193 Shift Registers: Shift Register IC 7496 , SISO, SIPO,PIPO,PISO, Bidirectional Shift Register , Universal Shift Register, Ring and Johnson Counter.	06
8	Introduction to VHDL: Introduction , Library, Entity, Architecture, Modeling Styles, Concurrent and sequential statements, Data objects and Data types, attributes. Design Examples for combinational circuits.	04

TERMWORK MARKS: 1. Attendance (Theory and Practical) - 05
2. Laboratory work (Experiments and Journal) -15
3. Assignments -05

The final certification and acceptance of TW ensures the satisfactory performance of Laboratory Work and Minimum Passing in the term work.

LABORTARY WORK:

1. Laboratory work should consist of at least 10 Experiments.

The Experiments should be based on following topics (Any Ten):

1) Zener diode as Regulator.
2) BJT Biasing Method.
3) OP-amp as Inverting and Non-inverting amplifier.
4) Applications of Op-amp.
5) IC 555 as astable Multivibrator.
6) Simulation of any circuit using Pspice.
7) Logic Gates.
8) Code Conversion.
9) Multiplexer, Demultiplexer.
10) Flip-flops using gates and ICs.
11) Design of Sequential circuits.
12) VHDL for Combinational logic.

Text Books:

1. Robert L. Boylestad, Louis Nashelsky, “Electronic devices and circuit Theory”, PHI
2. Ramakant A. Gaikwad, “Op-amp and linear Integrated circuits”, PHI
3. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill.
4. M. Morris Mano, “Digital Logic and computer Design”, PHI.
5. J. Bhasker.“ VHDL Primer”, Pearson Education

Reference Books:

1. Martin s. Roden, Gordon L. Carpenter, William R. Wieserman “Electronic Design-From Concept to Reality”, Shroff Publishers and Distributors.
2. D.roy Choudhury,shail B.jain, “Linear integrated Circuits”, New age International Publisher.
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.

Theory Examination :

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
SEITC305	Database Management System	03	02	--	03	01	--	04

Sub. Code	Subject Name	Examination Scheme							
		Theory Marks				TW	Pract.	Oral	Total
		Internal Assessment			End Semester Exam				
SEITC305	Database Management System	Test 1	Test 2	Avg. of Test1 & Test2					
		20	20	20	80	25	25	-	150

Objective:

- 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.
- Apply normalization techniques to normalize the database
- Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access.

Outcome: The student should be able:

- To describe data models and schemas in DBMS
- To understand the features of database management systems and Relational database.
- To use SQL- the standard language of relational databases.
- To understand the functional dependencies and design of the database.
- To understand the concept of Transaction and Query processing.

Detailed Syllabus:

Module	Detailed content	Hours
1	**Introduction Database Concepts:** Introduction, Characteristics of databases, File system V/s Database system, Users of Database system, Concerns when using an enterprise database, Data Independence, DBMS system architecture, Database Administrator,	02
2	**Entity–Relationship Data Model :** Introduction, Benefits of Data Modeling, Types of Models, Phases of Database Modeling, The Entity-Relationship (ER) Model, Generalization, Specialization and Aggregation, Extended Entity-Relationship (EER) Model.	03
3	**Relational Model and Algebra :** Introduction , Mapping the ER and EER Model to the Relational Model , Data Manipulation , Data Integrity ,Advantages of the	06

	Relational Model, Relational Algebra , Relational Algebra Queries, Relational Calculus.	
4	**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, Nested and complex queries .	06
5	**Integrity and Security in Database:** Domain Constraints, Referential integrity, Assertions, Trigger, Security, and authorization in SQL	04
6	**Relational–Database Design :** Design guidelines for relational schema, Function dependencies, Normal Forms- 1NF, 2 NF, 3NF, BCNF and 4NF	04
7	**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 , Timestamp-based , Validation-based protocols, Deadlock handling, Recovery System: Failure Classification, Storage structure, Recovery & atomicity, Log based recovery, Shadow paging.	06
8	**Query Processing and Optimization: Overview** ,Issues in Query Optimization ,Steps in Query Processing , System Catalog or Metadata, Query Parsing , Query Optimization, Access Paths , Query Code Generation , Query Execution , Algorithms for Computing Selection and Projection , Algorithms for Computing a Join , Computing Aggregation Functions , Cost Based Query Optimization .	05

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 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. Mark L. Gillenson, Paulraj Ponniah, " Introduction to Database Management",Wiley
3. Sharaman Shah ,"Oracle for Professional", SPD.
4. Raghu Ramkrishnan and Johannes Gehrke, " Database Management Systems",TMH
5.Debabrata Sahoo "Database Management Systems" Tata McGraw Hill, Schaum's Outline

Term Work:

Assign a case study for group of 2/3 students and each group to perform on their case study following experiments-

1) Problem Definition and draw ER /EER diagram
2) Design Relational Model
3) Perform DDL operation
4) PL/SQL
5) Perform DML and DCL operations
6) Executes- Assertions, Trigger,
7) Implementation ACID properties
8) Draw Query tree
9) Estimate cost of query

Laboratory Syllabus:

1) Problem Definition and draw ER /EER diagram
2) Design Relational Model
3) Perform DDL operation
4) PL/SQL
5) Perform DML and DCL operations
6) Executes- Assertions, Trigger,
7) Implementation ACID properties
8) Draw Query tree
9) Estimate cost of query

Tools used:

Oracle, DB2, MY SQL or any other open source tools.

Theory Examination :

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
SEITC306	Principles of Analog and Digital Communication	03	02	--	03	01	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
SEITC306	Principles of Analog and Digital Communication	20	20	20	80	25	---	25	150

Prerequisite

Basic knowledge of electrical engineering concepts and analog and digital electronics.

Course Objective

To introduce the basic principles and techniques used in analog and digital communications, involving analog and digital modulation techniques, communication receiver and transmitter design, baseband and bandpass communication techniques, line coding techniques, noise analysis and multiplexing techniques.

Course Outcome

The student can analyse analog communication systems, can understand differences between analog and digital representation and transmission of information, trade-offs (in terms of bandwidth, power, and complexity requirements) between basic analog and digital communication systems and can design basic analog or digital communication systems to solve a given communications problem.

Detailed Syllabus:

Module	Topics	Hours
1	**Introduction** Basics of analog communication systems (Block diagram), Sources of information, Baseband and bandpass signals, Types of communication channels, Frequency / Spectrum allocations, Need for modulation and demodulation	03
2	**Fourier Transform and Noise** Introduction to Fourier Transform, its properties, 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	04
3	**Analog Modulation and Demodulation** 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 transmission and reception**: 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) FM demodulator: Foster Seely discriminator, Ratio detector.	11

4	**Pulse Analog Modulation** Sampling theorem for low pass and bandpass signals with proof, anti aliasing filter, PAM, PWM and PPM generation and degeneration.	04
5	**Digital Modulation Techniques** 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	04
6	**Bandpass Modulation** Introduction to Line codes, Intersymbol interference, Binary phase shift keying, Differentally encoded phase shift keying, Quadrature phase shift keying, M-ary phase shift keying, Quadrature amplitude shift keying, Binary frequency shift keying, M-ary frequency shift keying, Minimum shift keying. (Block diagram, spectrum and bandwidth calculation and applications in each case)	10
	Total	(12 x 3)= **36 hours**

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

Recommended Books

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, Ist Ed.

Reference Books

George Kennedy, Bernard Davis, SRM Prasanna, Electronic Communication Systems, Tata McGraw Hill, 5th Ed.

[1] Wayne Tomasi, Electronic Communications Systems, Pearson Publication, 5th Ed.

[2] BP Lathi,Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University Press, 4th Ed.

[4] K Sam Shanmugam, Digital and Analog Communication Systems, Wiley India Pvt. Ltd, 1st Ed.

Suggested Topics of Experiments

1. Amplitude modulation - generation and detection
2. Frequency modulation generation and detection
3. Study of AM/ FM receiver
4. Signal sampling and reconstruction
5 PWM generation
6. PCM coding and decoding
7. Delta modulation and demodulation
8. TDM/ FDM
9. BPSK
10. BFSK
11. BASK
12. QPSK
13. Study of eye pattern

Term Work:

Term work shall consist of at least 08 experiments from the suggested topics. 04 experiments out of these have to be performed on hardware and 04 can be performed using suitable simulation software.

Distribution of marks for term work shall be asfollows:

1. Attendance (Theory and Practical): 05 Marks
2. Laboratory work (Experiments and Journal): 10 Marks
3. Assignments: 10 Marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory Work and Minimum Passing in the term work.

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each mo

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tutorial	Theory	TW/ Pract.	Tutorial	Total
SEITC401	Applied Mathematics - IV *	04	--	01	04	-	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg.					
SEITC401	Applied Mathematics –IV*	20	20	20	80	25	-	-	125

Course Objective:

This course will present matrix theory, Similar matrices and it's application to find the matrics function. Present methods of computing and using eigen values and eigen vectors. Set up and directly evaluate contour integrals Cauchys integral theorem and formula in basic and extended form. Present Taylor and Laurents series to find singularities zero's and poles also presents residues theory and it's applications. Present theory of probability, Baye's Theorem, Expectation and Moments and it's application. Present probability distribution such as binomial, Poisson and normal distribution with their properties. Present sampling theory and it's application for small and large sample. Present methods of computing optimization using simplex method.

Student Learning Outcomes:

Students in this course will apply the method of solving complex integration and computing residues. Use residues to evaluate various contour integrals. Demonstrate ability to manipulate matrices and compute eigen values and eigenvectors.

Students in this course will apply the Procedure and methods to solve technical problems.

Detailed Syllabus:

Sr.No.	Details	Hrs
Module 01	**Complex Integration** 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 $\int_0^{2\Pi} f(\sin\theta,\cos\theta)d\theta, \int_{-\infty}^{\infty} f(x)dx.$	**(10)**
Module 02	**Matrices:-** 2.1 Eigen values and eigen vectors 2.2 Cayley-Hamilton theorem(without proof) 2.3 Similar matrices, diagonalisable of matrix. 2.4 Derogatory and non-derogatory matrices ,functions of square matrix.	**(08)**
Module 03	**Correlation** 3.1Scattered diagrams, Karl Pearson's coefficient of correlation, covariance, Spearman's Rank correlation. 3.2 Regression Lines.	**(04)**
Module 04	**Probability** 4.1 Baye's Theorem, 4.2 Random Variables:- discrete & continuous random variables, expectation, Variance, Probability Density Function & Cumulative Density Function. 4.3 Moments, Moment Generating Function. 4.4 Probability distribution: binomial distribution, Poisson & normal distribution. (For detail study)	**(08)**
Module 05	**Sampling theory** 5.1 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. 5.2 Test of significant of small samples:- Students t- distribution for dependent and independent samples. 5.3 Chi square test:- Test of goodness of fit and independence of attributes, Contingency table.	**(08)**
Module 06	**Mathematical Programming** 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, Dual simplex method. 6.4 Non Linear Programming:-Problems with equality constrains and inequality constrains (No formulation, No Graphical method).	**(10)**

Term work:
Term work shall consist of minimum four SCILAB practicals and six tutorials.
SCILAB practicals : 08 marks
Tutorials : 12 marks
Attendance : 05 marks
Total : 25 marks

Recommended 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 & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.
4. Probability and Statistics for Engineering, Dr. J Ravichandran, Wiley-India.
5. Mathematical Statistics by H. C Saxena, S Chand & Co.

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. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
4. Operations Research by S.D. Sharma Kedar Nath, Ram Nath & Co. Meerat.
5. Engineering optimization (Theory and Practice) by Singiresu S.Rao, New Age International publication.
6. Probability by Seymour Lipschutz, McGraw-Hill publication.

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tutorial	Theory	TW/ Pract.	Tutorial	Total
SEITC402	Computer Networks	04	02	--	04	01	--	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Pract.	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of 2 Tests					
SEITC402	Computer Networks	20	20	20	80	25	---	25	150

Course Objectives:

- To be familiar with the basics of data communication.
- To be familiar with the basics of Computer networks and working of Internet.
- To be familiar with various types of computer networks.
- To have experience in designing communication protocols.
- To be exposed to the TCP/IP protocol suite.
- To understand the working of Packet Switched network (PSN).
- To be familiar with Windows and UNIX networking style.

Course Outcomes:

1. Ability to understand principles of LAN design such as topology and configuration depending on types of users accessing the network.
2. Ability to understand design performance issues like different type of network interfaces network components and choosing appropriate network type and media.
3. Ability to understand network industry standards such as: the OSI & TCP models, Routing Protocols, Address Resolution and Reverse Address Resolution Protocols, IP Addressing and Subnetting, MAC Addressing.
4. Ability to work with network tools.
5. Ability to understand the working of network operating system.

Detailed Syllabus:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction**	Network Applications, Network Hardware, Network Software, Reference Models.	**04**
2	**The Physical Layer**	Guided Transmission Media, Wireless Transmission, Communication Satellites, The Public Switched Telephone Network, The Mobile Telephone System, Cable Television.	**06**
3	**The Data Dink Layer**	Data Link Layer Design Issues, 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.	**08**
4	**The Medium Access Sub-layer**	The Channel Allocation Problem, Multiple Access Protocols, Ethernet, Data Link Layer Switching.	**06**
5	**The Network Layer**	Network Layer Design Issues, Routing Algorithms, Congestion Control Algorithms, Quality Of Service, Internetworking, The Network Layer In The Internet: The IP Protocol, IPv4 header, IP Addressesing, Subnetting, Internet Control Protocols, The Interior Gateway Routing Protocol: OSPF, The Exterior Gateway Routing Protocol: BGP.	**10**
6	**The Transport Layer**	The Transport Service, Elements Of Transport Protocols,The Internet Transport Protocol: UDP, The Internet Transport protocol: TCP: -Introduction To TCP, The TCP Service Model, The TCP Protocol, The TCP Segment Header, TCP Connection Establishment, TCP Connection Release, Modeling TCP Connection Management, TCP Transmission Policy, TCP Congestion Control, TCP Timer Management, Transactional TCP.	**10**
7	**Case study**	Networking using Windows and Linux Operating systems.	**04**

Text Books:

1. A. S. Tanenbaum,"Computer Networks", 4th edition, Prentice Hall

2. B. F. Ferouzan,"Data and Computer Communication", Tata McGraw Hill.

References:

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 Suit", Tata McGraw Hill.

Term work

Students are expected to perform 8 programming assignments two case study assignments.

Suggested Practical List

- Network OS installation and configuration.
- Understanding various networking commands like ARP, RARP, ping, tracert, telnet, nslookup.
- Installation and Understanding of Ns-2 simulator.
- Emulation of Sliding window protocol and other data link layer protocols using NS-2.
- Implementation of Routing Algorithms using NS-2.
- Implementation of shortest path algorithms.
- Case Study: Networking using Windows and Linux Operating systems.

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Subject Code	Subject Name	Teaching Scheme			Credit Assigned		
		Theory	Pract.	Tut.	Theory	TW	Total
SEITC403	Computer Organization and Architecture	03	-	01	03	01	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks				TW	Pract	Oral	Total
		Internal Assessment			End Semester Exam				
		Test1(T1)	Test2(T2)	Average of T1 & T2					
SEITC403	Computer Organization and Architecture	20	20	20	80	25	-	25	150

Pre-requistes: Fundamentals of Computer, Digital Logic Circuits, Programming Languages (C, C++, Java)

Course Educational Objectives (CEO):

CEO 1	To conceptualize the basics of organizational and architectural issues of a digital computer.
CEO 2	To analyze performance issues in processor and memory design of a digital computer.
CEO 3	To understand various data transfer techniques in digital computer.
CEO 4	To analyze processor performance improvement using instruction level parallelism

Course Learning Outcomes:

A	Ability to understand basic structure of computer.
B	Ability to perform computer arithmetic operations.
C	Ability to understand control unit operations.
D	Ability to design memory organization that uses banks for different word size operations.
E	Ability to understand the concept of cache mapping techniques.
F	Ability to understand the concept of I/O organization.
G	Ability to conceptualize instruction level parallelism.

Detail Syllabus:

Module	Detailed Contents	Hours
1	**Overview of Computer Architecture & Organization:** Introduction of Computer Organization and Architecture. Basic organization of computer and block level description of the functional units. Evolution of Computers, Von Neumann model. Performance measure of Computer Architecture. Introduction to buses and connecting I/O devices to CPU and Memory, bus structure.	**04**
2	**Data Representation and Arithmetic Algorithms:** Number representation: Binary Data representation, two's complement representation and Floating-point representation. IEEE 754 floating point number representation. Integer Data computation: Addition, Subtraction. Multiplication: Signed multiplication, Booth's algorithm. Division of integers: Restoring and non-restoring division Floating point arithmetic: Addition, subtraction	**10**
3	**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 RISC and CISC architectures and design issues. Case study on 8085 microprocessor: Features, architecture, pin configuration and addressing modes.	**12**
4	**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. Virtual Memory: Concept, Segmentation and Paging , Page replacement policies.	**12**
5	**I/O Organization and Peripherals:** Input/output systems, I/O modules and 8089 IO processor. Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA. Peripheral Devices: Introduction to peripheral devices, scanner, plotter, joysticks, touch pad.	**6**
6	**Introduction to parallel processing systems:** Introduction to parallel processing concepts, Flynn's classifications, pipeline processing, instruction pipelining, pipeline stages, pipeline hazards.	**4**

Text Books:

1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization”, Fifth Edition, Tata McGraw-Hill.
2. John P. Hayes, “Computer Architecture and Organization”, Third Edition.
3. William Stallings, “Computer Organization and Architecture: Designing for Performance”, Eighth Edition, Pearson.
4. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, Tata McGraw-Hill.

Reference Books:

1. Dr. M. Usha, T. S. Srikanth, “Computer System Architecture and Organization”, First Edition, Wiley-India.
2. “Computer Organization” by ISRD Group, Tata McGraw-Hill.
3. Ramesh Gaonkar, “Microprocessor Architecture, Programming and Applications with the 8085, Fifth Edition,Penram.

Oral examination will be based on the above syllabus.

There will be at least eight assignments covering the above syllabus.

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

Note: The faculty should conduct tutorials based on the above syllabus including two case studies on recent developments covering the above contents.
8085 microprocessor should be included only as a sample case study. No questions in University Exams / Class Tests should be asked on 8085 microprocessor.

SUGGESTED LIST OF ASSIGNMENTS FOR COA TUTORIALS:

1. To study Full Adder (7483).
2. To study ALU (74181).
3. To study MASM (Micro Assembler).
4. A program for hexadecimal addition and multiplication.
5. A program for binary multiplication.
6. A program for Hamming code generation , detection and correction.
7. A program for Booth’s multiplication
8. A program for LRU page replacement algorithm.
9. A program for FIFO page replacement algorithm.
10. To study mapping techniques of Cache memory.
    10.1 Direct Mapped cache
    10.2 Associative Mapped cache
    10.3 Set Associative Mapped cache

11. To study memory allocation policies.
    11.1 First-fit algorithm
    11.2 Best-fit algorithm

12. A program to implement serial communication (PC - PC communication).
13. A program to implement parallel communication. (PC - Printer communication).

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	**Practical**	**Tutorial**	**Theory**	**TW/ Practical**	**Tutorial**	**Total**
SEITC404	Automata Theory	03	--	01	03	--	01	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
SEITC404	Automata Theory	20	20	20	80	25	---	--	125

Course Objectives:

To build up mathematical fundamentals required to understand the theory of computation

1. To formalize mathematical models of computation: basic machines, deterministic and non deterministic machines and pushdown machines and Turing Machines.
2. To learn fundamentals of formal grammars and languages.
3. Develop understanding of different types of Turing machines, their use, capabilities & limitations.
4. Understand the concept of Undecidability

Course Outcomes: After completing the course successfully, students will be able to:

1. Design different types of machines.
2. Compare different types of languages and machines
3. Use the pumping lemma and closure properties to prove that some problems cannot be solved by particular machines.
4. Understand Power and Limitations of theoretical models of Computation.
5. Match constraints of a language to power of machines.

Detailed Syllabus:

Sr. No	Detail contents	Number of Hours
1.	**Basic Mathematical Fundamentals:** Sets, Logic, Functions, Relations and Languages, pigeonhole principle, mathematical induction.	02
2.	**Introduction and Finite Automata:** Alphabets, Strings, Languages, Finite Automata (FA), acceptance of strings, and languages, Deterministic Finite Automata (DFA) and Non Deterministic Finite Automata (NFA), transition diagrams and Language recognizers. Conversions and Equivalence: Equivalence between NFA with and without ε- transitions, NFA to DFA conversion, minimization of FSM, equivalence between two FSM's, Finite Automata with output- Moore and Mealy machines.	06
3.	**Regular Expressions & Languages:** FA and Regular Expressions, Conversion from RE to FA and FA to RE, Pumping lemma for regular languages, Closure properties of regular languages, Equivalence and minimization of Automata.	05
4.	**Context Free Grammars and Languages:** CFG, Leftmost, Rightmost derivations, Ambiguity in grammars and languages. Simplification of Context Free Grammars, Chomsky normal form (CNF), Greiback normal form (GNF), Pumping Lemma for Context Free Languages.	04
5.	**Push Down Automata:** Definition and languages of PDA, Equivalence& conversion of CFG's and PDA's, Deterministic PDA.	06
6.	**Turing Theory:** Turing Machines, definition, model, design of TM, Variations of TM: Multitape TMs, Non Deterministic TM, Universal TM, The Church-Turing thesis.	08
7.	**Undecidability and Recursively enumerable languages: Recursive and** Recursively enumerable languages, Context-Sensitive Languages and the Chomsky Hierarchy. Unsolvable Problems: Halting Problem, Post's Correspondence Problem (PCP).	05

TERM WORK

Journal work should comprise of writing 10 assignments based on the above syllabus.
Use of JFLAP software is desirable for experimenting with formal languages: topics including nondeterministic finite automata, nondeterministic pushdown automata, multi-tape Turing machines, several types of grammars.

TEXT BOOKS

1. Kavi Mahesh, **"Theory of Computation A Problem Solving Approach"**, Wiley India

2. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, **"Introduction to Automata Theory, Languages and Computation",** Pearson Education.

3. J.C.Martin, **"Introduction to languages and the Theory of Computation"**, TMH.

REFERENCES

1. Daniel I.A. Cohen, "**Introduction to Computer Theory"**, John Wiley & Sons.

2. Michael Sipser, **"Theory of Computation",** Cengage Learning.

3. N.Chandrashekhar& K.L.P. Mishra, "Theory of Computer Science, Automata Languages & Computations", PHI publications.

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
SEITC405	Web Programming	04	02	--	04	01	--	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
SEITC405	Web Programming	20	20	20	80	25	---	25	150

Objective:
As the part played by Internet in our daily life increases so does the importance of methods and means of Web site realization. This course is devoted to acquire knowledge and skills for creation of Web site considering both client- and server-side programming.

Outcome:
Student must be able to:

- Learn basics of web architecture and web development.
- Acquire the knowledge of tools used in industry for web application development.
- Create theweb application using tools and techniques learned.

Topics:

- Introduction to web technologies
- Client side programming – HTML 5.0, XHTML, CSS, JavaScript
- Server side programming I – ASP.NET and JSP
- Server side programming II -- PHP
- Server side database connectivity
- Web extensions

Detailed Syllabus

Sr. No.	Detail Contents	Weightage	Number of hours
1	Introduction to web technologies: Introduction to OSI layers, 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,Web Site Design Issues: Planning a Web Site – Objective and Goals, Audience, Organizing contents, Publishing of Web Site. Function of Web Server	05%	03
2	Client Side Programming– HTML 5.0, CSS and JavaScript: Basic HTML, formatting and fonts, Anchors, images, lists, tables, frames and forms, Introduction to CSS, Using CSS for text, background, links and positioning, Introduction to JavaScript, JavaScript language constructs, Objects in JavaScript- Built in, Browser objects and DOM objects, event handling, form validation and cookies. Introduction to JQUERY, The Basics of JQUERY programming, form validation using JQUERY.	25%	12
3	Server side programming I: ASP.NET and JSP Introduction to c# language,ASP.NET essentials, Life cycle of ASP.NET application,Developing web forms using ASP.NET, Using ASP.NET server controls to create web forms, Session tracking , Introduction to servlet and JSP, life cycle of JSP and servlet, Introduction to basic objects in JSP.	35%	16
4	Server side programming II: PHP Introduction to PHP- Data types, control structures, built in functions,Building web applications using PHP- tracking users, Introduction to PHP framework.	10%	08
5	Server side database connectivity: Database connectivity using ADO.Net, JSP &JDBC connectivity with example,PHP and Mysql database connectivity with example.	20%	06
6	Web Extensions: XML, Introducing XSL, XSL elements, transforming with XSLT, Web feeds (RSS), Introduction to web services.	05%	03

Text Books:

1. “Web Technologies: Black Book”, Dreamtech publication
2. “Learning PHP 5”, David Sklar, O’Reilly Publication
3. “The Web Warior Guide to Web Programming”, Bai, zak, Ekedahl,Farrell, CENGAGE Learning Publication

Reference Books:

1. “Internet and world wide web how to program”, Deitel&Deitel, Prentice Hall publication
2. “Developing web applications”, Ralph Moseley, M.T.Savaliya, Wiley Publication.
3. “Web Programming”, Chris Bates, Third edition, Wiley publication
4. “Web Technologies”, Uttam K. Roy, Oxford University Press

Suggested Practical List:

1. Web pages using HTML 5.0 using Dreamviewer (Preferred) / Any other HTML editor
2. Web pages using JavaScript illustrating the objects in JavaScript
3. Form validation/ event handling using jQuery
4. Web Application development using ASP.NET
5. Database connectivity with ADO.NET
6. Database connectivity using JDBC and JSP
7. Installation and configuration of WAMP server
8. Introduction of PHP framework(Yii,CakePHP, CodeIgniter) and simple application development using the same.
9. Web application development using PHP
10. Database connectivity with PHP
11. A mini project – Complete web site development using
    a. HTML, CSS, JavaScript and ASP.NET OR
    b. HTML, CSS, JavaScript and PHP

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/pract	Tut	Total
SEITC406	Information Theory and Coding	4		1	4	1	--	5

Sub Code	Subject Name	Examination Scheme							Total
		Theory				TW	Pr	Oral	
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Avg. of Test 1 & 2					
SEITC406	Information Theory and Coding	20	20	20	80	25	--	--	125

Course Objective:

To introduce to the students the concept of information and entropy of Information

To give the student the concept of compression of information , error control of Information, and securing information through cryptography.

To give the student the mathematical foundation of compression, error control and security of information.

Course Outcome:

Ability of students to understand true meaning of Information and Entropy

Ability of students to understand three aspects of information i.e. compression, error control and security.

Detailed Syllabus:

Unit. No	Topics	Number of Hours
1	**Information Theory & Source Coding** 1.1. Introduction to Information Theory 1.2. Entropy & Types of Entropy 1.3. Source Coding 1.4. Prefix Coding 1.5. Channel Capacity	**8**
2	**Compression Algorithms** 2.1 Optimal Compression 2.2 Compression Algorithms 2.3 Huffman Coding, Adaptive Huffman Compression 2.4 Dictionary Based Compression 2.5 Speech Compression 2.6 Sliding Window Compression 2.7 LZW,RLE 2.8 Lossy & Lossless Compression Schemes 2.9 Image Compression – GIF,JPEG	**10**
3	**Error Control Coding Techniques** 3.1 Types of Codes 3.2 Error Checking & Correcting Codes 3.3 Linear Block Codes 3.4 Cyclic Codes 3.5 BCH Codes 3.6 Convolution Codes	**10**
4	Basic Number Theory 4.1 Modular Arithmetic 4.2 Solving ax+by=d 4.3 Congruences 4.4 Chinese Remainder Theorem 4.5 Modular Exponentiation 4.6 Fermat's Little and Euler Theorem 4.7 Prime Number Generation 4.8 Random Number Generation 4.9 Primitive Roots 4.10 Legendre and Jacobi Symbols 4.11 Discrete Probability 4.12 Discrete Logarithms	**12**

5	Cryptographic Techniques 5.1 Security Goals, Threats and Attack on Information 5.2 Classic Cryptography 5.3 Symmetric Key Cryptography – Stream Ciphers, Block Cipher, Stream Cipher,DES,Triple DES,AES 5.4 Public and Private Key Cryptography – RSA,Diffie-Hellman 5.5 Hash Function – MD5,SHA-1,Digital Signature	8

Text Books:

1. "Information Theory, Coding and Cryptography" Ranjan Bose, Tata McGrawHill , Second Edition.
2. "Information Coding Techniques" R Avudaiammal, Tata McGrawHill , Second Edition.
3. "Essentials of Error-Control Coding", Jorge Castineira Moreirra, Wiley-India Edition
4. "Introduction to Cryptogrpahy with Coding theory" Trappe and Washington" Pearson

References:

1. Element of information theory: Thomas Cover wiley
2. An introduction to Theory of numbers: Ivan nivan Wiley

Tutorial:

Journal work should comprise of writing 10 assignments based on the above syllabus.

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

AC 11.5.2017

Item No. 4.180

UNIVERSITYOFMUMBAI

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)

University of Mumbai

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

S. E. Information Technology (Semester-III)

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	Relation: Definition, types of relation, composition of relations, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation. Function: Definition and types of function, composition of functions, recursively defined functions.	08	CO1 CO2
III	Laplace Transform	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). Unit step function, Heavi side function, Dirac-delta function, Periodic function and their Laplace transforms, Second shifting theorem.	08	CO3
IV	Inverse Laplace Transform	Inverse Laplace transform with Partial fraction and Convolution theorem (without proof). Application to solve initial and boundary value problem involving ordinary differential equations with one dependent variable and constant coefficients.	08	CO4
V	Complex Variable & mapping	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. Conformal Mapping, Linear, Bilinear transformations, Cross ratio, fixed points and standard transformation such as rotation and magnification, inversion, translation.	10	CO6
VI	Permutations, Combinations and Probability	Rule of sum and product, Permutations, Combinations, Algorithms for generation of	08	CO5

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

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. Lapplace 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 Algebric 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 De-multiplexers, 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		

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				
		Test1	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 Kay, Secondary key, Foreign Key, Mapping the ER and EER Model to the Relational Model, Introduction to Relational Algebra, Relational Algebra expressions for • 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

Text Books:

1. Korth, Slberchatz,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, Ist 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**

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:	**Software requirement:**
PC i3 processor and above	Turbo/Borland C complier.

Detailed Syllabus:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Introduction of C programming language		
I	Stack	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	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	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	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:	**Software requirement:**
PC i3 processor and above	Any SQL Compiler

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, Slberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
2. Raghu Ramkrishnan 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 though 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	**Theory** 1.1 Overview of procedure and object oriented Programming, Java Designing Goals, Features of Java Language. 1.2 Introduction to the principles of object-oriented programming: Classes, Objects, Abstraction, Encapsulation, Inheritance, Polymorphism, 1.3 Keywords, Data types, Variables, Operators, Expressions, Types of variables and methods. 1.4 Control Statements: If Statement, If-else, Nested if, switch Statement, break, continue. Iteration Statements: for loop, while loop, and do-while loop. **Experiment 1:** (Perform any three programs that covers Classes, Methods, Control structures and Looping statements) i) Write a Java program to understand how to accept input using Scanner or	12	LO 1 LO 2

BufferedReader and print output using System.out.println statement.

ii) Write a Java program to display the default value of all primitive data types in Java.

iii) Write a Java program that prints all real solutions to the quadratic equation ax2+bx+c = 0. Read in a, b, c and use the quadratic formula. If the discriminate b2-4ac is negative, display a message stating that there are no real solutions.

iv) Write a java program to test whether string is palindrome or not

v) Write a java program to count number of alphabets, digits, special symbols, blank spaces and words from the given sentence.

vi) Write a java program to count number of vowels and consonants from the given strings.

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.

1. createAccount()
2. deposit()
3. withdraw()
4. computeInterest()
5. displayBalance()

viii) Write a menu driven Java program which will

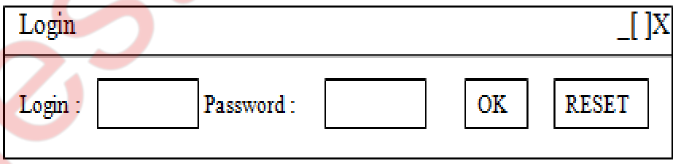
		read a number and should implement the following methods 1. factorial() 2. reverse() 3. testArmstrong() 4. testPalindrome() 5. testPrime() 6. fibonacciSeries() ix) Write a Java program to demonstrate Method overloading		
2)	Classes, Objects, Arrays and Recursion	**Theory** 2.1 Classes & Objects: Class Fundamentals: Assigning Object Reference Variables, Passing parameters to Methods and Returning parameters from the methods, Nested and Inner Classes. 2.2 Constructors: Parameterized Constructors, finalize( ) Method, Method overloading, Constructors overloading, Recursion, Command-Line Arguments. 2.3 Wrapper classes, Java.util.Scanner, Java. io.BufferedReader, Java.io.DataInputStream, Java.io.DataOutputStream and String Buffer classes and String functions. 2.4 Arrays & Vectors: One Dimensional arrays, Two Dimensional array, Irregular arrays, dynamic arrays, Array List and Array of Object. **Experiment 2** (Perform any Five programs that covers Classes & objects, Constructors, Command Line Arguments,	12	LO 1 LO 2

		Arrays/Vectors & recursions) 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. a) To find GCD and LCM b) To find X^Y c) To print n Fibonacci numbers		

		d) To find reverse of number e) To 1+2+3+4+……..+(n-1)+n x) Write the Menu driven program to perform a) Addition of two matrices of order m*n and p*q b) Multiplication of two matrices of order m*n and p*q c) Transpose of matrix of order m*n d) addition of diagonal and non-diagonal elements		
3)	Inheritance, Interface and Packages	**Theory** 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 3.2 Defining an interface, extending interfaces , implementing interfaces, accessing implementations through interface references, Interfaces vs. Abstract classes. 3.3 Packages – Steps for defining, creating and accessing a Package, importing packages,Making JAR Files for Library Packages, java.util.Vector **Experiment 3** (Perform any Two programs that covers Inheritance, interfaces and packages) i) Write a java programs to demonstrate hierarchical inheritance ii) Write a java program to demonstrate extending & implementing Interfaces	08	LO 3

		iii) Write a java program to demonstrate Modules and packages iv) Write a java program to create user defined packages		
4)	Exception Handling and Multithreading	**Theory:** 4.1 Exception handling Mechanism: try, catch, throw, throws and finally. 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. **Experiment 4** (Perform any Two programs that covers Exception Handling & Multithreading) i) Write java programs to demonstrate Exception handling using try, catch, throw, throws and finally statements. 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). 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.	06	LO3 LO 4

		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 v) Write java programs to create user defined threads by extending thread class and by implementing runnable. vi) Write java program to print Table of Five, Seven and Thirteen using Multithreading (Use Thread class for the implementation) . 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. viii) Write a java program to implement use of nested try-catch concept using appropriate example. ix) Write java program to create the child thread. Comment on the execution of main and Child Thread. x) Write java program to implement the concept of Thread Synchronization xi) Write a Java program to identify whether inputted data is byte/short/int/long/float/double/String/char type. (Use Exception Handling)		
5)	Applet Programming, GUI	5.1 Applet: Applet fundamentals, Applet lifecycle, Creating applet, paint method Applet tag, Applet class methods.	10	LO3 LO4

	development using AWT and Event handling	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 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. **Experiment 5** (Perform any Three programs that covers Applet Programming, GUI development using AWT and Event handling) i) Write java program to draw the house on an applet. 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.  iii) Write java program to create an advertisement banner on an applet using multithreading iv) Write java program to create a registration form using AWT. v) Write a Java program to demonstrate the use of AWT components namely buttons,labels, text boxes, lists/combos, menus with event handling.		LO 5

		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	**Theory** 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 **Experiment 6** (Perform any one programs that covers concept of Swings) 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. 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.	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

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.

University of Mumbai

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

S. E. Information Technology (Semester-IV)

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

ourse 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, prepositional 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, 11^{th} edition, McGraw Hill Publication.
2. Network Security and Cryptograph byBernard 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, 5^{th} edition, Addison Wesley Publication.
2. Abstract Algebra by I. N. Herstain, 3^{rd} eition, John Wiley and Sons Publication.
3. Discrete Mathematics by Norman Biggs, 2^{nd} 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(DESGN), 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 Eduction.
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 Edication.
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/0 Hardware, Application I/0 Interface, Kernel I/0 Subsystem, Transforming I/0 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				Term Work	Oral & Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	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	Application s 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

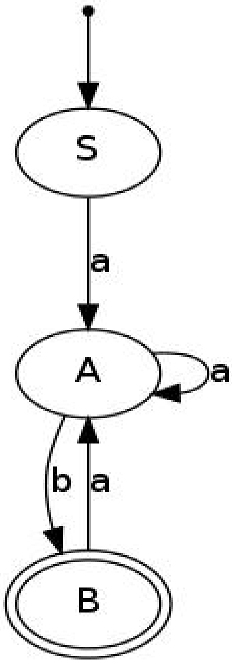
References

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* begining with Starting state and *Accepting* in a terminating state.

A simple example of DFA is:

<table>
<tr><td rowspan="4">
</td><td>Functions</td></tr>
<tr><td>S(x)
{ if(x == 'a') goto A(next);
else print("Error"); }</td></tr>
<tr><td>A(x) { if(x == 'a') goto A(next);
else if(x == 'b') goto B(next);
else print("Error"); \}</td></tr>
<tr><td>B(x)
{ if(x == 'a') goto A(next);
else if(x == 'b') goto B(next);
else if(end) print("Accept");
else print("Error"); \}</td></tr>
</table>

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.

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	NS2.34, Protocol Analyzer (eg. Wireshark), Packet tracer (Eg. CISCO packet tracer)

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, traceroute, 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

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	a) Study of Unix networking commands (ifconfig, ping, traceroute, netstat, nslookup, whois, hostname, tcpdump). b) Study of Unix file system (tree structure). c) Study of .bashrc, /etc/bashrc and Environment variables. d) Study File and directory permissions. e) Study of Editor Vi/other editor. f) Study of Bash shell, Bourne shell and C shell in Unix operating system.	04	LO1 LO2 LO5 LO6
III	Basic System administrative task	Process management Memory management File system management User management	04	LO1 LO2 LO5
IV	Shell scripts	a) Write a shell script program to display list of user currently logged in. b) Write a shell script program to display “HELLO WORLD”. c) Write a shell script program to develop a scientific calculator. d) Write a shell Script program to check whether the given number is	04	LO1 LO4

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

		list of files in the directory.		

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			
		Test1	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	*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	1. Program for 16 bit BCD addition 2. Program to evaluate given logical expression. 3. Convert two digit Packed BCD to Unpacked BCD. (any two)	04	LO2 LO6
III	Loop operations in 8086 Assembly language programming	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			
		Test1	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	**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. **Lab Experiment:** Write python programs to understand Expressions, Variables, Quotes, Basic Math operations, Strings: Basic String Operations & String Methods, List, Tuples, Dictionaries, Arrays. (Minimum Three Programs based on math operations, Strings and List/Tuples/ Dictionaries)	10	LO 1
II	Decision Making and Functions	**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	10	LO 2

		function in the function, Checking & Setting Your Parameters, Calling Functions from within Other Functions, Functions Inside of Functions, Layers of Functions **Lab Experiment:** Write python programs to understand different decision making statements and Functions. (Minimum Three Programs based on Decision making, Looping Statements and Functions)		
III	Object Oriented Programming using Python programming	**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. Modules and Packages: Creating Modules and Packages, Documenting & Viewing Module, Basics of Testing Your Modules and Packages, Importing & exporting Modules. **Lab Experiment:** Write python programs to understand different Object oriented features in Python (Minimum four programs based on a) Classes & objects,	10	LO 3

		b) Constructors, c) Inheritance & Polymorphism, d) Exception handling		
IV	Files Handling	**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 Pickle in Python, Lambda and Filter, Map & range functions. **Lab Experiment:** Write python programs to understand different File handling operations	07	LO 4
V	GUI Programming and Databases	**Theory:** GUI Programming - Writing a GUI with Python: GUI Programming Toolkits, Creating GUI Widgets with Tkinter, Creating Layouts, Radio Buttons and Checkboxes, Dialog Boxes. Database Access - Python's Database Connectivity, Types of Databases Used with Python, Mysql database Connectivity with Python, Performing Insert, Deleting & Update operations on database **Lab Experiment:** Write python programs to understand GUI designing and database operations (Minimum Three programs based on GUI designing using Tkinter, Mysql database creation & Database connectivity with DML	07	LO 5

		operations using python		
VI	Web Programming	**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 **Lab Experiment:** Write python programs to understand TCP and UDP Sockets in Python (Minimum One programs based on TCP or UDP Sockets)	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		

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:	Overview, Measures of Query Cost Selection Operation, Sorting, Join Operation, Other Operations Evaluation of Expressions. Query Optimization Overview, Transformation of Relational Expressions Estimating Statistics of Expression Results Choice of Evaluation Plans	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	Advanced Database Access protocols: Discretionary Access Control Based on Granting and Revoking Privileges; Mandatory Access Control and Role-Based Access Control. Overview of Advanced Database models like Mobile databases, Temporal databases, Spatial databases.	09	CO3 CO4
IV	Distributed Databases	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;	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, Slberchatz,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 3nd 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 programing 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	a) Design and Implementation of a product cipher using Substitution and Transposition ciphers b) Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal	4	LO1 LO2
II	a) Implementation of Diffie Hellman Key exchange algorithm 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 c) Exploring wireless security tools like Kismet, NetStumbler etc.	4	LO2 LO3
III	a) Study the use of network reconnaissance tools like WHOIS, dig,traceroute, nslookup to gather information about networks and domain registrars. b)Study of packet sniffer tools wireshark, :- **1**. Observer performance in promiscuous as well as non-promiscuous mode. **2**. Show the packets can be traced based on different filters.	4	LO4 LO5
IV	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, etc.	4	LO5
V	a) Detect ARP spoofing using nmap and/or open source tool ARPWATCH and wireshark. b) Simulate DOS attack using Hping and other tools c) Use the NESSUS/ISO Kaali Linux tool to scan the network for vulnerabilities.	6	LO4 LO5

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

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 Cookbok", O'reilly
3. Raspberry Pi User Guide

References:

1. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , 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/advsopstem.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 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	Introduction • Introduction to advanced data structures: • Introduction/Fundamentals of the analysis of algorithms o Recurrences: ▪ The substitution method ▪ Recursive tree method ▪ Masters method o Probabilistic analysis o Amortized analysis o Randomized algorithms o Mathematical aspects and analysis of algorithms	10	CO1 CO2
II	Advanced Data Structures	• 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 Analysis of All problems	11	CO1 CO2 CO3
III	Divide and Conquer	• Introduction • Binary search • Finding the minimum and maximum • Merge sort • Quick sort • Strassen’s matrix multiplication Analysis of All problems	7	CO2 CO3
IV	Greedy algorithms	• Introduction • Knapsack problem • Job sequencing with deadlines • Minimum cost spanning trees	8	CO2 CO3

		o Kruskal's algorithm o Prim's algorithm • Optimal storage on tapes • Optimal merge pattern • Subset cover problem • Container loading problem Analysis of All problems		CO5
V	Dynamic algorithms And NP-Hard and NP-Complete	Introduction Dynamic algorithms • 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	• 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

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 ITEST/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 Treebhoohu, "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				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
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

Detailed syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Knowledge of Mathematics	2	
I.	Introduction to Computer graphics and Output primitives	**Introduction**: Display Devices, Bitmap and Vector based graphics, Overview of Coordinate System. **Scan Conversion** of**:** point, line using Digital differential analyzer & Bresenham's algorithm, circle using midpoint approach, **Curve Generation**: Bezier and B-Spline curves. **Introduction to fractals**: generation procedure, classification, dimension and Koch Curve.	7	C01
II.	Area Filling, Transformations (2D and 3D)	**Area filling**: Inside/Outside Test, Scan line Polygon Fill Algorithm, Boundary Fill and Flood Fill algorithm. **Basic Geometrical 2D Transformations:** Translation, Rotation, Scaling, Reflection, Shear, their homogeneous Matrix representation and Composite transformation. **Three Dimensional transformations:** Translation, Scaling, Rotations, Composite.	8	CO1 CO2
III.	Viewing (2D and 3D) Projection and Clipping	**Viewing**: Introduction, Viewing Pipeline, View Coordinate reference frame, Window to viewport transformation. **Three-Dimensional Viewing:** 3D Pipeline, Viewing transformation, **Projections**: Parallel (Oblique and orthographic), Perspective (one Point) **Clipping**: Point clipping, Line clipping**:** Cohen Sutherland Algorithm, Liang Barsky algorithms, Polygon clipping: Sutherland Hodgeman polygon clipping and Weiler Atherton. Text Clipping.	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.

University of Mumbai

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

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

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 Date 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-Mediods; 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 3nd 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 Vercellis ,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	AWS cloud computing Platform, a) Elastic Compute Cloud(EC2): Compute Basics, Instance types, Life cycle of instances. b) Simple Storage Service (S3): Basics and Operations, Features, Amazon Glacier, Glacier vs S3. c) Elastic Block Storage (EBS):Basics and Types of EBS Volumes d)Amazon Virtual Private Cloud (Amazon VPC): Subnets, Route tables, Elastic IP Addresses (EIP), Elastic Network Interfaces (ENIs) & Security groups & ACL. e) Exploring Elastic Load Balancing (ELB): Basics, Types of load balancers, Configuring Elastic Load Balancing, Basics of Cloud Watch & Auto Scaling.	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 Pratical Guide, Nishith Tripathi, Jeffery H Reed, Wiley
2. Wireless Mobile Internet Security, 2^{nd} Edition, Man, Young Rhee, Wiley- IEEE press
3. Designing for Cisco Internetwork Solutions (DESGN), 2^{nd} Edition, CCDA, Diane Teare, cisco Press.

References:

1. Introduction to Digital mobile communication, 2^{nd} 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
1 & 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.		

Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd 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.	

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 Madisetti , 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				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
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	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 Developing SEO plans Prior to Site Development, SEO for Raw traffic ; E-commerce Sales; Mindshare/Branding; Direct Marketing; Reputation Management; Ideological Influence	09	CO1
II	Search Engine Optimization	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. 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.	09	CO1 CO2
III	Web Services	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.	08	CO1 CO2 CO3
IV	Rich Internet Application	**Introduction to AJAX**, Blogs, Wikis, RSS feeds **Working with Java Script Object Notation (JSON)**, Implement JSON on server side,	08	CO4

		Implementing Security and Accessibility in AJAX Applications: Secure AJAX application, Accessible Rich Internet Applications **Developing RIA using AJAX Techniques:** CSS, HTML, DOM, XMLHTTPRequest, JavaScript, PHP, AJAX as REST Client **Introduction to Open Source Frameworks and CMS for RIA:** Django, Drupal, Joomla introduction and comparison.		
V	Web Analytics 2.0	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.	08	CO4 CO5
VI	Web 3.0 and Semantic Web	**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	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

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				Term Work	Oral & Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. of two Tests				
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	**Introduction of Cybercrime**: Types of cybercrime ,categories of cybercrime , Computers' roles in crimes, Prevention from Cyber crime, Hackers, Crackers, Phreakers **Ethical Hacking** :Difference between Hacking and Ethical hacking : Steps of Ethical Hacking, Exploring some tools for ethical hacking: reconnaisance tools, scanning tools	6	CO1
II	Introduction to Digital Forensics and Digital Evidences	**Digital Forensic** ,Rules for Digital Forensic The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics, **Digital Evidences** : Types and characteristics and challenges for Evidence Handling	6	CO2
III	Computer Security Incident Response Methodology	**Introduction to Computer Security Incident** Goals of Incident response, Incident Response Methodology, Formulating Response Strategy, **IR Process** – Initial Response, Investigation, Remediation, Tracking of Significant ,Investigative Information, Reporting **Pre Incident Preparation,** Incident Detection and Characterization. **Live Data Collection** : Live Data Collection on Microsoft Windows Systems: Live Data	11	CO3

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

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 HillGreen 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.

University of Mumbai

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

B. E. Information Technology (Semester-VII)

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:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	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, *Services Within Modular Networks, Network Management Protocols and Features*	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, *Route* 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	

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	**Software Vulnerabilities:** Buffer overflow, Format String, Cross-Site Scripting, SQL Injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits **Operating System Security:** Memory and Address Protection, File Protection Mechanism, User Authentication. Linux and Windows: Vulnerabilities, File System Security **Database Security:** Database Security Requirements, Reliability and Integrity, Sensitive Data, Inference Attacks, Multilevel Database Security	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)**		

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, Acess 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. 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
1V	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 twoTests					
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				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		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, Broad cast 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 XMLdocument ,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		

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				Term Work	Practical & oral	Oral	Total
		Internal assessment			End Sem. Exam				
		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				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
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	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	06	CO1 CO2
II	Fuzzy Rules, Reasoning, and Inference System	Fuzzy Rules: Fuzzy If-Then Rules, Fuzzy Reasoning Fuzzy Inference System (FIS): Mamdani FIS, Sugeno FIS, Comparison between , Mamdani and Sugeno FIS.	06	CO1 CO2
III	Neural Network-I	Introduction: What is a Neural network? Fundamental Concepts, Basic Models of Artificial Neural Networks, Arificial Intelligence and Neural Networks, McCulloch-Pitts Neuron Learning: Error-Correction Learning, Memory based Learning, Hebbian learning, Competitive Learning, Boltzmann Learning Perceprton: Perceprton Learning Rule, Perceptron Learning Algorithm, Perceprton Convergence Theorem, Perceptron learning and Non-separable sets.	09	CO1 CO2
IV	Neural Networks -II	Back propaggation: Multilayered Network Architecture, Back porpagation Algorithm, Practical Consideration in impin 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	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, Fau1t tree analysis and Event tree Analysis	05

<u>Assessment</u>:

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, Imporance 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 General2^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	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **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 **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. **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 **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
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,	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

<u>Assessment</u>:

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. Kennetch 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 Elseveir 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	**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	**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
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 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 toimplications of 73^{rd}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 familiarise the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Demonstrateunderstanding 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	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	**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 onapproximately 40% of contents and second test based on remainingcontents (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 (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

University of Mumbai

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

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

		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.		
V	Big Data Mining Algorithms	**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.	10	CO 4
VI	Big Data Analytics Applications	**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.	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 Madisetti.

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) • Implementing Frequent Item set Mining • Implementing Clustering algorithms • Implementing Classification Algorithms	06	LO 4
5	Big Data Applications (Any 2) • 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 datsets 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 Madisetti , 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

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Practical & Oral</th><th rowspan="3">Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal assessment</th><th rowspan="2">End Sem. Exam</th></tr>
<tr><th>Test1</th><th>Test2</th><th>Avg. of two Tests</th></tr>
<tr><td>ITL803</td><td>DevOps Lab</td><td>--</td><td>--</td><td>--</td><td>--</td><td>25</td><td>25</td><td>--</td><td>50</td></tr>
</table>

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.

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

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				Term Work	Practical & oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of two Tests					
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. • 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**: • Grouping, loops and conditional execution, Functions **Exploratory data analysis** • Range, summary, mean, variance, median, standard deviation, histogram, box plot, scatterplot	04	**LO 1, LO 4**
IV	**Graphics in R** • Graphics and tables • Working with larger datasets • Building tables with aggregate • Introduction to ggplot2 graphics	06	**LO 3**
V	**Regression and correlation** • 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 • 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 Grolemund, 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				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
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) embers 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: 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				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
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.		

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					
ITDLO8042	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				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of two Tests					
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**

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 techo 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.		

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 Clewwto 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

	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,	
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

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
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.

<u>Assessment</u>:

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	**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 Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)	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.

<u>Assessment</u>:

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	Enterpreneurship 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	**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 Behavior (OB)** • 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	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and	6

	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.	
04	**Human resource Planning** • 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** • 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

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16^{th} Ed, 2013
2. V S P Rao, Human Resource Management, 3^{rd} Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6^{th} edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15^{th} Ed, 2015, Himalaya Publishing, 15^{th}edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5^{th} 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, (2^{nd}ed), 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) activein 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 Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement	07

	Patent databases: Important websites, Searching international databases	

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	**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 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, VinocenzoMorabito, 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

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
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, Maclillan 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

<u>Assessment</u>:

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.

AC7/6/2014

Item no. - 4.29

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Information Technology (Final Year – Sem.VII & VIII)

Revised course (REV- 2012)

From Academic Year 2015 -16

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

From Dean'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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the 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 philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Information Technology of University of Mumbai, happy to state here that, Program Educational Objectives were finalized in a meeting where more than 30 members from different Institutes were attended, who were either Heads or their representatives of Information Technology Department. The Program Educational Objectives finalized for undergraduate program in Information Technology are listed below;

1. To prepare Learner's with a sound foundation in the basics of engineering fundamentals.
2. To prepare Learner's to use effectively modern programming tools to solve real life problems.
3. To prepare Learner's for successful career in Indian and Multinational Organisations and to excel in Postgraduate studies
4. To encourage and motivate Learner's for entrepreneurship.
5. To inculcate professional and ethical attitude, good leadership qualities and commitment to social responsibilities in Learners.
6. To encourage Learner to use best practices and implement technologies to enhance information security and enable compliance, ensuring confidentiality, information integrity, and availability.

In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

Dr. J. W. Bakal
Chairman, Board of Studies in Information Technology,

B.E. Engineering (Semester VII)

Revised course for Information Technology

Academic Year 2015 -16 (REV- 2012)

Course Code	Course Name	Teaching Scheme (hrs/week)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Prac	Tut.	Total
ITC701	Software Project Management	4			4			4
ITC702	Cloud Computing	3			3			3
ITC703	Intelligent System	4			4			4
ITC704	Wireless Technology	4			4			4
ITC705	Elective - I	4			4			4
ITL701	Software Project Management		2			1		1
ITL702	Cloud Computing		2			1		1
ITL703	Intelligent System		2			1		1
ITL704	Wireless Technology		2			1		1
ITT705	Elective - I		2			1		1
ITP706	Project-I		*			3		3
	Total	19	10		19	08		27

***Work load of the teacher in semester VII is equivalent to 6 hrs/week.**

Elective –I (Semester VII)	
ITC7051	Image Processing
ITC7052	Software Architecture
ITC7053	E-Commerce & E-Business
ITC7054	Multimedia Systems
ITC7055	Usability Engineering
ITC7056	Ubiquitous Computing

Examination Scheme

Course Code	Course Name	Theory					Term work	Pract/ Oral	Total
		Internal Assessment			End sem exam	Exam duration (in Hrs)			
		TEST 1	TEST 2	AVG.					
ITC701	Software Project Management	20	20	20	80	3	25	25	150
ITC702	Cloud Computing	20	20	20	80	3	25	25	150
ITC703	Intelligent System	20	20	20	80	3	25	25	150
ITC704	Wireless Technology	20	20	20	80	3	25	25	150
ITC705	Elective - I	20	20	20	80	3	25	25	150
ITP706	Project-I						25	25	050
	Total	100	100	100	400	15	150	150	800

B.E. Engineering (Semester VIII)
Revised course for Information Technology from
Academic Year 2015 -16, (REV- 2012)

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ITC801	Storage Network Management and Retrieval	4			4			4
ITC802	Big Data Analytics	4			4			4
ITC803	Computer Simulation and Modeling	4			4			4
ITC804	Elective -II	4			4			4
ITL801	Storage Network Management and Retrieval		2			1		1
ITL802	Big Data Analytics		2			1		1
ITL803	Computer Simulation and Modeling		2			1		1
ITL804	Elective -II		2			1		1
ITP805	Project - II		**			6		6
	Total	16	08		16	10		26

****Workload of the teacher in semester VIII is equivalent to 12 hrs/week.**

Elective –I I (Semester VIII)	
ITC8041	Enterprise Resource Planning
ITC8042	Wireless Sensor Networks
ITC8043	Geographical Information Systems
ITC8044	Robotics
ITC8045	Soft Computing
ITC8046	Software Testing & Quality Assurance

Examination Scheme

Course Code	Course Name	Theory					Term work	Pract/ Oral	Total
		Internal Assessment			End sem exam	Exam duration (in Hrs)			
		TEST 1	TEST 2	AVG.					
ITC801	Storage Network Management and Retrieval	20	20	20	80	3	25	25	150
ITC802	Big Data Analytics	20	20	20	80	3	25	25	150
ITC803	Computer Simulation and Modeling	20	20	20	80	3	25	25	150
ITC804	Elective -II	20	20	20	80	3	25	25	150
ITP805	Project - II						50	50	100
	Total	80	80	80	320	12	150	150	700

Course Code	Course Name	Teaching Scheme (hrs/week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC701	Software Project Management	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme								
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITC701	Software Project Management	20	20	20	80	25	---	25	150

Course Objectives:

This course will help students to identify key areas of concern over Project Life Cycle (PLC) and use of project management principles across all the phases of PLC. The course will also help student to make them understand the importance and necessity of project plan and how it is helpful to project manager in monitoring and controlling the various aspects of the project such as schedule, budget, etc. The course will make them understand the importance of team and how to work as a team member, share best project management practices.

Course Outcomes:

Upon completion of the course, students should be able to:

- Articulate similarities and differences between IT projects and other types of projects.
- Justify an IT project by establishing a business case
- Develop a project charter
- Develop a work breakdown structure for an IT project

- Estimate resources (time, cost, human being, etc.)
- Establish task inter-dependencies
- Construct and analyze a network diagram
- Identify IT project risks and develop risk mitigation strategies
- Ensure the quality of the project using various standards
- Demonstrate Team work and team spirit and how to overcome the conflicts

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**An overview of IT Project Management**	Introduction, the state of IT project management, context of project management, need of project management, project goals, project life cycle and IT development, information technology project methodology (ITPM), project feasibility, request for proposal (RFP), the business case, project selection and approval, project contracting, PMBOK.	4
2	**Project Integration Management**	Introduction, project management process, project integration management, the project charter, project planning framework, the contents of a project plan, the planning process.	4
3	**Project Scope Management**	Introduction, scope planning, project scope definition, project scope verification, scope change control, the Work Breakdown Structure (WBS), the linear responsibility chart.	4
4	**Project Time Management**	Introduction, developing the project schedule, Scheduling Charts, logic diagrams and network (AOA, AON), critical path, calendar scheduling and time based network, management schedule reserve, PDM network, PERT, CPM, Resource loading, resource leveling, allocating scarce resources to projects and several projects, Goldratt's critical chain.	10
5	**Project Cost Management**	Cost estimating, Cost escalation, Cost estimating and system development cycle, Cost estimating process, Elements of budgets and estimates, Project cost accounting and MIS, Budgeting using cost accounts, Cost schedules and forecasts.	4

6	**Project Quality Management**	Introduction, Quality tools and philosophies, quality systems, the IT project quality plan.	3
7	**Project Human Resource Management**	Introduction, organization and project planning, the project team, multidisciplinary teams, the project environment, project leadership, ethics in projects, multicultural projects, Role of project manager, IT governance and the project office. Introduction to change, the nature of change, the change management plan, dealing with resistance and conflicts.	5
8	**Project Communication Management**	Introduction, monitoring and controlling the project, the project communications plan, project metric, project control, designing the control system, the plan-monitor-control cycle, data collection and reporting, reporting performance and progress, information distribution.	4
9	**Project Risk Management**	Basic concepts, Identification, Assessment, Response planning, Management.	4
10	**Project Procurement Management**	Introduction, project procurement management, outsourcing.	3
11	**The Implementation Plan and Project Closure**	Introduction, project implementation, administrative closure, project evaluation, project audit.	3

Text Books:

1. Jack T. Marchewka, Information Technology Project Management, 4th edition, Wiley India, 2009.
2. John M. Nicholas, Project Management for Business and Technology, 3rd edition, Pearson Education.

References:

1. E-Book - Project Management Body of Knowledge (PMBOK).
2. Claudia M. Baca, Patti M. Jansen, PMP: Project Management Professional Workbook, Sybex Publication.
3. S. J. Mantel, J. R. Meredith and etal., Project Management 1st edition, Wiley India, 2009.
4. Joel Henry, Software Project Management, A real-world guide to success, Pearson Education, 2008.
5. Gido and Clements, Successful Project Management, 2nd edition, Thomson Learning

6. Hughes and Cornell, Software Project Management, 3rd edition, Tata McGraw Hill
7. Joseph Phillips, IT Project Management, end edition, Tata McGraw Hill
8. Robert K. Wyzocki, Effective Project Management, 5th edition, Wiley
9. Brown, K.A. Project Management, McGraw Hill, 2002.
10. Dinsmore, P. C. (Ed.), The AMA Handbook of Project Management. AMACOM, 1993.

Term work:

Term work shall consist of at least 10 experiments covering all topics of the syllabus. Distribution of marks for term work shall be as follows:

1. Attendance (Theory and Practical): 05 Marks
2. Laboratory work (Experiments and Journal): 15 Marks
3. Assignments: 5 Marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory Work and Minimum Passing in the term work.

Suggested Practical List:

In practical, a group of maximum **three** students should be formed. Each group is supposed to complete all lab experiments (given below) on the case study given by the subject teacher. In lab experiments, students can used the tools like MsWord to prepare document whereas MsProject for preparing WBS, N/w diagram, PERT, CPM, performance analysis of the project, etc.

1. Project and System's Management
2. Feasibility study
3. Project Proposal
4. Project Planning
5. Activity Planning
6. Analyzing the project network diagram
7. Cost estimation and budgeting
8. Risk management
9. Performance analysis of project
10. Project evaluation and closure

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (hrs/week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC702	Cloud Computing	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC702	Cloud Computing	20	20	20	80	25	---	25	150

Course Objectives:

This course will help the students to get familiar with cloud computing fundamentals, architecture, services, implementation and deployment techniques etc.

Course Outcomes:

After completion of the course the learner should be able to:

1. Differentiate different computing techniques.
2. Compare various cloud computing providers/ Software.
3. Handle Open Source Cloud Implementation and Administration.
4. Understand risks involved in cloud computing.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	Introduction to Cloud Computing	- Introduction – Component of CC – Comparing CC with Virtualization, Grids, Utility Computing, client-server model, P-to-P Computing – Impact of CC on Business – Key Drivers for Cloud Computing - Cloud computing Service delivery model - Cloud Types – Private, Public and Hybrid, when to avoid public cloud, Cloud API	**2**
2.	Virtualization	- Introduction & benefit of Virtualization – Implementation Levels of Virtualization- VMM Deisgn Requirements and Providers – Virtualization at OS level – Middleware support for Virtualization – Virtualization structure/tools and mechanisms: Hypervisor and Xen Architecture, Binary Translation with full Virtualization, Para Virtualization with Compiler Support – - Virtualization fo CPU, Memory and I/O Devices, Hardware support for Virtualization in intel x86 processor – CPU Virtualization – Memory Virtualization and I/O Virtualization – Virtualization in Multicore processors	**4**
3.	Cloud computing Services	XaaS, IaaS, PaaS- Leveraging PaaS for Productivity- Languages for PaaS- DBaaS(Database as a services) – SaaS (Software as a service) – Comparison of various cloud computing providers/ Softwares.	**4**
4.	Cloud Computing and Business Value	Key Business Drivers for CC- Cloud computing and out sourcing – Types of Scalability – Security issues in Cloud Computing- time to Market Benefits- Distribution over Internet – Three levels of Business value from Cloud computing.	**4**
5.	Open Source Cloud Implementation and Administration	Eucalyptus and Open Stack Architecture Features – Components – Various mode of operations – Installation and configuration process of both open source – Cloud Administration and Management Task – Creating User Interface (Web Interface) of Private cloud.	**6**

6.	Cloud Deployment Techniques	Factors for Successful Cloud Deployment – Network Requirements – Potential Problem areas in a cloud Network and their Mitigation – Cloud Network Topologies – Automation and Self-service feature in a cloud –cloud performance.	**4**
7.	Security	Security for Virtualization Platform – Host security for SaaS, PaaS and IaaS – Data Security – Data Security Concerns – Data Confidentiality and Encryption – Data Availability – Data Integrity – Cloud Storage Gateways – Cloud Firewall	**4**
8.	Architecture for Cloud Application	Cloud Application requirements- Architecture for traditional Vs Cloud Applications- Multi-ties Application Architecture- SOA for Cloud applications – Resource oriented SOA – Method –oriented SOA and Event Driven SOA – Parallelization within Cloud Applications – Leveraging In-memory Operations for Cloud Application	**4**
9	Cloud Programming	Programming Support for Google Apps engine: GFS, Big Tables, Googles NO SQL System, Chubby, Google Distibuted Lock Service, Programming Support for Amazon EC2: Amazon S3, EBS and Simple DB etc.	**4**
10	Adoption and Use of Cloud	Adoption of Public cloud by SMBs- Public Cloud Adoption phase for SMBs- Vendor liability and Management Adoption process of Public clouds by Enterprises – Managed Private clouds Migrating Application to the cloud – Impact of Shared Resources and Multi-Tenancy on cloud Applications – Phases during Migration an Application to An IaaS Cloud	**4**
11	Risks of Cloud Computing and Related Costs	Risk Assessment and Management – Rosk of Vendor Lock-in – Risk of Loss of control over IT services- Risk of Poor Provisioning – Risk of Multi-tenant environment – Risk failure of cloud provider – SLA risk –security, malware and Internet Attacks – Risk with Application Licensing.	**2**
12	AAA Administration for Clouds	AAA model – SSO for Clouds – Authentication management and Authorization management in clouds – Accounting for Resource utilization.	**2**

13	Security as a service	What can security as service offer- Benefits for Security as a service – Issues with Security as a Service- Identity Management as a Service	**2**
14	Mobile Cloud Computing	Introduction, Defination, Architecture, Benefits, challenges in mobile and at cloud shield	**2**

Text Books:

1. Cloud Computing Principles and Paradigms, Rajkumar Buyya Wiley

2. Distributed and Cloud Computing, Kai Hwang, Mk Publication

3. Cloud computing Black Book Dreamtech Publication

References:

1. Using Goolgle Apps engine O'reilly Publication

2. Programming Amazon EC2, O'reilly Publication

3. Cloud security, Ronald L. Wiley Publication

4. Cloud computing Dr. Kumar Saurabh, wily Publication

5. Virtualization for Dummies, Wiley Publication

Term work:

Suggested Practical List (If Any):

1. Implementation of Private cloud using Eucalyptus or Open stake

   - Working with KVM to create VM

   - Installation and configuration of Private cloud

   - Bundling and uploading images on a cloud

   - Creating web based UI to launch VM

   - Working with Volumes – Attached to the VM

2. Programming using Google Apps engine and Pythone

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (hrs/week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC703	Intelligent System	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC703	Intelligent System	20	20	20	80	25	---	25	150

Course Objectives:

1. To introduce the students' with different issues involved in trying to define and simulate intelligence.
2. To familiarize the students' with specific, well known Artificial Intelligence methods, algorithms and knowledge representation schemes.
3. To introduce students' different techniques which will help them build simple intelligent systems based on AI/IA concepts.

Course Outcomes:

1. Students will develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents.
2. Students will be able to choose an appropriate problem-solving method and knowledge-representation scheme.
3. Students will develop an ability to analyze and formalize the problem (as a state space, graph, etc.) and select the appropriate search method.
4. Students will be able to develop/demonstrate/ build simple intelligent systems or classical toy problems using different AI techniques.

DETAILED SYLLABUS

Module	Detailed Content	Hours
1	**Introduction:** Introduction to AI, AI Problems and AI techniques, Solving problems by searching, Problem Formulation.	04
2	**Intelligent Agents:** Structure of Intelligent agents, Types of Agents, Agent Environments PEAS representation for an Agent.	03
3	**Uninformed Search Techniques:** DFS, BFS, Uniform cost search, Depth Limited Search, Iterative Deepening, Bidirectional search, Comparing Different Techniques.	04
4	**Informed Search Methods**: Heuristic functions, Hill Climbing, Simulated Annealing, Best First Search, A*, IDA*, SMA*, Crypto-Arithmetic Problem, Backtracking for CSP, Performance Evaluation.	08
6	**Adversarial Search:** Game Playing, Min-Max Search, Alpha Beta Pruning.	03
7	**Knowledge and Reasoning:** A Knowledge Based Agent, WUMPUS WORLD Environment, Propositional Logic, First Order Predicate Logic, Forward and Backward Chaining, Resolution. , Introduction to PROLOG.	08
8	**Planning**: Introduction to Planning, Planning with State Space Search, Partial Ordered planning, Hierarchical Planning, Conditional Planning, Planning with Operators.	04
9	**Uncertain Knowledge and Reasoning:** Uncertainly, Representing Knowledge in an Uncertain Domain, Conditional Probability, Joint Probability, Bays theorem, Belief Networks, Simple Inference in Belief Networks.	06
10	**Learning:** Learning from Observation, General Model of Learning Agents, Inductive Learning, Learning Decision Trees, Rote Learning, Learning by Advice, Learning in Problem Solving, Explanation based Learning	05
11	**Expert Systems:** Representing and using Domain Knowledge, Expert System-shell, Explanation, Knowledge Acquisition	03

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. Elaine Rich, Kevin Knight, Artificial Intelligence, Tata McGraw Hill, 2nd Edition.

Reference Books:

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

Term work:

Term Work shall consist of at least 8 practical and 2 assignments based on the list given below:

Suggested Practical:

1. Implementing Water jug problem using 1. BFS. , 2. DFS (Un-Informed Search)
2. Implementing 8 puzzle problem with Heuristic function using Hill Climbing. (Informed Search)
3. Implementing 8 puzzle problem with Heuristic function – Best First Search (Informed Search)
4. Implementing 8 Queen Problem with Heuristic function (Informed Search)
5. Implementing Tic-Tac-Toe problem to demonstrate Min – Max and Alpha Beta Pruning. (Adversarial Search)
6. Implementing WUMPUS world problem. (Knowledge and Reasoning)
7. Introduction to PROLOG – solving Basic problems like Factorial, Fibonacci series, Implementing User Defined String functions etc. (PROLOG)
8. Implementing Family Information System (PROLOG)
9. Implementing Mini Expert system. (PROLOG)

(Note: List of experiments is not limited with the above list , teacher can choose different set of experiments but care should be taken to explore variety of topics.)

Term Work: 25 Marks (total marks) = 15 Marks (Experiment) + 5 Marks (Assignment) + 5Marks (Attendance (theory + practical))

Oral examination is to be conducted based on the complete syllabus.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (hrs/week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Tota l
ITC704	Wireless Technology	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC704	Wireless Technology y	20	20	20	80	25	---	25	150

Course Objectives:

Get acquainted with modern wireless communication networks. Evolution of cellular networks, to understand basic framework of various protocols and standards used to develop wireless personal and wide area networks

Course Outcomes:

1. Understand the new trends in mobile/wireless communications networks
2. Understand the characteristics of mobile/wireless communication channels
3. Understand the multiple radio access techniques
4. Understand the multiuser detection techniques
5. Understand various wireless networks and their technologies
6. Understand need of securities and economies in wireless systems

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	Fundamentals of wireless Communication	• Fundamentals of Wireless Communication Advantages, Limitations and Applications • Wireless Media • Infrared Modulation Techniques • DSSS And FHSS • Multiple access technique: TDMA,CDMA, FDMA, CSMA,OFDMA [fundamentals] • Frequency Spectrum • Radio and Infrared Frequency Spectrum	**08**
2	Wireless technology	• The cellular concepts: Frequency Reuse, Channel assignment strategies, Handoff strategies Interference and System Capacity [Design problems] • Evolution of cellular networks 1G, 2G,3G,4G •GSM: System Architecture, Radio Subsystem, Channel Types, GSM frame structure • CDMA: Architecture, Frequency and channel specifications, forward and Reverse CDMA Channels.	**10**
3	Wire less in local loop (WLL)	User requirements of WLL systems, WLL system architecture, MMDS, LMDS, WLL subscriber terminal, WLL interface to the PSTN	**04**
4	Wire less local area networks (WLAN)	Introduction, WLAN Equipment, WLAN topologies and Technologies, IEEE 802.11 WLAN : Architecture, Physical Layer, Data Link Layer , MAC Layer, Security Latest developments of IEEE 802.11 standards	**08**
5	Wireless personal area netwoks (WPAN)	Introduction ,WPAN technologies and Protocols, Bluetooth (802.15.1)[Protocol stack and network connection establishment, security aspects] HR –WPAN (UWB) (IEEE 802.15.3) LR-WPAN (IEEE 802.15.4) Zigbee [Stack architecture, components , Network Topologies , Applications] Wireless Sensor networks [Network model and protocol stack ,	**08**

		routing algorithms, Applications]	
6	Wireless metropolitan area networks	IEEE 802.16 [Protocol Architecture], IEEE 802.16a [Wimax] Wimax and LTE /3GPP comparison	**04**
7	Security issues in Wireless Systems	The need, attacks , security services, wired equivalent privacy protocol(WEP), Mobile IP, VPN [PPTP, L2TP, IPSec]	**03**
8	Economies of Wireless Network	Economic Benefits, Economics of Wireless industry Wireless data forecast, charging issues	**03**

Text Books:

1. Modern wireless communication systems: by Simon Haykin, Michael Moher, adapted by David Koilpillai ; Pearson (Indian edition 2011)

2. Wireless Networks: by Nicopolitidia, M S Obaidat, GI Papadimitriou; Wiley India (student edition 2010)

3. Wireless communications: by T L Singal; Tata McGraw Hill Education private Ltd.(edition 2011)

References:

1. Wireless and Mobile Networks: Dr. Sunilkumar S. Manvi & Mahabaleshwar S. Kakkasageri

2. Wireless Communications and Networking: by Vijay K. Garg

3. Wireless Communications: by Theodore S. Rappaport

Term work: Students are asked to perform lab sessions using Ns-2 Simulator and Matlab platform.

Assignments should be given based on syllabus.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ITC7051	Image Processing	04	02	---	04	01	---	05

Course Code	CourseName	Examination Scheme							
		Theory Marks				TW	Pract.	Oral	Total
		Internal Assessment			End Semester Exam				
ITC7051	Image Processing	Test 1	Test 2	Average of Test1 & Test2					
		20	20	20	80	25	---	25	150

Course Pre-requisite: As images are two dimensional signals, the single dimensional Digital Signal Processing fundamentals are part of the prerequisite study.

Objective: One picture is worth thousand words. A course in digital image processing teaches how such visual information can be used in various applications. This course will introduce the basic ideas and techniques used for processing images and their popular applications.
The objectives of this course are:

- To cover the basic theory and algorithms that are widely used in digital image processing,
- To expose students to current technologies and issues that are specific to image processing systems
- To develop skills in using computers to process images.

Outcome: Students should demonstrate the ability:

- To understand the fundamental concepts of a digital image processing system,
- To make extensive use of these concepts in implementing processing techniques such as noise removal, enhancement, compression for efficient storage and transmission, object extraction, representation and description for recognition or building computer vision, etc.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	Weightage of marks
0	Introductions to Signal Processing Only as a prerequisite for Image Processing. Hence not part of theory exam.	Analog, discrete and digital signals, 1D, 2-D signals with examples. Discrete time signals: sequences, Discrete time systems LTI systems and their properties. Convolution and Correlation- need, methods and examples	04	0%
1	Introduction to digital image processing	Introduction: Definition of digital image, generation of digital image, steps in digital image processing, 2D sampling, spatial and tonal resolutions, pixel connectivity, elements of digital image processing systems	05	10%
2	Image enhancement in the spatial domain	Point operations, histogram processing, spatial filtering: smoothing, sharpening, median, highboost	07	20%
3	Two Dimensional Discrete Fourier Transform	Introduction to image in frequency domain, Concept of basis images, two dimensional D.F.T. and its properties, two dimensional F.F.T. Filtering in the frequency domain: smoothening, sharpening and homomorphic filtering.	06	15%
4	Image segmentation	Detection of discontinuities, edge linking and boundary detection, Hough transform, thresholding, region oriented segmentation.	06	10%
5	Image representation and description	Boundary descriptors: shape number, Fourier descriptor, statistical moments; regional descriptors	06	10%
6	Image data compression	Image data redundancies: coding, inter-pixel, psychovisual; Fundamentals of lossless compression : Arithmetic coding, Huffman coding, LZW coding, RLE, Bit plane coding, predictive coding Lossy compression : JPEG, Subband coding, Vector quantization, Image compression standard, Fidelity criteria	06	15%
7	Image morphology	Morphological operation : Dilation erosion, Opening & Closing, Hit or Miss Transform, Basic Morphological Algorithms	04	10%

8	Applications of image processing	Case Study on the following applications: Digital watermarking, Biometric authentication (face, finger print, signature recognition), Vehicle number plate detection and recognition, Content Based Image Retrieval, Text Compression.	04	10%

Text Books:

1. Gonzalez & Woods, Digital Image Processing, Pearson Education, Third Edition.
2. W. Pratt, Digital Image Processing, Wiley Publication, Fourth Edition, 2013.

Reference Books:

1. J. G. Proakis and D. G. Manolakis, Digital Signal processing Principals,Algorithms and Applications,PHI publications, Third edition,
2. Milan Sonka , Digital Image Processing and Computer Vision, Thomson publication, Second Edition.2007.
3. A.K. Jain, Fundamentals of Image processing, Prentice Hall of India Publication, 1995
4. Gonzalez & Woods, Digital Image Processing using MATLAB, Pearson Education
5. S.Jayaraman, S Esakkirajan and T Veerakumar, Digital Image Processing ,McGraw Hill Education (India) Private Limited, New Delhi, 2009.
6. S.Sridhar, Digital Image Processing ,Oxford University Press, New Delhi, 2011.

Term work:

At least 08 experiments covering entire syllabus must be performed during the semester and it should be presented in the practical record. Term work assessment must be based on the overall performance of the student with every practical graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. Due weightage should be given for the student’s attendance.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests shall be considered as final IA marks

Suggested Practical List:

A minimum of 8 experiments from the suggested list must be performed. The DSP experiments (experiment 1 and 2) are the prerequisites.

1. Write a MATLAB program or C++ program for generating the following discrete time signals:
    a. Exponential signal
    b. Unit step and unit ramp signals
    c. Sinusoidal signal
    d. Composite signal with minimum 3 sinusoids added
2. Write a MATLAB program to demonstrate convolution and correlation operations with different examples of discrete time sequences.
3. Write a program for the following point processing operations and compare the results with MATLAB built in functions
    a. Image negative
    b. Gray level slicing with or without background
    c. Power law transformations
    d. Bit plane slicing
    e. Histogram equalization
4. Write a program for image enhancement and compare the results with MATLAB built in functions.
    a. Smoothing
    b. Sharpening
    c. High boost filtering
5. Write a program for image noise removal and analyze the results using,
    a. Averaging
    b. Median filter
6. Write a MATLAB program for 2D Discrete Fourier Transform and Inverse transform using built in functions.
7. Write a MATLAB PROGRAM for Transform domain processing using low pass and high pass filters and analyze the results for the following (any one):
    a. Ideal filter
    b. Butterworth filter
    c. Gaussian filter
8. Write a MATLAB PROGRAM for edge detection in 2 directions and compare the results with built in functions for the following operators (any one):
    a. Robert operator
    b. Prewitt operator
    c. Sobel operator
9. Write a MATLAB PROGRAM to compress the image using any one of the following lossless image compression techniques:
    a. Huffman
    b. RLE
    c. LZW
10. Write a MATLAB PROGRAM to compress the image using any one of the following

lossy image compression techniques:

a. JPEG
b. IGS
c. Predictive coding

11. Write a MATLAB PROGRAM to perform the following basic and derived morphological operations:
    a. Dilation
    b. Erosion
    c. Opening
    d. Closing
    e. Boundary Detection
12. Write a MATLAB PROGRAM to represent / describe the image using any one of the following:
    a. Chain code / shape number
    b. Moments
    c. Fourier descriptors
    d. Euler number

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (hrs/week)			Credits Assigned			
ITC7052	Software Architecture	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
		04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC7052	Software Architecture	20	20	20	80	25	---	25	150

Course Objectives:

- To provide students with a strong foundation in developing large, practical software-intensive applications.
- To train students with sound technical exposure to the concepts, principles, methods and best practices in software architecture.
- To develop the ability among students to learn the details of modeling techniques, design, implementation, deployment, and system adaptation.
- To enable students to choose the right tool for the job at hand and document design rationale.
- To prepare students to gain experiences with examples in design pattern application and case studies in software architecture.

Course Outcomes:

At the end of the course, students should be able to:

1. Argue the importance and role of software architecture.
2. Recognize major software architectural styles, design patterns, and frameworks.
3. Design software architecture for large scale software systems.
4. Describe various documentation approaches and architectural description languages.
5. Apply architectural patterns to quickly generate architectural alternatives and choose between them.

Prerequisites:

This course builds on the study of Object Oriented Software Engineering. We assume fluency with Object Oriented Languages and UML

DETAILED SYLLABUS:

Sr. No	Module	Detailed Content	Hours
1	**1**	**Basic Concepts** 1.1 Concepts of Software Architecture 1.2 Models. 1.3 Processes. 1.4 Stakeholders.	**03**
2	**2**	**Designing Architectures** 2.1 The Design Process. 2.2 Architectural Conception. 2.3 Refined Experience in Action: Styles and Architectural Patterns. 2.4 Architectural Conception in Absence of Experience. 2.5 Putting it all Together: Design Processes Revisited	**05**
3	**3**	**Connectors** 3.1 Connectors in Action: A Motivating Example. 3.2 Connector Foundations. 3.3 Connector Roles. 3.4 Connector Types and Their Variation Dimensions. 3.5 Example Connectors. 3.6 Using the connector Framework	**06**
4	**4**	**Modeling** 4.1 Modeling Concepts. 4.2 Ambiguity, Accuracy, and Precision. 4.3 Complex Modeling: Mixed Content and Multiple Views. 4.4 Evaluating Modeling Techniques. 4.5 Specific Modeling Techniques: Generic Techniques, Domain and Style specific ADLs, Extendable ADLs.	**04**
5	**5**	**Visualization** 5.1 Visualization Concepts. 5.2 Common issues in Visualization. 5.3 Visualization Techniques: Textual Visualization, UML, xADL.	**04**
6	**6**	**Analysis** 6.1 Analysis Goals. 6.2 Scope of Analysis.	**06**

		6.3 Architectural Concern being Analyzed. 6.4 Level of Formality of Architectural Models. 6.5 Type of Analysis. 6.6 Analysis Techniques.	
7	**7**	**Implementation and Deployment** 6.1 Concepts. 6.2 Existing Frameworks. 6.3 Software Architecture and Deployment. 6.4 Software Architecture and Mobility.	**04**
8	**8**	**Applied Architectures and Styles** 8.1 Distributed and Networked Architectures. 8.2 Architectures for Network-Based Applications. 8.3 Decentralized Architectures. 8.4 Service-Oriented Architectures and Web Services.	**08**
9	**9**	**Designing for Non-Functional Properties** 9.1 Efficiency. 9.2 Complexity. 9.3 Scalability and Heterogeneity. 9.4 Adaptability. 9.5 Dependability.	**04**
10	**10**	**Documentation** 10.1 Uses of Architectural Documentation. 10.2 Views 10.3 Choosing the Relevant Views 10.4 Documenting a View 10.5 Documentation across Views	**04**

Text Books:

1. Richard N. Taylor, Nenad Medvidovic, Eric M. Dashofy, "Software Architecture: Foundations, Theory, and Practice", Wiley Publications.
2. Len Bass, Paul Clements, Rick Kazman, "Software Architecture in Practice", Pearson

References:

1. M. Shaw, "Software Architecture Perspectives on an Emerging Discipline", Prentice Hall.

Term work: Term work should be based on the Lab experiments and assignments.

Suggested Practical List:

1. Modeling using xADL
2. Analysis – Case study
3. Visualization using xADL
4. Integrate software components using a middleware
5. Use middleware to implement connectors
6. Wrapper to connect two applications with different architectures
7. Creating web service
8. Architecture for any specific domain

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus.
- Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs./Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC7053	E-Commerce and E-Business	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC7053	E-Commerce and E-Business	20	20	20	80	25	---	25	150

Course Objectives:

- To understand technical aspect of E-commerce and E-Business
- To describe the process of E-commerce and E-business
- To understand Infrastructure design issues of E-commerce

Course Outcomes:

Graduates will be able to design and conduct experiments, as well as analyze and interpret the technological, user, network requirements for developing the various modules of e commerce/business site, will be able to apply the knowledge gained and modern engineering tools in their application domain.

Pre requisites:

Internet Technologies, Database concepts, Internet Security, Middleware technologies, web services

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**E – commerce :- Introduction to E commerce**	Definition of e com , different types of e com , Examples of e com E commerce trade cycle , Advantages and disadvantages of ecom , Traditional commerce Vs E commerce	**2**
2	**Overview of Hardware and software technologies for E com**	Client side programming (Dream weaver , Front page) , Server side programming (PHP) , Database connectivity , session tracking , middleware technologies from e com perspective and security aspects wrt to e commerce, integration of web services	**8**
3	**Payment System for e commerce**	Traditional payment model , Characteristics of payment system, SET Protocol for credit card payment, E-cash, E-check, smart cards	**8**
4	**E – Marketing Strategies**	Value chain , Working of e – market , Transactions at e – market , Strategies for marketing for selling on the web – Advertising supported , advertising subscription mixed model , fee for transaction model Sales and Promotions Strategies for Purchasing and support activities	**8**
5	**E business :- Introduction to e business**	Definition of e business , Characteristics , elements of e business , e business roles , Impact of e business , challenges of e business , difference between e business , e commerce	**4**
6	**Developing e business models**	E- business structure , Evolution of e –business and its stages , E – business models , Characteristics of Internet based software and e business solutions	**3**
7	**E-business strategies**	Strategic planning process, SCM , CRM , ERP , procurement	**7**
8	**Design and development of**	a) Building an e commerce website. :- SDLC , system design , Issues involved in designing a	**8**

	an business website	website , Prerequisites required for designing in – house website, steps involved in web site development , e-business and web site development solutions , security issues involved and analysing website traffic --- Case study b) Analysis and design – (Workflow management, process modelling , data modelling) , UI design , use case design , information architecture , security concerns	

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

Term work:

Term work should include at least 8 experiments.

Journal must include at least 2 assignments.

Term work: - 25 marks (total) = 15 marks (experiments) + 5 marks (Assignments) + 5 marks (attendance – theory + Practical).

Oral exam will be based on the above syllabus.

Suggested Practical List (If Any):

Exp 1: All experiments should be part of final e-commerce / e business portal development

1. Home page design
2. Form validation (Ajax enabled)
3. Catalog design and Search techniques (Web mining , and Ajax enabled)
4. Access control mechanism (session management)
5. Payment systems
6. Security features
7. Creating Web Site to integrate web Services
8. Server side using Web Services

Exp 2: Case study of M commerce, bit coins, Google app engine, and other current e com / e business technologies

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme Hrs./Week			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC7054	Multimedia Systems	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC7054	Multimedia Systems	20	20	20	80	25	---	25	150

Course Objectives:

- To understand technical aspect of Multimedia Systems
- To understand and evaluate the process of development of Multimedia Systems
- To understand the framework and standards available for different Multimedia applications

Course Outcomes:

Students will be able to understand the relevance and underlying infrastructure of multimedia systems. The purpose of this course is to make the students capable to apply their multimedia knowledge to understand the current requirements of multimedia products. The standards and frameworks introduced will help the students develop the multimedia systems as per industry standards

Pre requisites:

Interactive I/O devices, Networking, basic concepts communication devices, Standards & frameworks

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Multimedia	What is multimedia, Hypermedia, Multimedia tools, Multimedia Authoring & its Tools, VERML, File Formats.	**2**
2	Color in Images & Video	Colour Models for Images & Videos, Video Signals, Digital Video, MIDI, Quantization, Transmission of Audio	**4**
3	Compression Algorithms	Lossless Compression , Introduction, Basics, RLC ,VLC, lossless Image Compression, Lossy Compression, introduction, Distortion, Rate Distortion Theory, Quantization	**4**
4	Image Compression Standards	JPEG standards, JPEG 2000 standards, JPEG –LS standards, Bi-Level Image Compression Standards	**4**
5	Video Compression Techniques	Introduction, Motion Compensation ,Motion vectors, H.261& H.263,MPEG-1&MEPEG-2MPEG_4,MPEG-7,MPEG21	**5**
6	Audio Compression	ADPCM, Vocoders, Psychoacoustics, MPEG audio.	**3**
7	Multimedia Network Applications	Quality of Multimedia Data transmission, Multimedia over IP, Multimedia over ATM, Media on Demand, Multimedia over Wireless Network	**6**
8	Multimedia Data bases	Design and Architecture of Multimedia Data base, Types, Organization, Medias Abstraction, Query Language.	**7**
9	Frame Work for Multimedia Standards	Introduction, Standard Activates, Standard to built a news Global Information Infrastructure, Standardization process on Multimedia Communication, ITU-I Mediacom 2004 Framework, ISO/MPEG -21 Framework, IETF Multimedia Internet Standards.	**6**

10	Application layer:	Introduction, ITU applications, MPEG Application , Digital Broadcasting Applications, Universal multimedia access.	**7**

Text Books:

1) Fundamentals of Multimedia by Ze-Nian Li& Mark.S.Drew

2) Introduction to Multimedia Communication, Application, Middleware, Networking by K.R.Roa, Zoran S,Bojkovic & Dragorad A. Milovanovic.

References:

Multimedia systems by Thakker

Term work:

Term work should include at least 8 experiments.

Journal must include at least 2 assignments.

Term work :- 25 marks (total) = 15 marks (experiments) + 5 marks (Assignments) + 5 marks (attendance – theory + Practical).

Oral exam will be based on the above syllabus.

Suggested Practical List (if any):

1) Creating sample movies/ animations in flash.

2) Designing a multimedia application / multimedia authoring system.

3) Design a web application using dream viewer &fireworks

4) Construction of website using pictures, video, audio

5) Design a game application in flash

6) Record speech & perform compression & decompression

7) Case study on all file formats related to multimedia system

8) Case study on different authoring tools

9) Different levels of control in slide show presentation

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total 4 questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 3 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs./Week)		Credits Assigned				
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC7055	Usability Engineering	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC7055	Usability Engineering	20	20	20	80	25	---	25	150

Course Objectives:

Is to provide concrete advice and methods that can be systematically employed to ensure a high degree of usability in the final user interface.

Course Outcomes:

Students will be able to create useful usable and used interface.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	1	**Introduction** Cost Savings, Usability Now, Usability Slogans, Discount Usability Engineering, Recipe For Action, Usability and Other Considerations, Definition of Usability, Example: Measuring the Usability of Icons, Usability Trade-Offs, Categories of Users and Individual User Differences	**06**
2	2	**Generations of User Interfaces** Batch Systems, Line-Oriented Interfaces, Full-Screen Interfaces, Graphical User Interfaces, Next-Generation Interfaces, Long-Term Trends in Usability	**02**
3	3	**The Usability Engineering Lifecycle** Know the User, Competitive Analysis, Goal Setting, Parallel Design, Participatory Design, Coordinating the Total Interface, Guidelines and Heuristic Evaluation, Prototyping, Interface Evaluation, Iterative Design, Follow-Up Studies of Installed Systems, Meta-Methods, Prioritizing, Usability Activities.	**08**
4	4	**Usability Heuristics** Simple and Natural Dialogue, Speak the Users' Language, Minimize User Memory Load, Consistency, Feedback, Clearly Marked Exits, Shortcuts, Good Error Messages, Prevent Errors, Help and Documentation, Heuristic Evaluation.	**08**
5	5	**Usability Testing** Test Goals and Test Plans, Getting Test Users, Choosing Experimenters, Ethical Aspects of Tests with Human, Subjects, Test Tasks, Stages of a Test, Performance Measurement, Thinking Aloud, Usability Laboratories,	**08**
6	6	**Usability Assessment Methods beyond Testing** Observation, Questionnaires and Interviews, Focus Groups, Logging, Actual Use, User Feedback, Choosing Usability Methods.	**04**
7	7	**Interface Standards** National, International and Vendor Standards, Producing Usable In-House Standards. **International User Interfaces** International Graphical Interfaces, International Usability Engineering, Guidelines for	**08**

		Internationalization, Resource Separation, Multilocale Interfaces.	
8	8	**Future Developments** Theoretical Solutions, Technological Solutions, CAUSE Tools: Computer-Aided Usability Engineering, Technology Transfer	**04**

Text Books:

- Usability Engineering by Jacob Nielson, Morgan Kaufmann, Academic Press.

*** eBook available**

References:

Developing User Interfaces - Ensuring Usability through Product & Process by Deborah Hix, Rex Hartson, Wiley

Suggested Practical List (If Any): Refer appendix A of the text book for Practical Exercise.

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs./Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC7056	Ubiquitous Computing	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC7056	Ubiquitous Computing	20	20	20	80	25	---	25	150

Course Objectives:

- To introduce the ideas of ubiquitous computing techniques based on human experience.
- To generate an ability to design, analyze and perform experiments on real life problems using various smart devices, smart interaction and smart environment.
- To integrate computation into the environment, rather than having computers as distinct objects.
- To enable people to move around and interact with computers more naturally than they currently do.

Course Outcomes:

On successful completion of this course the student has: Knowledge and understanding regarding:

- The objectives and the historical development of the field of ubiquitous computing
- Fundamentals of sensor technology and sensor networks
- Apply middleware techniques to implement ubiquitous computing systems
- Design of new (often embedded) interactive artifacts
- Context aware and adaptive systems
- Compare the usability of alternative design of interactions for specific ubiquitous computing systems

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Ubiquitous Computing	Definition, Advantage, Application and Scope. Properties of Ubiquitous Computing, Ubiquitous System Environment Interaction. Architectural Design for UbiCom Systems: Smart DEI Model.	**4**
2	Smart Devices and Services	Introduction to Smart Devices: Users, Mobiles, Cards and Device Networks. Service Architecture Models. Service Provision Life-Cycle. Virtual Machines and Operating Systems Mobile Computers and Communicator Devices.	**8**
3	Sensing and Controlling	Tagging the Physical World. Sensors and Sensor Networks. Micro Actuation and Sensing: Micro-Electro-Mechanical Systems (MEMS). Embedded Systems and Real-Time Systems. Control Systems for Physical World Tasks. Robots	**8**
4	Context-Aware Systems	Introduction to Context-Aware Computing, Context-Aware Systems, Context-Aware Applications, Designing and Implementing Context-Aware Applications, Issues for building Context-Aware Applications.	**8**
5	Human–Computer Interaction	User Interfaces and Interaction for Four Widely Used Devices. Hidden UI Via Basic Smart Devices. Hidden UI Via Wearable and Implanted Devices. Human-Centered Design (HCD). User Models: Acquisition and Representation. iHCI Desi	**10**
6	Ubiquitous Communication	Data Networks. Audio Networks. Wireless Data Networks. Universal and Transparent Audio, Video and Alphanumeric Data. Ubiquitous Networks. Network Design Issues. Human Intelligence Versus Machine Intelligence. Challenges in Ubiquitous System, Social Issues: Promise Versus Peril.	**10**

Text Books:

[1] Stefan Poslad. Ubiquitous Computing: Smart Devices, Environments and Interactions, Wiley Publication.

[2] John Krumm. Ubiquitous Computing Fundamentals. CRC Press.

References:

[1] Yin-Leng Theng and Henry B. L. Duh. Ubiquitous Computing: Design, Implementation, and Usability. IGI Global.

[2] Adam Greenfield. Everyware the Drawing age of Ubiquitous Computing, Published in Association with AIGA.

[3] Mobile and Ubiquitous Computing", Georgia Tech, 2003.

Term work:

Term work will be based on Practical and Assignments covering the topics of the syllabus.

Suggested Practical List (If Any):

1. Applications for location-based messages
2. Global Positioning system
3. Context-Aware system
4. Human Computer Interaction
5. Ubiquitous Communication
6. Case study of Class Room 2020
7. Case study of Super Market
8. Case study of Hospital Management

Theory Examination:

• Question paper will comprise of 6 questions, each carrying 20 marks.
• Total 4 questions need to be solved.
• Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
• Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs./Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITP706	Project I	---	*	---	---	03	---	03

***Work load of the teacher in semester VII is equivalent to 6 hrs/week.**

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITP706	Project I	---	---	---	---	25	---	25	50

Objective: To help the learner to develop some of the following:

1. Relate theory with real time applications.

2. Experiencing the issues involved with creation and design of simple products and processes.

Outcomes: The learner should be able to prepare a synopsis of the work selected.

Guidelines for Project

- Students should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by experimental/simulation methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Project I

- Project I should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
- Project I should be assessed through a presentation by a panel of Internal and External examiners appointed by the University of Mumbai.

Course Code	Course Name	Teaching Scheme (Hrs./Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC801	Storage Network Management and Retrieval	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITC801	Storage Network Management and Retrieval	20	20	20	80	25	---	25	150

Course Objectives:

a. Study and evaluate the need for Storage networking, current storage technologies: SAN, NAS, IP storage etc., which will bridge the gap between the emerging trends in industry and academics.

b. Understanding and building Storage networks and its backup and recovery techniques.

c. Study the information retrieval system as per different application in storage networks.

Course Outcomes:

1) Students will be able to evaluate storage architectures, including storage subsystems, SAN, NAS, and IP-SAN, also define backup, recovery.
2) Examine emerging technologies including IP-SAN.
3) Define information retrieval in storage network and identify different storage virtualization technologies.

Prerequisite: Computer Networks, Database Management Systems and Operating Systems

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
I	NEED FOR STORAGE NETWORK	INTRODUCTION:- Limitations of traditional server centric architecture,. Storage centric architecture and its advantages. BASICS OF STORAGE NETWORK:- Intelligent Storage Systems (ISS), Data protection (RAID implementation methods).RAID arrays ,Components, RAID technologies, RAID levels, RAID impact on disk, performance & RAID comparison.	**10**
II	STORAGE NETWORK ARCHITECTURE	SCSI, SAN: FC SAN FC Protocol Stack, IP Storage, Infiniband, Virtual Interfaces	**08**
III	ADVANCED STORAGE TECHNOLOGY	NETWORK ATTACHED STORAGE (NAS):- Local File systems, Network File systems and file servers, Shared Disk File systems: Case study, Comparison: NAS, FC SAN and iSCSI SAN. STORAGE VIRTUALIZATION:- Virtualization in I/O path, Limitations and requirements, Definition of Storage Virtualization, Storage virtualization on Block and file level, Storage virtualization on various levels of Storage network, Symmetric and Asymmetric Virtualization.	**14**
IV	STORGAE NETWORK BACKUP AND RECOVERY	BC Terminology, BC Planning Lifecycle, General Conditions for Backup, Recovery Considerations, Network Backup Services Performance Bottlenecks of Network Backup, Backup Clients, Back up file systems, Backup Databases, Next Generation Backup.	**06**

V	INFORMATION RETRIEVAL IN STORAGE NETWORK	Overview, Abstraction , Information System, Measures, from Data to Wisdom, Document and Query Form, Query structures, The matching process, Text analysis: Indexing, Matrix representation, Term extraction, Term association, , Stemming , Multilingual retrieval systems	**10**

Text Books:

1. ULF Troppen, Rainer Erkens and Wolfgang Muller , " Storage Networks Explained: Basic and Applications of Fibre Channel SAN, NAS and ISCSI and Infifniband " , Wiley
2. EMC Educational Services, "Information Storage and Management", wiley India
3. R. R. Korfhage, "Information Storage and Retrieval", Wiley

References:

1. Richard Barker and Paul Massiglia, " Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SANs" , Wiley.
2. Robert Spalding, " Storage Networks: The Complete Reference", Tata McGraw Hill
3. W. Curtis Preston, "Using SANs and NAS", O'Reilly

Term work: based on Laboratory Practical's/ Case studies and assignment

1. Term work shall consist of 10 practical implementation, case studies and study of simulators or tools available.
2. Study and implementation of simulation tool Navishpere and Unisphere related to storage network management.
3. Case study on Building and implementing SAN.
4. Study and implementation of any information retrieval tool.

Theory Examination:
• Question paper will comprise of 6 questions, each carrying 20 marks.
• Total 4 questions need to be solved.
• Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
• Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme Hrs./Week			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC802	Big Data Analytics	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC802	Big Data Analytics	20	20	20	80	25	---	25	150

Course Objectives:

1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql Map-Reduce.
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.

Course Outcomes: At the end of this course a student will be able to:

1. Understand the key issues in big data management and its associated applications in intelligent business and scientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Book	Hours
1	Introduction to Big Data	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions.	**From Ref. Books**	**03**
2	Introduction to Hadoop	What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; Physical Architecture; Hadoop limitations.	Hadoop in Practise Chapter 1	**02**
3	NoSQL	1. What is NoSQL? NoSQL business drivers; NoSQL case studies; 2. NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns; 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	**No-SQL book**	**04**
4	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, 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.	**Text Book 1**	**06**

5	Finding Similar Items	Applications of Near-Neighbor Search, Jaccard Similarity of Sets, Similarity of Documents, Collaborative Filtering as a Similar-Sets Problem . **Distance Measures:** Definition of a Distance Measure , Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.	**Text Book 1**	**03**
6	Mining Data Streams	**The Stream Data Model**: A Data-Stream-Management System, Examples of Stream Sources, Stream Querie, Issues in Stream Processing. **Sampling Data in a Stream** : Obtaining a Representative Sample , The General Sampling Problem, Varying the Sample Size. **Filtering Streams**: The Bloom Filter, Analysis. **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, Decaying Windows.	**Text Book 1**	**06**
7	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, Use of Combiners to Consolidate the Result Vector. Topic sensitive Page Rank, link Spam, Hubs and Authorities.	**Text Book 1**	**05**
8	Frequent Itemsets	**Handling Larger Datasets in Main Memory** Algorithm of Park, Chen, and Yu, The Multistage Algorithm, The Multihash Algorithm. **The SON Algorithm and MapReduce** **Counting Frequent Items in a Stream** Sampling Methods for Streams, Frequent Itemsets in Decaying Windows	**Text Book 1**	**05**
9	Clustering	CURE Algorithm, Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets,	**Text**	**05**

		Answering Queries	**Book 1**	
10	Recommendation Systems	A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	**Text Book 1**	**04**
11	Mining Social-Network Graphs	Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities, SimRank, Counting triangles using Map-Reduce	**Text Book 1**	**05**

Text Books:

1. Anand Rajaraman and Jeff Ullman "**Mining of Massive Datasets**", Cambridge University Press,

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

3. Judith Hurwitz, Alan Nugent, Dr. Fern Halper, Marcia Kaufman, "**Big Data for Dummies",** Wiley India

4. Michael Minelli, Michele Chambers, Ambiga Dhiraj, "**Big Data Big Analytics: Emerging Business Intelligence And Analytic Trends For Today's Businesses",** Wiley India

5. Phil Simon**, "Too Big To Ignore: The Business Case For Big Data",** Wiley India

6. Paul Zikopoulos, Chris Eaton**, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data',** McGraw Hill Education.

7. Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich**, "Professional Hadoop Solutions",** Wiley India.

Oral Exam:

An oral exam will be held based on the above syllabus.

Term work:

Assign a case study for group of 2/3 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.

Term work: (15 marks for programming exercises + 10 marks for mini-project)

Suggested Practical List: Students will perform at least 8 programming exercises and implement one mini-project. The students can work in groups of 2/3.

1. Study of Hadoop ecosystem
2. 2 programming exercises on Hadoop
3. 2 programming exercises in No SQL
4. Implementing simple algorithms in Map- Reduce (3) - Matrix multiplication, Aggregates, joins, sorting, searching etc.
5. Implementing any one Frequent Itemset algorithm using Map-Reduce
6. Implementing any one Clustering algorithm using Map-Reduce
7. Implementing any one data streaming algorithm using Map-Reduce
8. 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 etc.

Theory Examination:
- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs./Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC803	Computer Simulation and Modeling	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITC803	Computer Simulation and Modeling	20	20	20	80	25	25	---	150

Course Objectives:

This course presents an introduction to discrete event simulation systems. Emphasis of the course will be on modeling and the use of simulation languages/software to solve real world problems in the manufacturing as well as services sectors. The course discusses the modeling techniques of entities, queues, resources and entity transfers in discrete event environment. The course will teach the students the necessary skills to formulate and build valid models, implement the model, perform simulation analysis of the system and analyze results properly.

The "theory" of simulation involves probability and statistics, thus a good background in probability and statistics is a required prerequisite

Course Outcomes:

- Understand the meaning of simulation and its importance in business, science, engineering, industry and services
- Identify the common applications of discrete-event system simulation.
- Practice formulation and modeling skills.

- Understand simulation languages
- Ability to analyze events and inter-arrival time, arrival process, queuing strategies, resources and disposal of entities
- An ability to perform a simulation using spreadsheets as well as simulation language/package
- Ability to generate pseudorandom numbers using the Linear Congruential Method
- Ability to perform statistical tests to measure the quality of a pseudorandom number generator
- Ability to define random variate generators for finite random variables
- Ability to analyze and fit the collected data to different distributions

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	UNIT - I Introduction to simulation	Introduction to Simulation. Simulation Examples. General Principles	**15**
2	UNIT - II Mathematical & Statistical Models in Simulation	Statistical Models in simulation. Queuing Models	**8**
3	UNIT - III Random Numbers	Random Number Generation. Testing random numbers (Refer to Third edition) Random Variate Generation: Inverse transform technique, Direct Transformation for the Normal Distribution, Convolution Method, Acceptance-Rejection Technique (only Poisson Distribution).	**9**
4	UNIT – IV Analysis of simulation data	Input Modeling Verification, Calibration and Validation of Simulation Models Estimation of absolute performance.	**12**
5	UNIT V	Case study	

	Application	• Processor and Memory simulation • Manufacturing & Material handling	**4**

Text Books:

Discrete Event System Simulation; Third Edition, Jerry Banks, John Carson, Barry Nelson, and David M. Nicol, Prentice-Hall

Discrete Event System Simulation; Fifth Edition, Jerry Banks, John Carson, Barry Nelson, and David M. Nicol, Prentice-Hall

References:

1. System Modeling & Analysis; Averill M Law, 4th Edition TMH.
2. Principles of Modeling and Simulation; Banks C M , Sokolowski J A; Wiley
3. System Simulation ; Geoffrey Gordon ; EEE
4. System Simulation with Digital Computer; Narsing Deo, PHI

Term work:

Laboratory work: 10 marks

Mini Simulation Project presentation: 10 marks

Attendance / Quiz: 5 marks

Suggested Practical List (If Any):

Perform simulation exercises given in the text book (third edition) using spreadsheets and/or simulation language/package

- Queue- single server, multi-server, classic case- dump truck
- Inventory – Lead time=0, lead time fixed, lead time probabilistic
- Reliability problem
- Tutorials on statistical models
- Random number generate and test
- Goodness of fit test
- Output analysis – Point estimate and Confidence Interval

Simulation: Real World Examples – can be in the field of business, transportation, medical, computing, manufacturing and material handling- Presentation to be taken.

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs./Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC8041	Enterprise Resource Planning	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC8041	Enterprise Resource Planning	20	20	20	80	25	---	25	150

Course Objectives: This course presents an introduction to ERP and related technologies. The course discusses ERP Manufacturing Perspective and ERP modules. The course will teach the learners the ERP implementation lifecycle, emphasis on ERP benefits and introduces the ERP tools.

Course Outcomes: The learner will be familiar with ERP and related technologies like Business Processing Reengineering (BPR), Supply Chain Management (SCM),Customer Relationship Management(CRM), MIS - Management Information System, DSS - Decision Support System, EIS - Executive Information System etc. The learner should gain the knowledge on ERP tools and ERP benefits.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	Introduction to ERP	Enterprise – An Overview Integrated Management Information, Business Modeling, Integrated Data Model	04
2.	ERP and Related 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
3.	ERP Manufacturing Perspective	MRP - Material Requirement Planning, BOM - Bill Of Material, MRP - Manufacturing Resource Planning, DRP - Distributed Requirement Planning, PDM - Product Data Management	06
4.	ERP Modules	Finance, Plant Maintenance, Quality Management, Materials Management	06
5.	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	06
6.	ERP Implementation Lifecycle	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
7.	ERP case Studies	E-Commerce to E-business E-Business structural transformation, Flexible Business Design, Customer Experience, Create the new techo enterprise, New generation e-business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications	06
8.	E-Business	Enterprise resource planning the E-business Backbone Enterprise architecture, planning, ERP usage in Real	08

	Architecture	world, ERP Implementation, Future of ERP applications, memo to CEO ,E-Procurement, E-Governance, Developing the E-Business Design	
9.	Introduction to ERP tools	JD Edwards-Enterprise One Microsoft Dynamics-CRM Module	04

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.

Reference Books:

1. Guide to Planning ERP Application, Annetta Clewwto 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

Theory Examination:
- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs/Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC8042	Wireless Sensor Networks	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC8042	Wireless Sensor Networks	20	20	20	80	25	---	25	150

Course Objectives:

1. To understand the concepts of sensor networks and study the architecture of WSN.

2. To understand applications of WSN.

3. To discuss the challenges in designing MAC and routing protocols for wireless sensor networks.

4. To study different operating systems and look at performance issues.

5. To understand WSN Standards and future trends in WSN.

5. To study Challenges of Security in Wireless Sensor Networks and Protocols and Mechanisms for Security.

Course Outcomes:

1. Students shall be able to understand and study the functionalities, applications and architecture of WSN.

2. Students shall be able to describe the challenges in designing various protocols for wireless sensor networks.

3. Students shall be able to understand the current technology trends for the implementation and deployment of wireless sensor networks.

4. Students shall gain an understanding of WSN Standards and future trends in WSN.

5. Students shall be able to understand security aspects like Privacy issues, attacks and countermeasures.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	Overview and Introduction of Wireless Sensor Network	Background of Sensor Network Technology; Types of Application; Challenges for WSNs: Characteristics requirements, Required mechanism; Basic Sensor Network Architectural Elements; Sensor Network scenarios: Types of sources and sinks, single-hop versus multi hop networks, Multiple sinks and sources, three types of mobility; Some examples of sensor nodes: Mica Mote family, EYES nodes, BT nodes.	**6**
2.	Applications of Wireless Sensor Network	Category 1(C1WSNs), Category 2(C2WSNs), Range of Applications, Examples of Category 1 WSN (C1WSNs) Applications, and Examples of Category 2 WSN(C2WSNs) Applications.	**4**
3.	MAC Protocols	Fundamentals of (wireless) MAC protocols, Requirements and design considerations for MAC Protocols in WSN, Low duty cycle protocols and wakeup concepts, STEM,S-MAC, Mediation device protocol, Wakeup radio concepts, Contention- based protocols, CSMA protocols, PAMAS, Schedule-based protocols, LEACH, SMACS, Traffic-adaptive medium access protocol(TRAMA),IEEE 802.15.4 MAC protocol, Slotted CSMA-CA protocol	**9**

4.	Network and Transport layer Protocol.	Network layer : Data Dissemination and Gathering, Routing Challenges and Design Issues, Routing Strategies: Flooding and it's variants, Power-Efficient Gathering in Sensor Information Systems, Geographical routing, Transport layer : Transport protocol Design issues, Examples of Existing Transport Control Protocols: CODA, ESRT, RMST, PSFQ, GARUDA, ATP; Performance of Transport Control Protocols :Congestion, packet loss recovery.	**7**
5.	Operating Systems , Performance and Traffic Management Issues	Operating System Design Issues, Examples of Operating Systems: TinyOS, Mate, MagnetOS, MANTIS,OSPM,EYES OS, SenOS, EMERALDS, PicOS , WSN Design Issues, Performance Modeling of WSNs	**7**
6.	WSN standards and Future trends in wireless sensor networks	Wireless sensor network standards-IEEE 802.15.4 Low rate WPAN standard, The ZIGBEE alliance etc. Future trends in wireless sensor networks: Wireless Multimedia Sensor Networks, Sensor Network Applications in Challenging Environments.	**6**
7	Security	Fundamentals of Network Security ,Challenges of Security in Wireless Sensor Networks, Security Attacks in Sensor Networks, Protocols and Mechanisms for Security, IEEE 802.15.4 and ZigBee Security	**9**

Text Books:

1. HOLGER KARL,ANDREAS WILLIG., "*Protocols, and Architectures: For Wireless Sensor Networks*", Wiley Student Edition
2. Kazem Sohraby, Daniel Minoli, Taieb Znati., "*Wireless Sensor Networks: Technology, Protocols, and Applications*", Wiley Student Edition.
3. Waltenegus Dargie and Christian Poellabauer., "*Fundamentals of Wireless Sensor Networks-Theory & Practice*", John Wiley publication, 2010.
4. J. Zheng and A. Jamalipour, "*Wireless Sensor Networks : A Networking Perspective* " John Wiley publication,2009

References:

1. Edgar H. Callaway Jr., *"Wireless Sensor Networks - Architectures and Protocols",*AUERBACH Publications, CRC Press, 2004.

2. Feng Zhao, Leonidas Guibas ,"*Wireless Sensor Networks: An Information Processing Approach"* , Morgan Kaufmann Series in Networking 2004.

Term work: Term work shall consist of at least 06 experiments from the suggested list & 04 assignments based on the syllabus.

Distribution of marks for term work shall be as follows.

1. Attendance (Theory & Practical) :05 marks
2. Laboratory Work (Experiment & Journal):15 marks
3. Assignment : 05 marks.

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

Suggested Practical List :

1. Installation of OMNET ++.

2. Installation & configuration of TinyOS.

3. Implementation of any two routing algorithms using JAVA

4. Implementation of any two programs on Tiny OS.

5. Study of any of the WSN operating systems.

Theory Examination:
• Question paper will comprise of 6 questions, each carrying 20 marks.
• Total 4 questions need to be solved.
• Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
• Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs./Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Term Work /Practical	Tutorial	Total
ITC8043	Geographical Information Systems	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme						
		Theory Marks			Term Work	Practical	Oral	Total
		Internal assessment		End Sem. Exam				
		Test 1	Test 2					
ITL8043	Geographical Information Systems	20	20	80	25	---	25	150

Course Objective:

- To provide an understanding of the basic concepts and uses of GIS technology
- To develop an ability to analyze, interpret geospatial data
- To provide an understanding of the basic principles of Remote Sensing and its use in GIS
- To provide a research platform for students in the area of GIS adapting to ever changing Technologies

Course Outcomes:
After completing this course, students will be able to:

- Apply the knowledge of science for real world applications in GIS
- Design and conduct experiments as well as analyze, interpret the geospatial data using GIS tools
- Function with multidisciplinary Teams.
- Use the techniques, skills and modern engineering tools necessary for engineering practice.
- Adapt to Open source standards

DETAILED SYLLABUS:

Module No.	Unit No.	Details of Topic	Hrs.
1.0		**Fundamentals of GIS**	06
	1.1	Introduction, Definition of GIS, Evolution of GIS , components of GIS,	
	1.2	Geospatial Data, Geographic Coordinate System, Map Projections, Commonly Used Map Projections, UTM grid system, Map Scale	
	1.3	Cartographic Symbolization, Types of Maps, Typography, Map Design, Map Production	
2.0		**Data Management, Models and Quality Issues**	06
	2.1	Vector Model : Topology, Non topological Vector models, Attribute Data in GIS, Attribute Data Entry, Vector Data Query, Manipulation of Fields and Attribute Data	
	2.2	Raster Data Model : Elements of Raster Data Model, Types of Raster Data, Raster Data Structure, Raster Data Query, Data Compression, Data Conversion, Integration of Raster and Vector data	
	2.3	Data input and editing, Data quality Issues: Accuracy, Consistency, Precision and Resolution, Completeness; sources of error in GIS	
3.0		**GIS Data Exploration Analysis and Visualization**	2+2+4+4=12
	3.1	Data exploration: Descriptive statistics, Graphs, Dynamic Graphics	
	3.2	Vector Data Analysis: Buffering, Overlay, Distance Measurement, Pattern Analysis, Map Manipulation	
	3.3	Raster Data Analysis: Local Operations, Neighborhood Operations, Zonal Operations, Data Extraction, Data Generalization, Comparison of Vector and Raster Based Data	
	3.4	Spatial Interpolation: Elements of Spatial Interpolation, Global methods, Local Methods, Kriging, Comparison of Spatial Interpolation Methods	
4.0		**Terrain mapping, Geocoding and Segmentation**	04
	4.1	Terrain Mapping and Analysis: Data for Terrain Mapping and Analysis: DIM, TIN, Terrain Mapping, Slope and Aspect, Surface Curvature, Raster versus TIN	
	4.2	Geocoding and Dynamic Segmentation: Geocoding, Applications of Geocoding, Dynamic Segmentation, Applications of Dynamic Segmentation	

5.0		**Remote Sensing Fundamentals**	12
	5.1	Remote Sensing: Basic Principles, Electromagnetic Remote Sensing, Energy Sources, Energy Interactions with Surface Materials, , Energy Interactions with Earth's Atmosphere, Spectral Reflectance Curves	
	5.2	Microwave Remote Sensing, The Radar Principle, Factors Affecting Microwave Measurements, Radar Wavebands, SLAR Systems, SAR, Interpreting SAR Images, Geometrical Characteristics, Remote Sensing, Platform and Sensors, Satellite System Parameters, Sensor Parameters, Imaging Sensor Systems, Earth Resources Satellites, Meteorological Satellites. Data Formats, Standard Products	
	5.3	Visual Image Interpretation: Information Extraction By human and Computer, Remote sensing Data Products, Image Interpretation, Elements of Image Interpretation	
6.0		**Project Management**	04
	6.1	Planning of Project , Implementation of Project, Management of Project, Case study	
7.0		**Modern trends and Applications of GIS**	04
	7.1	Multimedia GIS, Internet GIS, Mobile GIS **,**Applications of GIS in Urban and municipal area	

Recommended Books

1. Kang-tsung Chang, "Introduction to Geographical Information Systems", Tata McGraw Hill, Third Edition, 2003
2. M. Anji Reddi, "Remote Sensing and Geographical Information Systems", B. S. Publications, Second Edition, 2001
3. Basudeb Bhatta ,Remote Sensing and GIS ,Oxford University Press,2^{nd} Edition
4. Ian Heywood, Sarah Cornelius & etal., "An Introduction to Geographical Information Systems", 2nd Edition, Pearson Education
5. A.M. Chandra and S.K. Ghosh, Remote Sensing and Geographical Information Systems , Narosa Publishing House Pvt ltd.
6. Peter A Burrough and McDonell, "Principles of Geographical Information Systems", Oxford University Press, 1998.
7. M. N. DeMers, "Fundamentals of Geographic Information Systems", 3rd edition, Wiley.
8. George B Korte, "The GIS Book", Onword press, Thomson Learning, 5th Edition, 2003
9. Tor Bernhardsen, "Geographic Information Systems – An Introduction", 3rd edition, Wiley Publications

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the tests will be considered as final IA marks.

Term Work:

Term Work shall consist of at least 10 programs based on the above syllabus using any suitable software.

Distribution of marks for term work shall be as follows:
1. Attendance (Theory and Practical): 05 Marks
2. Laboratory work (Performing Experiments and Journal): 20 Marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory Work and Minimum Passing in the term work.

Theory Examination:
- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs./Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Term Work /Practical	Tutorial	Total
ITC8044	Robotics	04	02	---	04	01	---	05

Course Code	Course Name	Examination Scheme						
		Theory Marks			Term Work	Practical	Oral	Total
		Internal assessment		End Sem. Exam				
		Test 1	Test 2					
ITL8044	Robotics	20	20	80	25	---	25	150

Course Objectives: The Lerner is introduced to the fundamentals and kinematics of Robots. The topics like Differential motions & velocities, Trajectory Planning, Mobile Robot Motion Planning etc. are discussed.

Course Outcomes: At the end of this course, learners will be able to

a. Understand kinematics and dynamics of stationary and mobile robots
b. Understand trajectory planning for rigid robot and mobile robots
c. Implement trajectory generation and path planning algorithms
d. Work in interdisciplinary projects

Detailed Syllabus:

1. Fundamentals	Robot Classification, Robot Components, Degrees of freedom, Joints, Coordinates, Coordinate frames, workspace, applications	03 Hrs	Chapter 1 – Text Book 1
2. Kinematics of Robots	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	07 Hrs	Chapter 2 – Text Book 1
3. Differential motions and velocities	Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian	06 Hrs	Chapter 3 – Text Book 1
4. Dynamic Analysis of	Lagrangian mechanics, Moments of	07 Hrs	Chapter 4 –

Forces	Inertia, Dynamic equations of robots, Transformation of forces and moment between coordinate frames		Text Book 1
5. Trajectory Planning	Trajectory planning, Joint-space trajectory planning, Cartesian-space trajectories	07 Hrs	Chapter 5 – Text Book 1
6. Mobile Robot Motion Planning	Concept of motion planning, Bug Algorithms – Bug1, Bug2, Tangent Bug	04 Hrs	Chapter 2 – Text Book 2
7. Potential Functions and Visibility Graphs	Attractive/Repulsive potential, Gradient descent, wave-front planner, navigation potential functions, Visibility map, Generalized Voronoi diagrams and graphs, Silhouette methods	08 Hrs	Chapter 4 & 5 – Text Book 2
8. Coverage Planning	Cell Decomposition, Localization and Mapping	06 Hrs	Chapter 6, 9 – Text Book 2

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, 2005.

Reference Books

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.

Term Work:

Term Work shall consist of at least 10 programs based on the above syllabus using any suitable software.

Distribution of marks for term work shall be as follows:
1. Attendance (Theory and Practical): 05 Marks
2. Laboratory work (Performing Experiments and Journal): 20 Marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory Work and Minimum Passing in the term work.

List of Experiments:

Note: At least one experiment shall be performed from every group. Total number of experiments should be 10.

1. Forward kinematics of n-DOF robot arm – Simulation – (maximum 2 experiments)
2. Inverse Kinematics of n-DOF robot arm – Simulation (maximum 2 experiments)
3. Dynamic modeling of n-DOF robot arm & Simulation (maximum 2 experiments)
4. Trajectory planning of n-DOF robot arm (maximum 2 experiments)
5. Simulation of Bug1, bug2 and tangent bug algorithms (maximum 3 experiments)
6. Simulation of Potential field, voronoi graph, and visibility graph methods (maximum 3 experiments)

Theory Examination:
• Question paper will comprise of 6 questions, each carrying 20 marks.
• Total 4 questions need to be solved.
• Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
• Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs/Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC8045	Soft Computing	04	02	---	04	01	---	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC8045	Soft Computing	20	20	20	80	25	---	25	150

Course Objectives:

AIM: To introduce the techniques and methodologies of soft computing and adaptive neuro-fuzzy inferencing systems which differ from conventional AI and computing in terms of its tolerance to imprecision and uncertainty.

- To introduce the ideas of soft computational techniques based on human experience.
- To generate an ability to design, analyze and perform experiments on real life problems using various Neural Learning Algorithms.
- To conceptualize fuzzy logic and its implementation for various real world applications.
- To apply the process of approximate reasoning using Neuro-Fuzzy Modeling.
- To provide the mathematical background to carry out optimization using genetic algorithms.

Course Outcomes:

Student should be able to mimic human like thought process on deterministic machines and apply it to different real world problems faced in the professional front.

DETAILED SYLLABUS:

Sr.No.	Module	Detailed Content	Hours
1	Introduction to Soft Computing	**Neural Networks:** Definition, Advantages, Applications, Scope. **Fuzzy logic:** Definition, Applications. **Hybrid System:** Definition, Types of Hybrid Systems, Applications. **Genetic Algorithms:** Definition, Applications.	**2**
2	Neural Networks	**Fundamental Concepts and Models of Artificial Neural Systems:** Biological Neurons and Their Artificial Models, Models of Artificial Neural Networks, Neural Processing, Learning and Adaptation, Neural Network Learning Rules and Comparison. **Linearly and Non-Linearly Separable Pattern Classification. Perceptron Convergence Theorem. Multi-layer Feedforward Network:** Delta Learning Rule for Multiperceptron Layer**,** Generalized Delta Learning Rule, Feedforward Recall and Error Back-propagation Training, LearningFactors,CharacterRecognitionApplication. **Associative Memory:** Hopfield Network, Bidirectional Associative Memory. **Radial Basis Function Networks.**	**20**
3	Fuzzy Set Theory	Brief Review of Conventional Set Theory, Introduction to Fuzzy Sets, Properties of Fuzzy Sets, Operations on Fuzzy Sets, Membership Functions.Fuzzy Extension Principle, Fuzzy Relations, Projection and Cylindrical Extension of Fuzzy Relations, Fuzzy Max-Min and Max-Product Composition. Fuzzy Knowledge Based Systems with Applications, Defuzzification Methods, Fuzzy Composition Rules, Architecture of Mamdani Type Fuzzy Control Systems.	**16**
4	Hybrid Systems	**ANFIS**: Adaptive Neuro-Fuzzy Inference Systems: Introduction, ANFIS Architecture, and Hybrid Learning Algorithm.	**4**
5	Genetic Algorithms	What are Genetic Algorithms? Why Genetic Algorithms? Biological Background: The Cell, Chromosomes, Genetics, Reproduction, Neural Selection, Traditional Optimization and Search Techniques, Genetic Algorithm and Search space: Simple GA, General GA, Operators in GA, Encoding, Selection, Crossover, Mutation, Stopping Condition for GA flow, Constraints in GA, Problem solving using GA, Classification of GA.	**6**

Text Books:

1. Jacek M. Zurada, “Introduction to Artificial Neural Systems,” Jaico Publishing House.
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications,” 3rd ed. Wiley India.
3. S. N. Sivanandam and S. N. Deepa, “Principles of Soft Computing,” 2nd ed. Wiley India.
4. Jang J.S.R, Sun C. T. and Mizutani E., “Neuro-Fuzzy and Soft Computing – A Computational Approach to Learning and Machine Intelligence,” PHI.

References:

1. Laurene Fausett, "Fundamentals of Neural Networks – Architectures, Algorithms, And Applications," Pearson Education.
2. Hagan T. Martin, H. B. Demuth, and Mark Beale, "Neural Network Design," Thomson Learning.
3. Satish Kumar, "Neural Networks – A classroom Approach," 2nd ed. Tata McGraw Hill.
4. Kishan Mehrotra, Chilukuri. K. Mohan, and Sanjay Ranka, "Elements of Artificial Neural Networks," 2nd ed. Penram Int. Publishing India.
5. H. J. Zimmermann, "Fuzzy Set Theory and its Applications," Allied Publishers Ltd.
6. Driakov D. Hellendoorn H. and Reinfrank M., "An Introduction to Fuzzy Control," Narosa Publishing House.

Term work:

Term work will be based on Practical and Assignments covering the topics of the syllabus.

Suggested Practical List (If Any):

1. Fuzzy membership function
2. Fuzzy Extension principle
3. Fuzzy controller
4. Perceptron Learning rule
5. Delta Learning Rule
6. Associative Memory
7. Genetic Algorithm
8. Competitive Learning

Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
- Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITC8046	Software Testing & Quality Assurance	04	02	---	04	01	--	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITC8046	Software Testing & Quality Assurance	20	20	20	80	25		25	150

Course Objectives: The students will learn

I. Basic software debugging methods.
II. White box and Black box testing methods
III. Writing the testing plans
IV. Different testing tools

Course Outcomes:

After completion of course the students will able to:

1: Identify the reasons for bugs and analyze the principles in software testing to prevent and remove bugs.
2: Implement various test processes for quality improvement
3: Apply the software testing techniques in commercial environments
4: Provides practical knowledge of a variety of ways to test software and an understanding of some of the trade-offs between testing techniques.
5: Familiar with the open source testing tools.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Unit-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.	**10**
	Unit 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.	**12**
	Unit 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 matrics, estimation model for testing effort, architectural design, information flow matrix used for testing, function point and test point	**10**

		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.	
	Unit IV Test Automation	Automation and Testing Tools: need, categorization, selection and cost in testing tool, guidelines for testing tools. Study of testing tools: WinRunner, QTP, LoadRunner, TestDirector and IBM Rational Functional Tester, Selenium etc.	**8**
	Unit V Testing for Specialized Environment	Testing Object Oriented Software: OOT basics, Object-oriented 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, Testing a data warehouse	**5**
	Unit VI Quality Management	Software Quality Management, McCall's quality factors and Criteria, ISO 9126 quality characteristics, ISO 9000:2000,software quality management	**3**

Text Books:

1. Software Testing Principles and Practices Naresh Chauhan Oxford Higher Education
2. Effective Methods for Software Testing , third edition by Willam E. Perry, Wiley Publication
3. Software Testing and quality assurance theory and practice by Kshirasagar Naik, Priyadarshi Tripathy , Wiley Publication
4. Software Testing Concepts and Tools by Nageswara Rao Pusuluri , dreamtech press

References:

1. Foundation of Software Testing 2 e , by Aditya P. Mathur , Pearson publication

2. Software Testing Tools by Dr. K.V.K.K. Prasad , dreamtech press

3. Software Testing Principles, techniques and tools by M.G. Limaye , Mc Graw Hill publication

Term work:

Term work will be based on Practical and Assignments covering the topics of the syllabus.

Suggested Practical List:

1. Write programs in C Language to demonstrate the working of the following
a. constructs: i) do...while ii) while….do iii) if…else iv)switch v) for

2. A program written in C language for Matrix Multiplication fails. Introspect the causes for its failure and write down the possible reasons for its failure.

3. Take any system (e.g. ATM system) and study its system specifications and report the various bugs.

4. Write the test cases for any known application (e.g. Banking application)

5. Create a test plan document for any application (e.g. Library Management System)

6. Design Test case using boundary value analysis by taking quadratic equation problem.

7. Design a test cases using equivalent class partitioning taking triangle problem

8. Study of any testing tool (e.g. Win runner)

9. Study of any web testing tool (e.g. Selenium)

10. Study of any test management tool (e.g. Test Director)

12. Study of any open source-testing tool (e.g. Test Link)

Theory Examination:

• Question paper will comprise of 6 questions, each carrying 20 marks.
• Total 4 questions need to be solved.
• Q.1 will be compulsory, based on entire syllabus where in sub questions of 2 to 3 marks will be asked.
• Remaining question will be randomly selected from all the modules.

Weight age of marks should be proportional to number of hours assigned to each module.

Course Code	Course Name	Teaching Scheme (Hrs./Week)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
BEITP805	Project II	---	**	---	---	06	---	06

****Work load of the teacher in semester VIII is equivalent to 12 hrs/week.**

Course Code	Course Name	Examination Scheme								
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITP706	Project I	---	---	---	---	50	---	50	100

Course Objectives:

1. Implimentaion of the topic selected in Project-I.

2. Initiating the learners to technical writing and documentation for reuse.

3. Developing proficiency in carrying out critical analysis, review and study of existing literature on technological experimentation and finding out of scholastic investigation

Outcomes: The learner should be able to:

1. Demonstrate the product that is implemented.

2. Produce the proper documentation of the work.

3. Able to work in team and communicate with peers.

4. Develop skills required by the industry.

Guidelines for Project

- Students should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by experimental/simulation methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Project II

- Project II should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Project II should be assessed through a presentation jointly by Internal and External Examiners approved by the University of Mumbai
- Students should be motivated to publish a paper based on the work in Conferences/students competitions

Computer Engineering

Sr. No.	Subject Code	Subject Name	Count
1	CSC 302	Object Oriented Programming Methodolgy*	1
2	CSC303	Data Structures	1
3	CSC304	Digital Logic Design and Analysis	1
4	CSC306	Electronic Circuits and Communication Fundamentals	1
5	CSC402	Analysis of Algorithms	1
6	CSC403	Computer Organization and Architecture*	1
7	CSC404	Data Base Management systems	1
8	CSC406	Computer Graphics	1
9	CPC501	Microprocessor	1
10	CPC502	Operating Systems	1
11	CPC503	Structured and Object Oriented Analysis and Design	1
12	CPC504	Computer Networks	1
13	CPL501	Web Technologies Laboratory	1
14	CPL502	Business Communication and Ethics*	1
15	CPC601	System Programming and Compiler Construction	1
16	CPC602	Software Engineering	1
17	CPC603	Distributed Databases	1
18	CPC604	Mobile Communication and Computing	1
19	CPE6011	Elective-I	1
20	CPL601	Network Programming Laboratory	1
21	CPC701	Digital Signal Processing	1
22	CPC702	Cryptography and System Security	1
23	CPC703	Artificial Intelligenc	1
24	CPE7042X	Elective-II	1
25	CPP701	Project I	1
26	CPL701	Network Threats and Attacks Laboratory	1
27	CPC801	Data Warehouse and Mining	1
28	CPC802	Human Machine Interaction	1
29	CPC803	Parallel and distributed Systems	1
30	CPE803X	Elective-III	1
31	CPP802	Project II	1
32	CPL801	Cloud Computing Laboratory	1
		Total	32

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Computer Engineering (Second Year – Sem. III & IV)

Revised course

(REV- 2012) from

Academic Year 2012 -13

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

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) 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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble:

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the 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. 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.

The Program Educational Objectives finalized for undergraduate program in Computer Engineering are listed below:

1. To prepare Learner's with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To prepare Learner's to use effectively modern tools to solve real life problems
3. To equip Learner's with broad education necessary to understand the impact of computer Technology in a global and social context
4. To encourage , motivate and prepare Learner's for Lifelong-learning
5. To inculcate professional and ethical attitude, good leadership qualities and commitment to social responsibilities

In addition to above 2 to3 more program educational objectives of their own may be added by affiliated Institutes. The Program outcomes are the skills and ability that Learner will demonstrate upon completion of undergraduate degree program in Computer Engineering. Few may be listed as follows:

1. Ability to effectively apply knowledge of computing and mathematics to computer science problems.
2. Ability to design, implement and evaluate computer-based components, systems, processes or programs to meet desired needs and specifications.
3. Ability and skills to effectively use state-of-the-art techniques and computing tools for analysis, design, and implementation of computing systems.
4. Ability to function effectively as a member of a team assembled to undertake a common goal.
5. An understanding of professional, ethical, legal, security, and social issues and responsibilities.
6. Ability to communicate effectively to both technical and non-technical audiences.
7. The ability to successfully pursue professional development thru lifelong learning

In addition to Program Educational Objectives, for each course of undergraduate program, Course Objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. In order to achieve outcome 1,2,and 3 a major emphasis is planned towards designing Laboratory courses third year onwards. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

Dr. Prachi Gharpure

Chairperson, Adhoc Board of Studies in Computer Engineering

University of Mumbai, Mumbai

Program Structure for B.E. Computer Engineering

Second Year (Computer) (Semester III)

(REV 2012)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC301	Applied Mathematics III*	4	-	1#	4	-	1	5
CSC 302	Object Oriented Programming Methodolgy*	4	2	-	4	1	-	5
CSC303	Data Structures	4	2	-	4	1	-	5
CSC304	Digital Logic Design and Analysis	3	2	-	3	1	-	4
CSC305	Discrete Structures	4	-	-	4	-	-	4
CSC306	Electronic Circuits and Communication Fundamentals	4	2	-	4	1	-	5
	Total	**23**	**8**	**1**	**23**	**4**	**1**	**28**

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract / oral	Tot
		Test 1	Test 2	Avg					
CSC301	Applied Mathematics III*	20	20	20	80	03	25!	-	125
CSC302	Object Oriented Programming Methodolgy*	20	20	20	80	03	25	25	150
CSC303	Data Structures	20	20	20	80	03	25	25	150
CSC304	Digital Logic Design and Analysis	20	20	20	80	03	25	-	125
CSC305	Discrete Structures	20	20	20	80	03	-	-	100
CSC306	Electronic Circuits and Communication Fundamentals	20	20	20	80	03	25	25	150
	Total	-	-	**120**	**480**	-	**125**	**75**	**750**

* Common Subjects with IT # Tutorial to be taken class wise ! **Tutorials will be evaluated as Term work**

Program Structure for B.E. Computer Engineering

Second Year (Computer) (Semester IV)

(REV 2012)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC401	Applied Mathematics IV*	4	-	1	4	-	1#	5
CSC402	Analysis of Algorithms	4	2	-	4	1	-	5
CSC403	Computer Organization and Architecture*	4	2	-	4	1	-	5
CSC404	Data Base Management systems	4	2	-	4	1	-	5
CSC405	Theoretical Computer Science	4	-		4	-	-	4
CSC406	Computer Graphics	3	2	-	3	1	-	4
	Total	**23**	**8**	**1**	**23**	**4**	**1**	**28**

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			End Sem Exam	Exam Duration (in Hrs)	TW	Prac / oral	Tot
		Test 1	Test 2	Avg					
CSC401	Applied Mathematics IV*	20	20	20	80	03	25!	-	125
CSC402	Analysis of Algorithms	20	20	20	80	03	25	25	150
CSC403	Computer Organization and Architecture*	20	20	20	80	03	25	25	150
CSC404	Data Base Management systems	20	20	20	80	03	25	25	150
CSC405	Theoretical Computer Science	20	20	20	80	03	-	-	100
CSC406	Computer Graphics	20	20	20	80	03	25	25	150
	Total	**-**	**-**	**120**	**480**	**-**	**125**	**100**	**825**

* Common Subjects with IT # Tutorial to be taken class wise

! **Tutorials will be evaluated as Term work**

Course Code	Course Name	Credits
CSC301	**Applied Mathaematics III**	05

Objectives:

1) Complex Variable (2) Laplace Transform (3) Fourier Series (4) Discrete Structures (5) Z-transform

These topics involve the study of analytic function and mapping of complex function, Laplace transform, Inverse Laplace transform and application of Laplace transform to solve differential equations, finding Fourier series, Sine and cosine Fourier integral and Z-transform. These topics help them to solve many engineering problems arising in course of their further studies and also while working in the practical life situations.

Outcomes:

Students in this course will apply the Procedure and methods to solve technical problems.

Details of the Syllabus:-

Module	Topics	Hrs
01	**Complex Variable & mapping** 1.1 Functions of a complex variable, Analytic functions, Cauchy-Riemann equations in Cartesian co-ordinates, Polar co-ordinates. 1.2 Harmonic functions, Analytic method and Milne Thomson methods to find f(z), Orthogonal trajectories. 1.3 Conformal Mapping, Linear, Bilinear transformations, Cross ratio, fixed points and standard transformation such as rotation and magnification, invertion, translation.	**(10)**
02	**Laplace Transform** 2.1 Introduction, Definition of Laplace transform, Laplace transform of constant, trigonometrical, exponential functions. 2.2 Important properties of Laplace transform: First shifting theorem, Laplace transform of $L\{t^n f(t)\}$, $L\{f(t)/t\}$, $L\left\{\frac{d^n f(t)}{dt^n}\right\}$, $L\{\int_0^t f(u)du\}$, $L\{f(at)\}$ without proof. 2.2Unit step function, Heavi side function, Dirac-delta function, Periodic function and their Laplace transforms, Second shifting theorem. 2.3Inverse Laplace transform with Partial fraction and Convolution theorem (without proof). 2.4 Application to solve initial and boundary value problem involving ordinary differential equations with one dependent variable and constant coefficients.	**(10)**

03	**Fourier series** 3.1 Dirichlet's conditions, Fourier series of periodic functions with period 2π and 2L. 3.2 Fourier series for even and odd functions. 3.3 Half range sine and cosine Fourier series, Parsevel's identities (without proof). 3.4Orthogonal and Ortho-normal functions, Complex form of Fourier series. 3.5 Fourier Integral Representation.	**(10)**
04	**Vector Algebra and Calculus** 4.1 Vector Algebra: Scalar and vector product of three and four Vectors and their properties. 4.2 Vector Calculus: Vector differential operator ∇, Gradient of a scalar point function, Diversions and Curl of Vector point function, $\nabla\ (u\ v)$, $\nabla.(\emptyset\bar{u}), \nabla x(\emptyset\bar{u}), \nabla x\ (\bar{u}x\bar{v})$. 4.3 Vector Integration: Line integral; conservative vector field,Green's theorem in a plane (Without proof) 4.4 GaussDivergence theorem & Stokes' theorem (Without proof and no problems on verification of above theorems).	**(10)**
05	**Z transform** 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 (all without proof) 5.3 Inverse Z transform: Binomial Expansion and Method of Partial fraction.	**(8)**

Term work:

Term work shall consist of minimum four SCILAB practicals and six tutorials.

SCILAB practicals	:	10 marks
Tutorials	:	10 marks
Attendance	:	05 marks
Total	**:**	**25 marks**

Text Books:

- Higher Engineering Mathematics by Grewal B. S. 38th edition, Khanna Publication 2005.
- Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
- A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar &

  J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.
- Discrete and Combinational Mathematics by Ralph P. Crimaldi, B Y Ramana.

References:

- Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
- Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
- Lapplace Treansforms by Murry R. Spieget, Schaun's out line series-McGraw Hill Publication.
- Discrete mathematics by ERIL FOSSETT, Wiley India.

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Subject Code	Subject Name	Credits
CSC302	Object Oriented Programming Methodology (OOPM)*	05

Course Objectives

1. To understand Object oriented concepts like data abstraction, encapsulation, etc.
2. To solve the real world scenarios using top down approach.
3. To understand various Java programming constructs.

Course Outcomes

1. Students will be able to solve computational problems using basic constructs like if-else, control structures, array, strings.
2. Student can understand how to model real world scenario using class diagram.
3. Students will exhibit communication between 2 objects using sequence diagram.
4. Students will be able to implement relationships between classes.
5. Students will be able to demonstrate various collection classes.
6. The students will be able to demonstrate programs on exceptions, multithreading and applets.

Sr. No	Topic	No of Hours
1	Programming Approach from proceduaral to Object Orientation OO methodologies: Grady Booch Methodology of OO development	4
2	OO Concepts: Object, Class, Encapsulation or information hiding, Inheritance, Polymorphism, Message communication, Abstraction, Reuse, Coupling and Cohesion, Sufficiency Completeness and Primitiveness, Meta class	5
3	Object Oriented Programming: Java Evolution: History, How java differs from others Overview of Java language: Introduction, Installing and implementing Java, JVM	3
4	Constants, variables and data types Operators and Expressions Revision of Branching and looping	6
5	Class Object and Method: member, method, Modifier, Selector, constructer, destructor, iterator, State of an object, Method Overloading, Inheritance, Method Overriding ,Final class, abstract class and method	6

6	Classes and Relationships : Implementation of Association and Aggegation using simple scenarios	2
7	Array, String, Vector	6
8	Interfaces : variables in Interfaces, Extending an Interface, Difference between an Abstarct class and an Interface	4
9	Multithread programming	4
10	Grouping of classes for deployment and reuse: Built-in Packages: java.lang: wrapper classes java.util: ArrayList and LinkedList Creating and using User defined packages	3
11	Managing Error and Exception	3
12	Applet programming	2

Suggested list of Programming Assignments /Laboratory Work

Divide laboratory work into 3 parts

A. Basic Java structural components and Conditional and control statements:

- To demonstrate the use of command line argument.
- To demonstrate various ways of accepting data through keyboard.
- To understand the working of an array.
- To understand string class and demonstrate its various functions.

B. Perform following practical on some case study like Banking Application, Library Application etc.

- Find out classes, objects and their properties.
- Create and display objects found in above.
- Add methods to classes and implement.
- Refine above objects by adding constructors and local variables.
- Show communication between the objects by calling instance of one object from another class.
- Find relationships like inheritance, association, aggregation, composition.
- Implement above relationships.

C.

- To implement user defined exceptions in Java.
- Demonstrate the use collection classes like ArrayList/LinkedList/HashSet/TreeSet/Map.

- To illustrate Multithreading in Java.
- Simple programs on Applets and AWT.

TermWork:

Students will submit Term Work in the form of a journal that will include at least 15 programming assignments. Each programming assignment will consist of an algorithm or class diagram/sequence diagram (if applicable), program listing with proper documentation and snapshot of the output.

Practical Examination will be based on the term work and questions will be asked to judge understanding of the assignments at the time of the examination.

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 marks) = 15 Marks (Experiment) + 5 Marks (Assignment) + 5 (Attendance (theory+practical))

Practical Exam will based on above syllabus

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Text Books:

1. Ralph Bravaco , Shai Simoson , "Java Programing From the Group Up" ,Tata McGraw-Hill
2. Grady Booch, Object Oriented Analysis and Design ;
3. Jaime Nino, Frederick A. Hosch, 'An introduction to Programming and Object Oriented Design using Java', Wiley Student Edition.

Reference Books:

1. Java: How to Program, 8/e, Dietal, Dietal, PHI
2. Grady Booch, James Rumbaugh, Ivar Jacobson, "The Unified Modeling Language User Guide", Pearson Education
3. Sachin Malhotra, Saurabh Chaudhary "Programming in Java", Oxford University Press, 2010

Subject Code	Subject Name	Credits
CSC303	**Data Structures (DS)**	5

Course Objectives

1. To teach efficient storage mechanisms of data for an easy access.
2. To design and implementation of various basic and advanced data structures.
3. To introduce various techniques for representation of the data in the real world.
4. To develop application using data structures.
5. To teach the concept of protection and management of data.
6. To improve the logical ability

Course Outcomes

1. Student will be able to choose appropriate data structure as applied to specified problem definition.
2. Student will be able to handle operations like searching, insertion, deletion, traversing mechanism etc. on various data structures.
3. Students will be able to apply concepts learned in various domains like DBMS, compiler construction etc.
4. Students will be able to use linear and non-linear data structures like stacks , queues , linked list etc.

Module	Detailed content	Hours
01	**Introduction to Data Structure** Types of Data Structure, Arrays, Strings, Recursion, ADT (Abstract Data type),Concept of Files,Operations with files, types of files	05
	Linear Data Structure	
02	**Linked List** Linked List as an ADT, Linked List Vs. Arrays, Memory Allocation & De-allocation for a Linked List, Linked List operations, Types of Linked List, Implementation of Linked List, Application of Linked List-polynomial, sparse matrix.	10
03	**STACK** The Stack as an ADT, Stack operation, Array Representation of Stack, Link Representation of Stack, Application of stack – Recursion, Polish Notation	04
04	**Queues** The Queue as an ADT, Queue operation, Array Representation of Queue, Linked Representation of Queue, Circular Queue, Priority Queue, & De-queue, Application of Queues – Johnsons Algorithm, Simulation	05

Non-linear Data Structure		
05	**Trees** Basic trees concept, Binary tree representation,Binary tree operation, Binary tree traversal, Binary search tree implementation, Thread Binary tree, The Huffman Algorithm, Expression tree, Introduction to Multiway search tree and its creation(AVL, B-tree, B+ tree)	10
06	**Graphs** Basic concepts, Graph Representation, Graph traversal (DFS & BFS)	04
Sorting AND Searching		
07	**Sorting :** Sort Concept, Shell Sort, Radix sort, Insertion Sort, Quick Sort, Merge Sort,Heap Sort, **Searching :** List Search,Linear Index Search, Index Sequential Search Hashed List Search, Hashing Methods , Collision Resolution	10

Text Books:

1. Data Structures A Psedocode Approach with C, Richard F. Gilberg & Behrouz A. Forouzan, second edition, CENGAGE Learning.
2. Data Structures using C, Reema Thareja, Oxford University press.
3. 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 Using C, ISRD Group, Second Edition, Tata McGraw-Hill
3. Data Structure Using C, Balagurusamy
4. C & Data Structures, Prof. P.S. Deshpande, Prof. O.G. Kakde, Dreamtech press.
5. Data Structures, Adapted by: GAV PAI, Schaum's Outlines

Termwork:

Term work should consist of at least 12 experiments.
Journal must include at least 2 assignments.
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 marks) = 15 Marks (Experiment) + 5 Marks (Assignment) + 5 (Attendance (theory+practical))
Practical exam will be based on the above syllabus.

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Suggested Experiments:

Note: Students are required to complete 12 experiments. The star (*) marks experiments are mandatory.

Linked List
• Implementations of Linked Lists menu driven program. • * Implementation of different operations on linked list – copy, concatenate, split, reverse, count no. of nodes etc • Representation of Sparse matrix using multilinked structure. Implementation of sparse matrix multiplication. • Implementation of polynomials operations (addition, subtraction) using Linked List. • Implementations of Linked Lists menu driven program (stack and queue) • Implementations of Double ended queue using Linked Lists. • Implementation of Priority queue program using Linked Lis
Stack
• Implementations of stack menu driven program • Implementation of multistack in one array. • * Implementations of Infix to Postfix Transformation and its evaluation program. • Implementations of Infix to Prefix Transformation and its evaluation program. • Simulation of recursion
Queue
• Implementations of circular queue menu driven program • * Implementations of double ended queue menu driven program • Implementations of queue menu driven program • Implementation of Priority queue program using array. • Implementation of Johnsons Algorithm • Implementation of Simulation Problem
Tree

• *Implementations of Binary Tree menu driven program • Implementation of Binary Tree Traversal program. • *Implementation of construction of expression tree using postfix expression. • Implementations of Huffman code construction • Implementations of BST program • Implementation of various operations on tree like – copying tree, mirroring a tree, counting the number of nodes in the tree, counting only leaf nodes in the tree. • Implementations of B-tree menu driven program • Implementations of B+ tree program • Implementation of Preorder traversal of a threaded binary tree. • Implementations of AVL Tree menu driven program
Sorting
• *Implementations of Shell sort, Radix sort and Insertion sort menu driven program • Implementations of Quick Sort, Merge sort and Heap Sort menu driven program
Searching
• *Implementations of searching methods (Index Sequential, Interpolation Search) menu driven program • Implementation of hashing functions with different collision resolution techniques
Graph
• * Implementations of Graph menu driven program (DFS & BSF)

Subject Code	Subject Name	Credits
CSC304	Digital Logic Design and Analysis	4

Course Objective:

1. To provide concepts that underpins the disciplines of digital electronics and microprocessor systems.
2. To provide the concept of modeling Combinational and sequential circuits.
3. To provide basic knowledge of how digital building blocks are described in VHDL.

Course Outcomes:

1. Binary and hexadecimal calculations and conversions.
2. Designing of combinational circuits.
3. Design synchronous and asynchronous sequential circuits.
4. Translate real world problems into digital logic formulations.
5. Construct test and debug digital networks using VHDL.
6. Learners will show awareness about TTL and CMOC Logic

Module	Detailed Contents	Hours
1	Number Systems and Codes: Revision of Binary, Octal, Decimal and Hexadecimal number Systems and their conversion, Binary Addition and Subtraction (1's and 2's complement method), Gray Code, BCD Code, Excess-3 code, ASCII Code, Error Detection and Correction Codes.	05
2	Boolean Algebra and Logic Gates: Theorems and Properties of Boolean Algebra, Standard SOP and POS form, Reduction of Boolean functions using Algebric method, K -map method (2,3,4 Variable), and Quine-McClusky Method. NAND-NOR Realization. Basic Digital Circuits: NOT,AND,OR,NAND,NOR,EX-OR,EX-NOR Gates, Logic Families: Terminologies like Propagation Delay, Power Consumption , Fan in and Fan out etc. with respect to TTL and CMOS Logic and comparison.	10
3	Combinational Logic Design: Introduction, Half and Full Adder, Half and Full Subtractor, Four Bit Binary Adder, one digit BCD Adder, Four Bit Binary Subtractor (1's and 2's compliment method), code conversion, Multiplexers and Demultiplexers, Decoders, One bit, Two bit ,4-bit Magnitude Comparator .	08
4	Sequential Logic Design: Concept of Multivibrators: Astable, Monostable and Bistable multivibrators, Flip Flops:SR, D, JK, JK	10

	Master Slave and T Flip Flop, Truth Tables and Excitation Tables, Flip-flop conversion. sequential circuit analysis , construction of state diagrams. Counters: Design of Asynchronous and Synchronous Counters, Modulo Counters, UP- DOWN counter . Shift Registers: SISO, SIPO,PIPO,PISO, Bidirectional Shift Register , Universal Shift Register, Ring and Johnson Counter. Pseudorandom sequence generator.	
5	Functional Simulation , Timing Simulation, Logic synthesis, Introduction to VHDL, Framework of VHDL program(Syntax and programming to be done only during Practicals), Introduction to CPLD and FPGA	03

Text Books:

1. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill.
2. Yarbrough John M. , "Digital Logic Applications and Design ", Cengage Learning
3. J. Bhasker." VHDL Primer", Pearson Education

Reference Books:

1. M. Morris Mano, "Digital Logic and computer Design", PHI.
2. Douglas L. Perry, "VHDL Programming by Example", Tata McGraw Hill.
3. Donald p Leach, Albert Paul Malvino,"Digital principles and Applications",Tata McGraw Hill.

Termwork:

Term work should consist of at least 12 experiments out of which at least 2 to be VHDL based.
Journal must include at least 2 assignments.
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 marks) = 15 Marks (Experiment) + 05 Marks (Assignment) + 05 (Attendance (theory+practical))

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Subject Code	Subject Name	Credits
CSC305	Discrete Structures	4

Course Objectives

1. To assimilate discrete mathematical concepts.
2. Introducing discrete maths as basic foundation of analysis and applications like communication,

Course Outcomes

1. Ability to reason logically.
2. Ability to understand use of functions, graphs and trees in programming applications.
3. Understand use of groups and codes in Encoding-Decoding.
4. Express recursive functions of other subjects like Data Structures as recurrence relation.

Module	Detailed content	Hours
01	**Set Theory** • Sets, Venn diagrams, Operations on Sets • Laws of set theory, Power set and Products • Partitions of sets, The Principle of Inclusion and Exclusion	**05**
02	**Logic** • Propositions and logical operations, Truth tables • Equivalence, Implications • Laws of logic, Normal Forms • Predicates and Quantifiers • Mathematical Induction	**06**
03	**Relations, Digraphs and Lattices** • Relations, Paths and Digraphs • Properties and types of binary relations • Manipulation of relations, Closures, Warshall's algorithm • Equivalence and partial ordered relations • Posets and Hasse diagram • Lattice	**08**

04	**Functions and Pigeon Hole Principle** • Definition and types of functions: Injective, Surjective and Bijective • Composition, Identity and Inverse • Pigeon-hole principle	**06**
05	**Generating Functions and Recurrence Relations** • Series and Sequences • Generating functions • Recurrence relations • Recursive Functions: Applications of recurrence relations e,g, Factorial, Fibonacci, Binary search, Quick Sort etc.	**06**
06	**Graphs and Subgraphs** • Definitions, Paths and circuits: Eulerian and Hamiltonian • Planer graphs, Graph coloring • Isomorphism of graphs • Subgraphs and Subgraph isomorphism	**06**
07	**Trees** • Trees and weighted trees • Spanning trees and minimum spanning tree • Isomorphism of trees and sub trees • Prefix codes	**05**
08	**Algebraic Structures** • Algebraic structures with one binary operation: semigroup, monoids and groups • Product and quotient of algebraic structures • Isomorphism, Homomorphism and Automorphism • Cyclic groups, Normal subgroups • Codes and group codes	**06**

Text Books:

1. Kenneth H. Rosen. ”Discrete Mathematics and its Applications”, Tata McGraw-Hill.
2. Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, “Discrete Mathematical Structures”, Pearson Education.
3. D. S. Malik and M. K. Sen, “Discrete Mathematical Structures”, Thompson.

References:

1. C. L. Liu, D. P. Mohapatra, “Elements of Discrete Mathematics” Tata McGrawHill.
2. J. P. Trembley, R. Manohar “Discrete Mathematical Structures with Applications to Computer Science”, Tata Mcgraw-Hill.
3. Y N Singh, “Discrete Mathematical Structures”, Wiley-India.

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Subject Code	Subject Name	Credits
CSC306	Electronic Circuits and Communication Fundamentals	05

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 make students aware of various types of integrated circuits that can be used in computer applications.
4. To make students aware that knowledge gained in electronic devices and circuits is useful in real life applications.

Course Outcomes:

1. Ability to understand and use semiconductor devices in circuits.
2. Ability to analyze the given circuit.
3. Ability to understand field effect devices and carry out their DC analysis.
4. Ability to understand concept of feedback and oscillations.
5. Ability to use oscillators in various applications.
6. Ability to use operational amplifier in various applications.
7. Ability to understand concept of phase lock loop and their use communication applications.
8. Ability to understand fundamental concepts of communication.
9. Ability to apply knowledge of electronic devices and circuits to communication applications.

Module	Detailed content	Hours
01	**Electronic Circuits** • Field effect based devices and circuits: • Junction Field Effect Transistors, JFET Characteristics, • FET amplification and switching, • DC load line and bias point, ate bias, self bias, voltage divider bias, coupling, bypassing and AC load lines, • FET models and parameters, • Common source circuit analysis principle of oscillation, • FET based Hartley and Colpitts Oscillator. • Crystal oscillator • BJT as power amplifier (only class A and C)	12
02	• Operational Amplifier and its applications: • Op-amp parameters and characteristics, • Inverting and Non-inverting amplifier, • Comparator, • Summing Amplifier, • Integrator, • Differentiator, • Zero Crossing Detector. • Phase Lock Loop: • Operating principle of PLL, • Lock range and capture range.	06

03	**Modulation** • Principles of Analog Communication: • Elements of analog communication systems, • Theory of amplitude modulation and types of AM, • Generation of DSB SC using balanced modulator, • Generation of SSB using phase shift method • Theory of FM and PM, • Generation of FM by Armstrong method	12
04	**Demodulation :** • Principle of super heterodyne receiver. • Foster seely detector for FM detection • Application of PLL (IC 565) as FM detector , Frequency translator, Phase shifter, and freq synthesizer	06
05	• Concept of sampling :Sampling Theorem, Types of sampling Quantization , A/D and D/A conversion concept • Pulse Modulation: generation and detection of PAM, PPM, PWM, PCM, DM and ADM.Principle of TDM and FDM.	12

Text Books:

1. David Bell, 'Electronic Devices and Circuits', Oxford, 5th Edition.
2. Wayne Tomasi 'Electronic Communication Systems (fundamentals through advanced)', Pearson Education, 4th Edition.
3. Ramakant A. Gayakwad, 'Op-amp and linear integrated circuits', PHI, 3rd edition.
4. G. Kennedy, B. Davis, S R M Prasanna, 'Electronic Communication Systems', Mc Graw Hill, 5th Edition.

References:

1. Robert Diffenderfer, 'Electronic Devices: Systems & Applications', Cengage Learning, India Edition.
2. K. R. Botkar, 'Integrated Circuits', Khanna Publishers, 9th Edition
3. Donald Neamen, 'Electronic Circuit Analysis and Design', Tata McGraw Hill,2nd Edition.
4. David Bell, 'Electronic Devices and Circuits', Oxford, 5th Edition.
5. Wayne Tomasi 'Electronic Communication Systems (fundamentals through advanced)', Pearson Education, 4th Edition.
6. Ramakant A. Gayakwad, 'Op-amp and linear integrated circuits', PHI, 3rd edition.
7. G. Kennedy, B. Davis, S R M Prasanna, 'Electronic Communication Systems', Mc Graw Hill, 5th Edition.
8. Robert Diffenderfer, 'Electronic Devices: Systems & Applications', Cengage Learning, India Edition.
9. K. R. Botkar, 'Integrated Circuits', Khanna Publishers, 9th Edition
10. Donald Neamen, 'Electronic Circuit Analysis and Design', Tata McGraw Hill,2nd Edition.

Termwork:

Term work should consist of at least 08 experiments.
Journal must include at least 2 assignments.
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 marks) = 15 Marks (Experiment) + 5 Marks (Assignment) + 5 (Attendance (theory+practical))
Oral exam will be based on the above syllabus.

Suggested List of Experiments:

1. Study of various test and measuring instruments
2. Implementation of diode detector
3. Implementation of single stage FET amplifier
4. Implementation of oscillators
5. Implementation of IC 741 based application
6. Implementation of IC741 based active filters
7. Implementation of IC555 based application
8. Troubleshooting of given faults
9. Modulation and demodulation of AM/SSB/FM
10. Study of superheterodyne receiver
11. Generation and detection of PAM/PPM/PWM
12. Generation and detection of PCM/DM/ADM
13. Study of FDM and TDM
14. SPICE based simulations

Important Note:

- **50% experiments from communication and 50% experiments from electronic circuits should be taken.**
- **In theory exam the weightage for marks out of 80 : 35 for Devices and 45 for communications**

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Subject Code	Subject Name	Credits
CSC401	Applied Mathaematics IV *	05

Course Objectives:

This course will present matrix theory, Similar matrices and it's application to find the matrics function. Present methods of computing and using eigen values and eigen vectors. Set up and directly evaluate contour integrals Cauchys integral theorem and formula in basic and extended form. Present Taylor and Laurents series to find singularities zero's and poles also presents residues theory and it's applications. Present theory of probability, Baye's Theorem, Expectation and Moments and it's application. Present probability distribution such as binomial, Poisson and normal distribution with their properties. Present sampling theory and it's application for small and large sample. Present methods of computing optimization using simplex method.

Course Outcomes:

Students in this course will apply the method of solving complex integration and computing residues. Use residues to evaluate various contour integrals. Demonstrate ability to manipulate matrices and compute eigen values and eigenvectors.

Students in this course will apply the Procedure and methods to solve technical problems.

Module **01**	**Complex Integration** 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 $\int_0^{2\Pi} f(\sin\theta,\cos\theta)\,d\theta, \int_{-\infty}^{\infty} f(x)\,dx$.	**(10)**
02	**Matrices:-** 2.1 Eigen values and eigen vectors 2.2 Cayley-Hamilton theorem(without proof) 2.3 Similar matrices, diagonalisable of matrix. 2.4 Derogatory and non-derogatory matrices ,functions of square matrix.	**(08)**
03	**Correlation** 3.1Scattered diagrams, Karl Pearson's coefficient of correlation, covariance,	**(04)**

	Spearman's Rank correlation. 3.2 Regression Lines.	
04	**Probability** 4.1 Baye's Theorem, 4.2 Random Variables:- discrete & continuous random variables, expectation, Variance, Probability Density Function & Cumulative Density Function. 4.3 Moments, Moment Generating Function. 4.4 Probability distribution: binomial distribution, Poisson & normal distribution. (For detail study)	**(10)**
05	**Sampling theory** 5.1 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. 5.2 Test of significant of small samples:- Students t- distribution for dependent and independent samples. 5.3 Chi square test:- Test of goodness of fit and independence of attributes, Contingency table.	**(08)**
06	**Mathematical Programming** 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, Dual simplex method. 6.4 Non Linear Programming:-Problems with equality constrains and inequality constrains (No formulation, No Graphical method).	**(08)**

Term work:

Term work shall consist of minimum four SCILAB practicals and six tutorials.

SCILAB practicals	:	10 marks
Tutorials	:	10 marks
Attendance	:	05 marks
Total	**:**	**25 marks**

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.

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Subject Code	Subject Name	Credits
CSC402	Analysis of Algorithm	5

Prequisites : Students should be familiar with Data structure concepts , Discrete structures

Course Objectives:

1. To teach various problem solving strategies..
2. To teach mathematical background for algorithm analysis and implementation of various strategies like divide and conquer, Greedy method, Dynamic programming , Backtracking , branch and bound
3. To teach different string matching algorithms.

Course Outcomes:

1. Ability to select appropriate problem solving strategies.
2. Ability to calculate time complexity and space complexity of an algorithm.
3. Ability to analyze different divide and conquer problems.
4. Ability to analyze different greedy method problems.
5. Ability to analyze different dynamic programming problems.
6. Ability to analyze different backtracking problems.
7. Ability to analyze different string matching algorithms.

Module	Detailed Content	Hrs.
1	**Introduction to analysis of algorithm** • Decision and analysis fundamentals • 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 • Randomized algorithms • Recursive algorithms • The substitution method • Recursion tree method • - Master method	**11**
2	**Divide and Conquer** • General method • Binary search • Finding minimum and maximum • Merge sort analysis • Quick sort analysis • Strassen’s matrix multiplication • The problem of multiplying long integers	**07**

	• - constructing Tennis tournament	
3	**Greedy Method** • General Method • Knapsack problem • Job sequencing with deadlines • Minimum cost spanning trees-Kruskal and prim's algorithm • Optimal storage on tapes • - Single source shortest path	**07**
4	**Dynamic Programming** • General Method • Multistage graphs • all pair shortest path • single source shortest path • Optimal binary search tree • 0/1 knapsack • Travelling salesman problem • - Flow shop scheduling	**08**
5	**Backtracking** • General Method • 8 queen problem(N-queen problem) • Sum of subsets • - Graph coloring	**05**
6	**String Matching Algorithms** • The naïve string matching Algorithms • The Rabin Karp algorithm • String matching with finite automata • The knuth-Morris-Pratt algorithm • - Longest common subsequence algorithm	**06**
7	**Branch and bound** • General method • 15 puzzle problem • Travelling salesman problem	**04**

Text Books:

1. Ellis horowitz , sartaj Sahni , s. Rajsekaran. "Fundamentals of computer algorithms" University Press.
2. T.H.coreman , C.E. Leiserson,R.L. Rivest, and C. Stein, "Introduction to algorithms", 2nd edition , PHI publication 2005.
3. Alfred v. Aho , John E. Hopcroft , Jeffrey D. Ullman , "Data structures and Algorithm" Pearson education , fourth impression 2009

Reference books:

1. Michael Gooddrich & Roberto Tammassia, "Algorithm design foundation, analysis and internet examples", Second edition , wiley student edition.

Suggested Practicals:

Implementations Programing Language must be in 'C' only.

Module no	Module name	Suggested Experiment list
1	**Introduction to analysis of algorithm:**	selection sort insertion sort (for this experiment comparative analysis on the basis of comparison required to sort list is expected for large values of n)
2	**Divide and Conquer**	-binary search -finding minimum and maximum **-Merge sort analysis*** **-Quick sort analysis*** (the above two experiments marked as * should be considered as single experiment. For this experiment comparative analysis on the basis of comparisons required to sort list is expected for large values of n) -Strassen's matrix multiplication -The problem of multiplying long integers **-constructing Tennis tournament***
3	**Greedy Method**	**-Knapsack problem*** -Job sequencing with deadlines **-Minimum cost spanning trees-Kruskal and prim's algorithm*** -Optimal storage on tapes -Single source shortest path
4	**Dynamic Programming**	-Multistage graphs -all pair shortest path -single source shortest path **-Optimal binary search tree*** -0/1 knapsack **-Travelling salesman problem*** -Flow shop scheduling
5	**Backtracking**	**-8 queen problem(N-queen problem)*** -Sum of subsets -Graph coloring -Knapsack problem
6	**String Matching Algorithms**	-The naïve string matching Algorithms -The Rabin Karp algorithm -String matching with finite automata -The knuth-Morris-Pratt algorithm **-Longest common subsequence algorithm***
7	**Branch and bound**	**-15 puzzle problem*** -Travelling salesman problem

Termwork:

Total experiments to be performed are 12 = (9 + 3)   9 Experiments marked * are mandatory.

For additional 3 experiments teacher can choose experiments from **suggested list.**

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

Termwork: 25 Marks (total marks) = 15 Marks Experiments + 05 Marks Assignment + 5 (Attendance (theory+practical))

Practical Exam will be based on above syllabus

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Subject Code	Subject Name	Credits
CSC403	Computer Organization and Architecture*	05

Course Objectives:

1. To conceptualize the basics of organizational and architectural issues of a digital computer.
2. To analyze performance issues in processor and memory design of a digital computer.
3. To understand various data transfer techniques in digital computer.
4. To analyze processor performance improvement using instruction level parallelism

Course Outcomes:

1. Ability to understand basic structure of computer.
2. Ability to perform computer arithmetic operations.
3. Ability to understand control unit operations.
4. Ability to design memory organization that uses banks for different word size operations.
5. Ability to understand the concept of cache mapping techniques.
6. Ability to understand the concept of I/O organization.
7. Ability to conceptualize instruction level parallelism.

Pre-requistes: Fundamentals of Computer, Digital Logic Circuits, Programming Languages (C, C++, Java)

Module	Detailed Contents	Hours
1	**Overview of Computer Architecture & Organization:** • Introduction of Computer Organization and Architecture. • Basic organization of computer and block level description of the functional units. • Evolution of Computers, Von Neumann model. • Performance measure of Computer Architecture. • Introduction to buses and connecting I/O devices to CPU and Memory, bus structure.	04
2	**Data Representation and Arithmetic Algorithms:** • Number representation: Binary Data representation, two's complement representation and Floating-point representation. IEEE 754 floating point number representation. • Integer Data computation: Addition, Subtraction. Multiplication: Signed multiplication, Booth's algorithm.	10

	• Division of integers: Restoring and non-restoring division • Floating point arithmetic: Addition, subtraction	
3	**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 RISC and CISC architectures and design issues. • Case study on 8085 microprocessor: Features, architecture, pin configuration and addressing modes.	12
4	**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. • Virtual Memory: Concept, Segmentation and Paging , Page replacement policies.	12
5	**I/O Organization and Peripherals:** • Input/output systems, I/O modules and 8089 IO processor. • Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA. • Peripheral Devices: Introduction to peripheral devices, scanner, plotter, joysticks, touch pad.	6
6	**Introduction to parallel processing systems:** • Introduction to parallel processing concepts • Flynn's classifications • pipeline processing • instruction pipelining, • pipeline stages • pipeline hazards.	4

Text Books:

1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization”, Fifth Edition, Tata McGraw-Hill.
2. John P. Hayes, “Computer Architecture and Organization”, Third Edition.
3. William Stallings, “Computer Organization and Architecture: Designing for Performance”, Eighth Edition, Pearson.
4. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, Tata McGraw-Hill.

Reference Books:

1. Dr. M. Usha, T. S. Srikanth, “Computer System Architecture and Organization”,First Edition, Wiley-India.
2. “Computer Organization” by ISRD Group, Tata McGraw-Hill.
3. Ramesh Gaonkar, “Microprocessor Architecture, Programming and Applications with the 8085, Fifth Edition,Penram.

Termwork:

Term work should consist of at least 08 experiments.
Journal must include at least 2 assignments.
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 marks) = 15 Marks (Experiment) + 5 Marks (Assignment) + 5 (Attendance (theory+practical))

oral exam will be based on the above syllabus.

Note:
1. The faculty should conduct eight programming practical / experiments based on the above syllabus including two case studies on recent developments covering the above contents.
All the programs should be implemented in C/C++/Java under Windows or Linux environment.
Experiments can also be conducted using available open source tools.
2. 8085 microprocessor should be included only as a sample case study to visualize the concepts. No questions in University Exams / Class Tests should be asked on 8085 microprocessor.

SUGGESTED LIST OF COA PRACTICAL / EXPERIMENTS

1. To study Full Adder (7483).

2. To study ALU (74181).

3. To study MASM (Micro Assembler).

4. A program for hexadecimal addition and multiplication.

5. A program for binary multiplication.

6. A program for Hamming code generation , detection and correction.

7. A program for Booth's multiplication

8. A program for LRU page replacement algorithm.

9. A program for FIFO page replacement algorithm.

10. A program to simulate the mapping techniques of Cache memory.

    10.1 Direct Mapped cache
    10.2 Associative Mapped cache
    10.3 Set Associative Mapped cache

11. A program to simulate memory allocation policies.

    11.1 First-fit algorithm
    11.2 Best-fit algorithm

12. A program to implement serial communication (PC - PC communication).

13. A program to implement parallel communication. (PC - Printer communication).

14. A program for printer simulation.

15. A program for keyboard simulation.

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Subject Code	Subject Name	Credits
CEC404	Database Management System	05

Course Objectives:

1. Learn and practice data modeling 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:

1. The learner will be able:
2. To describe data models and schemas in DBMS
3. To understand the features of database management systems and Relational database.
4. To use SQL- the standard language of relational databases.
5. To understand the functional dependencies and design of the database.
6. To understand the concept of Transaction and Query processing.

Module	Detailed content	Hours
1	**Introduction Database Concepts:** Introduction, Characteristics of databases, File system V/s Database system, Users of Database system, Concerns when using an enterprise database, Data Independence, DBMS system architecture, Database Administrator,	04
2	**Entity–Relationship Data Model :** Introduction, Benefits of Data Modeling, Types of Models, Phases of Database Modeling, The Entity-Relationship (ER) Model, Generalization, Specialization and Aggregation, Extended Entity-Relationship (EER) Model.	04
3	**Relational Model and Algebra :** Introduction , Mapping the ER and EER Model to the Relational Model , Data Manipulation , Data Integrity ,Advantages of the Relational Model, Relational Algebra , Relational Algebra Queries, Relational Calculus.	08
4	**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, Nested	09

	and complex queries .	
5	**Integrity and Security in Database:** Domain Constraints, Referential integrity, Assertions, Trigger, Security, and authorization in SQL	04
6	**Relational–Database Design :** Design guidelines for relational schema, Function dependencies, Normal Forms- 1NF, 2 NF, 3NF, BCNF and 4NF	06
7	**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 , Timestamp-based , Validation-based protocols, Deadlock handling, Recovery System: Failure Classification, Storage structure, Recovery & atomicity, Log based recovery, Shadow paging.	08
8	**Query Processing and Optimization: Overview** ,Issues in Query Optimization ,Steps in Query Processing , System Catalog or Metadata, Query Parsing , Query Optimization, Access Paths , Query Code Generation , Query Execution , Algorithms for Computing Selection and Projection , Algorithms for Computing a Join , Computing Aggregation Functions , Cost Based Query Optimization .	05

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 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 Mark L. Gillenson, Paulraj Ponniah, " Introduction to Database Management",Wiley
2. Sharaman Shah ,"Oracle for Professional", SPD.
3. Raghu Ramkrishnan and Johannes Gehrke, " Database Management Systems",TMH
4. Debabrata Sahoo "Database Management Systems" Tata McGraw Hill, Schaum's Outline

Termwork:

Term work should consist of at least 12 experiments.
Journal must include at least 2 assignments.
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 marks) = 15 Marks (Experiment) + 5 Marks (Assignment) + 5 (Attendance (theory+practical))
practical exam will be based on the above syllabus.

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.

3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Subject Code	Subject Name	Credits
CSC405	Theoretical Computer Science	4

Course Objectives:

1. Conceptual understanding of fundamentals of Grammars and languages.
2. Build concepts of theoretical design of basic machine, deterministic and non deterministic machines and pushdown machines.
3. Develop understanding of different types of Turing machines and their use.
4. Understand the concept of Undecidability.

Course Outcomes:

1. Understanding of Power and Limitations of theoretical models of Computation.
2. Ability to compare different types of languages and machines.
3. Ability to match constraints of a language to power of machines.

Module	Detailed content	Hours
01	**Introduction:** • Alphabets, Strings and Languages • Chomskey hierarchy and Grammars. • Finite Automata (FA) and Finite State machine (FSM).	**03**
02	**Regular Grammar (RG):** • Regular Grammar and Regular Expression (RE): Definition, Equivalence and Conversion from RE to RG and RG to RE. • Equivalence of RG and FA, Converting RG to FA and FA to RG. • Equivalence of RE and FA, Converting RE to FA and FA to RE.	**04**
03	**Finite Automata:** • Deterministic and Nondeterministic Finite Automata (DFA and NFA): Definitions, Languages, Transitions (Diagrams, Functions and Tables). • Eliminating epsilon-transitions from NFA.	**05**

	• DFA, NFA: Reductions and Equivalence. • FSM with output: Moore and Mealy machines.	
04	**Regular Language (RL):** • Decision properties: Emptiness, Finiteness and Membership. • Pumping lemma for regular languages and its applications. • Closure properties. • Myhill-Nerode Theorem and An application: Text Search.	**04**
05	**Context Free Grammars (CFG):** • Definition, Sentential forms, Leftmost and Rightmost derivations. • Context Free languages (CFL): Parsing and Ambiguity. • CFLs: Simplification and Applications. • Normal Forms: CNF and GNF. • Pumping lemma for CFLs and its applications. • Closure properties and Kleene's closure.	**06**
06	**Pushdown Automata(PDA):** • Definition, Transitions (Diagrams, Functions and Tables), Graphical Notation and Instantaneous Descriptions. • Language of PDA, Pushdown Stack Machine (PSM) as a machine with stack, Start and Final state of PSM. • PDA/PSM as generator, decider and acceptor of CFG • Deterministic PDA (DPDA) and Multi-stack DPDA.	**08**
07	**Turing Machine (TM):** • Definition, Transitions (Diagrams, Functions and Tables). • Design of TM as generator, decider and acceptor. • Variants of TM: Multitrack, Multitape and Universal TM. • Equivalence of Single and Multi Tape TMs. • Power and Limitations of TMs. • Design of Single and Multi Tape TMs as a computer of simple functions: Unary, Binary (Logical and Arithmetic), String operations (Length, Concat, Match, Substring Check, etc)	**10**

08	**Undecidability and Recursively Enumerable Languages:** • Recursive and Recursively Enumerable Languages. • Properties of Recursive and Recursively Enumerable Languages. • Decidability and Undecidability, Halting Problem, Rice's Theorem, Grebach's Theorem, Post Correspondence Problem, • Context Sensitivity and Linear Bound Automata.	**06**
09	**Comparison of scope of languages and machines:** • Subset and Superset relation between FSM, PSM and TM. • Subset and Superset relation between RL, CFL and Context Sensitive Language.	**02**

Text Books:

1. Michael Sipser, " Theory of Computation", Cengage learning.
2. John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, " Introduction to Automata Theory, Languages and Computation", Pearson Education

References:

1. J. C. Martin, "Introduction to Languages and the Theory of Computation", Tata McGrawHill.
2. Krishnamurthy E. V., "Introductory Theory of Computer Science", East-West Press.
3. Kavi Mahesh, "Theory of Computation: A Problem Solving Approach", Wiley-India.

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Subject Code	Subject Name	Credits
CSC406	Computer Graphics	04

Course Educational Objectives:

1. The main objective is to introduce to the students in the graphics mode, with the help of basic algorithms and methodologies .
2. The objective of the course is to equip students with fundamental knowledge and basic technical competence in the field of computer graphics.
3. Provide an understanding of how a computer draws the fundamental graphics primitives.
4. To learn Computer Graphics methodologies/Algorithms and techniques .
5. To learn Implementation of Computer Graphics Algorithms

Course Outcomes:

Upon successfully completing Fundamentals of Computer graphics course, students will have, at a minimum, the qualities listed in the expected learning outcomes below.

1. Student will have understood basic concepts of computer graphics
2. Acquire knowledge about drawing basic shapes such as lines, circle ellipse, polygon.
3. Shall be able to perform processing of basic shapes by various processing algorithms /techniques.
4. Acquire knowledge about two and three dimensional transformations.
5. Shall be able to apply the transformation algorithms to the basic shapes.
6. Shall have basic knowledge of windowing and clipping.
7. Shall be able to apply various algorithms of clipping.
8. Acquire knowledge about Visible Surface Detection methods
9. Acquire knowledge about Illumination Models and Surface Rendering
10. Acquire knowledge about Color Models

Module	Contents	Hours
1.	**Introduction to Computer Graphics** (a) What is Computer Graphics? (b) Where Computer Generated pictures are used (c) Elements of Pictures created in Computer Graphics (d) Graphics display devices (e) Graphics input primitives and Devices	**(02)**
2.	**Introduction to openGL** (a) Getting started Making pictures	**(02)**

	(b) Drawing basic primitives (c) Simple interaction with mouse and keyboard (**For implementation use openGL programming**)	
3.	**Output Primitives** (a) Points and Lines, Antialiasing (b) Line Drawing algorithms • DDA line drawing algorithm • Bresenham's drawing algorithm • Parallel drawing algorithm (c) Circle and Ellipse generating algorithms • Mid-point Circle algorithm • Mid-point Ellipse algorithm (d) Parametric Cubic Curves • Bezier curves • B-Spline curves	**(06)**
4.	**Filled Area Primitives** (a) Scan line polygon fill algorithm (b) Pattern fill algorithm (c) Inside-Outside Tests (d) Boundary fill algorithms (e) Flood fill algorithms	**(02)**
5.	**2D Geometric Transformations** (a) Basic transformations (b) Matrix representation and Homogeneous Coordinates (c) Composite transformation (d) Other transformations (e) Transformation between coordinated systems	**(04)**
6.	**2D Viewing** (a) Window to Viewport coordinate transformation (b) Clipping operations – Point clipping (c) Line clipping • Cohen – Sutherland line clipping • Liang – Barsky line clipping • Midpoint subdivision (d) Polygon Clipping • Sutherland – Hodgeman polygon clipping • Weiler – Atherton polygon clipping	**(04)**
7.	**3D Geometric Transformations and 3D Viewing** (a) 3D object representation methods B-REP , sweep representations , CSG (b) Basic transformations • Translation • Rotation	**(06)**

	• Scaling (c) Other transformations 1. Reflection 2. Rotation about an arbitrary axis (d) Composite transformations (e) Projections – Parallel and Perspective (f) 3D clipping	
8.	**3D Geometric Transformations and 3D Viewing** (a) Classification of Visible Surface Detection algorithm (b) Back Surface detection method (c) Depth Buffer method (d) Scan line method (e) BSP tree method (f) Area Subdivision method	**(04)**
9.	**Illumination Models and Surface Rendering** (a) Basic Illumination Models (b) Halftone and Dithering techniques (c) Polygon Rendering Constant shading , Goraud Shading , Phong Shading	**(03)**
10.	**11. Fractals** (a) Introduction (b) Fractals and self similarity Successive refinement of curves, Koch curve, Fractional Dimension, (c) String production and peano curves **(For implementation use C Programming)**	**(03)**

The journal should consist of 12 experiments and 3 assignments.

Following is the list of compulsory 10 experiments.

Additional 2 experiments can be implemented relevant to the course

1. Drawing the basic primitives and sierpinsky gasket using openGL*.
2. Create a polyline using mouse interaction using openGL*.
3. Bresenham's line drawing algorithm.
4. Mid-Point ellipse drawing algorithm.
5. Implementing Bezier curve.
6. Scanline fill algorithm.
7. 2D transformations.
8. Any one Line clipping algorithm cohen-sutherland / liang barsky.
9. Polygon Clipping algorithm sutherland hodgeman.
10. Any one Fractal generation (Koch curve / Hilbert curve / peano curves using string production)

***Implementation of experiments 1 and 2 must be in openGL.**
Implementation of experiments 3 to 10 must be done in C language.

Termwork:

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 marks) = 15 Marks (Experiment) + 5 Marks (Assignment) + 5 (Attendance (theory+practical))

Practical Exam will be based on above syllabus

TEXT BOOKS

1. Donald D. Hearn & M. Pauline Baker, " Computer Graphics-C Version", 2nd Edition, Pearson Education, 2002, ISBN 81-7808-794-4
2. F.S.Hill , Jr. , "Computer Graphics using OpenGL" , second edition PHI publication.
3. James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice, 2nd Edition in C, Audison Wesley, ISBN – 981-235-974-5
4. William M. Newman, Roberet F. Sproull, " Principles of Interactive Computer Graphics", Second Edition, Tata McGraw-Hill Edition

REFERENCE BOOKS

1. Rajesh K. Maurya, "Computer Graphics", 1st Edition, Wiley India Publication ISBN 978-81-265-3100-4.
2. Amarendra N Sinha, Arun D Udai, "Computer Graphics" ISBN 10: 0070034378, ISBN 13: 9780070634374, Tata McGraw-Hill Education, 2007.
3. Peter Shirley, Steve Marschner, A K Peters, "Fundamentals of Computer Graphics", 3rd Edition, A. K. Peters Ltd. , Natick, Massachusetts, Distributed by Shroff Publishers and Dist. Pvt. Ltd.
4. Zhigang Xiang, Roy A Plastock, " Computer Graphics", second edition, Shaum's Outlines, Tat McGraw Hill
5. David F. Rogers, "Procedural Elements for Computer Graphics", 2nd Edition, Tata McGraw-Hill Publications, 2001, ISBN 0-07-04-7371-4.

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

AC 7/6/2014
Item 4.26

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Computer Engineering (Third Year Year – Sem. V & VI),
Revised course
(REV- 2012) from Academic Year 2014 -15,
Under
FACULTY OF TECHNOLOGY
(As per Semester Based Credit and Grading System)

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) 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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble:

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the 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. 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.

The Program Educational Objectives finalized for undergraduate program in Computer Engineering are listed below:

1. To prepare Learner's with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To prepare Learner's to use effectively modern tools to solve real life problems
3. To equip Learner's with broad education necessary to understand the impact of computer Technology in a global and social context
4. To encourage , motivate and prepare Learner's for Lifelong-learning
5. To inculcate professional and ethical attitude, good leadership qualities and commitment to social responsibilities

In addition to above 2 to3 more program educational objectivesof their own may be added by affiliated Institutes.

The Program outcomes are the skils and ability that Learner will demonstrate upon completion of undergraduate degree program in Computer Engineering. Few may be listed as follows:

1. Ability to effectively apply knowledge of computing and mathematics to computer science problems.
2. Ability to design, implement and evaluate computer-based components, systems, processes or programs to meet desired needs and specifications.
3. Ability and skills to effectively use state-of-the-art techniques and computing tools for analysis, design, and implementation of computing systems.
4. Ability to function effectively as a member of a team assembled to undertake a common goal.
5. An understanding of professional, ethical, legal, security, and social issues and responsibilities.

6. Ability to communicate effectively to both technical and non-technical audiences.
7. The ability to successfully pursue professional development thru lifelong learning

In addition to Program Educational Objectives, for each course of undergraduate program,Course Objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

Dr. Prachi Gharpure

Chairperson, Adhoc Board of Studies in Computer Engineering,

University of Mumbai, Mumbai

Program Structure for B.E. Computer Engineering

Third Year (Computer)
(Semester V)

(REV 2012)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CPC501	Microprocessor	4	2	-	4	1	-	5
CPC502	Operating Systems	4	2	-	4	1	-	5
CPC503	Structured and Object Oriented Analysis and Design	4	2	-	4	1	-	5
CPC504	Computer Networks	4	2	-	4	1	-	5
CPL501	Web Technologies Laboratory	-	4	-	-	2	-	2
CPL502	Business Communication and Ethics*	-	2+ 2*	-	-	2		2
	Total	**16**	**16**	**-**	**16**	**8**	**-**	**24**

* 2 hours shown as Practicals to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			End Sem Exam	Exam Duration (in Hrs)	TW	Oral / Pract	Total
		Test 1	Test 2	Avg					
CPC501	Microprocessor	20	20	20	80	03	25	25 (prac)	150
CPC502	Operating Systems	20	20	20	80	03	25	25 (prac)	150
CPC503	Structured and Object Oriented Analysis and Design	20	20	20	80	03	25	25 (oral)	150
CPC504	Computer Networks	20	20	20	80	03	25	25 (pract)	150
CPL501	Web Technologies Laboratory	-	-	-	-	-	25	50 (oral)	75
CPL502	Business Communication and Ethics	-	-	-	-	-	50	-	50
	Total	**-**	**-**	80	320		175	150	725

Program Structure for B.E. Computer Engineering

Third Year (Computer) (Semester VI)

(REV 2012)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CPC601	System Programming and Compiler Construction	4	2	-	4	1	-	5
CPC602	Software Engineering	4	2	-	4	1	-	5
CPC603	Distributed Databases	4	2	-	4	1	-	5
CPC604	Mobile Communication and Computing	4	2	-	4	1	-	5
CPE6011	Elective-I	-	2+ 2*	-	-	2	-	2
CPL601	Network Programming Laboratory	-	4	-	-	2	-	2
	Total	**16**	**16**	**-**	**16**	**8**	**-**	**24**

* Hours shown as Practicals to be taken class wise

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			End Sem Exam	Exam Duration (in Hrs)	TW	oral / pract	Tot
		Test 1	Test 2	Avg					
CPC601	System Programming and Compiler Construction	20	20	20	80	03	25	25 (pract)	150
CPC602	Software Engineering	20	20	20	80	03	25	25 (oral)	150
CPC603	Distributed Databases	20	20	20	80	03	25	25 (oral)	150
CPC604	Mobile Communication and Computing	20	20	20	80	03	25	25 (pract)	150
CPE601X	Elective-I	-	-	-	-	-	50	-	50
CPL601	Network Programming Laboratory	-	-	-	-	-	25	50 (oral)	75
	Total	**-**	**-**	**80**	**320**	-	**175**	**150**	**725**

Elective I Sem 6

CPE6011 Operation Research

CPE6012 Project Management

CPE6013 Foreigh Language – German

CPE6014 Foreigh Language – French

Course Code	Course/Subject Name	Credits
CPC501	**Microprocessor**	**5**

Objectives:

1. To understand basic architecture of 16 bit and 32 bit microprocessors.
2. To understand interfacing of 16 bit microprocessor with memory and peripheral chips involving system design.
3. To understand techniques for faster execution of instructions and improve speed of operation and performance of microprocessors.
4. To understand RISC and CISC based microprocessors.
5. To understand concept of multi core processors.

Outcomes: Learner will be able to…

1. Write programs to run on 8086 microprocessor based systems.
2. Design system using memory chips and peripheral chips for 16 bit 8086 microprocessor.
3. Understand and devise techniques for faster execution of instructions, improve speed of operations and enhance performance of microprocessors.
4. Distinguish between RISC and CISC processors.
5. Understand multi core processor and its advantages.

Module	Detailed Contents	Hrs.
01	**Intel 8086/8088 Architecture** 1.1 8086/8088 Microprocessor Architecture, Pin Configuration, Programming Model, Memory Segmentation, Study of 8284 Clock Generator, Operating Modes, Study of 8288 Bus Controller, Timing diagrams for Read and Write operations, Interrupts.	10
02	**Instruction Set and Programming** 2.1 Instruction Set of 8086, Addressing Modes, Assembly Language Programming, Mixed Language Programming with C Language and Assembly Language.	08
03	**System designing with 8086** 3.1 Memory Interfacing: SRAM, ROM and DRAM (using DRAM Controller-Intel 8203). 3.2 Applications of the Peripheral Controllers namely 8255-PPI, 8253-PIT, 8259-PIC and 8237-DMAC. Interfacing of the above Peripheral Controllers with 8086 microprocessor. 3.3 Introduction to 8087 Math Coprocessor and 8089 I/O Processor.	12
04	**Intel 80386DX Processor** 4.1 Study of Block Diagram, Signal Interfaces, Bus Cycles, Programming Model, Operating Modes, Address Translation Mechanism in Protected Mode, Memory Management, Protection Mechanism.	06
05	**Pentium Processor** 5.1 Block Diagram, Superscalar Operation, Integer & Floating Point Pipeline Stages, Branch Prediction, Cache	08

	Organization. 5.2 Comparison of Pentium 2, Pentium 3 and Pentium 4 Processors. Comparative study of Multi core Processors i3, i5 and i7.	
06	**SuperSPARC Architecture** 6.1 SuperSPARC Processor, Data Formats, Registers, Memory model. Study of SuperSPARC Architecture.	04

Term Work:

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

- Laboratory work (experiments/practical & case studies):…………. (15) Marks.
- Assignments……………………………………………………….. (05) Marks.
- Attendance ………………………………………………………… (05) Marks

TOTAL: ………………………………………………………………. (25) Marks.

Practical/Experiments:

1. Total eight experiments / practical must be performed out of which five practical must be performed on assemblers for 8086 and three experiments must be performed on interfacing of 8086 with peripheral chips like 8255 PPI, 8253 PIT, 8259 PIC and 8237 DMAC.
2. In addition to eight experiments/practical, two case studies are mandatory, one case study on RISC processor and second case study on CISC processor.

Practical examination will be conducted based on the above syllabus.

Text Books:

1. Microprocessor and Interfacing: Douglas Hall, Tata McGraw Hill.
2. Microcomputer Systems: 8086/8088 family Architecture, Programming and Design: Liu & Gibson, PHI Publication.
3. Pentium Processor System Architecture: Tom Shanley & Don Anderson, Addison-Wesley.
4. Advanced Microprocessor: Daniel Tabak, Tata McGraw Hill.
5. The 80386DX Microprocessor: Hardware, Software and Interfacing: Walter A Triebel, Prentice Hall.

Reference Books:

1. 8086/8088 family: Design Programming and Interfacing: John Uffenbeck , PHI.
2. Intel Microprocessors: Barry B. Brey, 8^{th} Edition, Pearson Education India.
3. Processor Architecture and Interfacing: Swati Joshi, Atul Joshi, Hemlata Jadhav, Wiley.
4. The X86 Microprocessors: Architecture and Programming (8086 to Pentium): Das Lyla B, Pearson Education India.
5. The SPARC Architecture Manual
6. I Intel Manuals

7. Programmer’s Reference Manual for IBM Personal Computers: Steven Armbrust, Ted Forgeron, McGraw Hill
8. IBM PC Assembly Language and Programming: Peter Abel, 5th Edition, Prentice Hall of India

Course Code	Course/Subject Name	Credits
CPC502	**Operating Systems**	**5**

Objectives:

1. To introduce students with basic concepts of Operating System, its functions and services.
2. To familiarize the students with various views and management policies adopted by O.S. as pertaining with processes , Deadlock , memory , File and I/O operations.
3. To brief the students about functionality of various OS like Unix , Linux and Windows 7 as pertaining to resource management.
4. To provide the knowledge of basic concepts towards process synchronization and related issues.

Outcomes: Learner will be able to…

1. Appreciate the role of operating system as System software.
2. Compare the various algorithms and comment about performance of various algorithms used for management of memory , CPU scheduling, File handling and I/O operations.
3. Apply various concept related with Deadlock to solve problems related with Resources allocation, after checking system in Safe state or not.
4. To appreciate role of Process synchronization towards increasing throughput of system.
5. Describe the various Data Structures and algorithms used by Different Oss like Windows 7, Linux and Unix pertaining with Process , File , I/O management.
6. To control the behavior of OS by writing Shell scripts.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Introduction to Operating System, Objectives and Functions of O.S., OS Services, Special purpose systems, Types Of OS, System Calls, types of system calls, Operating system structure ,System Boot.	04
02	**Process Management** 2.1 **Process concept**, operations on process Process scheduling: basic concepts , scheduling criteria , scheduling algorithms, Preemptive, Non-preemptive, FCFS ,SJF ,SRTN ,Priority based, Round Robin ,Multilevel Queue scheduling,Operating System Examples. 2.2 **Synchronization:** Background , the critical section problem , Peterson's Solution, Synchronization Hardware Semaphores, classic problems of Synchronization: The Producer Consumer Problem:Readers writers problem, Semaphores, Dinning Philosopher Problem	10
03	**Deadlock** 3.1 Deadlock Problem, Deadlock Characterization, Deadlock Prevention. Deadlock avoidance Banker's algorithm for single & multiple resources , Deadlock recovery , Deadlock Detection,	04

04	**Memory Management** 4.1 **Memory management strategies:** background , swapping ,contiguous memory allocation, paging , structure of page tables , segmentation 4.2 **Virtual memory management:** Demand paging , copy-on write,Page replacement, FIFO, Optimal, LRU, LRU Approximation,Counting Based, , Allocation of frames , Thrashing	05
05	**File Management** **5.1** Files-System Structure, File System implementation, Directory implementation , Allocation Methods contiguous allocation, linked list allocation, indexed allocations, Free space management. 5.2 **Secondary storage** : structures: Disks Scheduling Algorithm: FCFS, SSTF, SCAN, CSCAN, LOOK, Disk Management	06
06	**Input Output Management** 6.1 Overview , I/O Hardware , Application I/O Interface	02
07	**Case Study of UNIX** 7.1 History of UNIX, Overview of UNIX ,UNIX File System, Data structures for process/memory management ,Process states and State Transitions, Using the System(Booting and login),Process scheduling , Memory management , Shell programming	08
08	**Case Study of Linux** 8.1 History , Design Principles , Kernel Modules , Process management , Scheduling , Memory management , File Systems , Input and Output , Inter process communication , Network structure , Security	05
09	**Case study: Windows 7** 9.1 History, Design Principles , System components , environmental subsystems , File System, Networking, Programmer Interface	04

Term Work:

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

- Laboratory work (experiments+mini project): …………… (15)
- Assignments:……………………………………………… (05)
- Attendance ………………………………………………. (05)

TOTAL: …………………………………………… (25)

Practical/Experiments:

Laboratory work shall consist of minimum **08** experiments and mini project, 2 assignments based on above theory syllabus.

For mini project form a group of maximum 3 students.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

Practical exam will be based on the above syllabus.

Text Books:

1. Silberschatz A., Galvin P., Gagne G. “Operating Systems Principles”, Willey Eight edition
2. Achyut S. Godbole , Atul Kahate “Operating Systems” McGraw Hill Third Edition
3. “Operating System-Internal & Design Principles”, William Stallings, Pearson
4. Andrew S. Tanenbaum, “Modern Operating System”, Prentice Hall.

Reference Books:

1. “Linux Command Line & Shell Scripting”, Richard Blum and Christine Bresnahan, 2nd edition, Wiley.
2. “The Design of Unix Operating System”, Maurice J. Bach, Prentice Hall.
3. Unix and Shell Programming by B. M. Harwani Oxford
4. Unix Concept and Application 4th Edition by Sumitabha Das 'Mc Graw Hill'
5. Thomas Rebecca : Yates A user guide to the Unix system.

Syllabus for Practical:

Suggested topics for experiment but not limited to:

1. *Exploring basic commands for handling File system under Unix/Linux using shell scripts.
   (creating groups , chown , chmod , directory name, tty , diff, umask ,top)
2. *Pattern matching utilities like awk, grep , nroff , troff , sort etc.
3. *Exploring the boot process of Unix/Linux and implementing practical on it (for ex. MBR, passing different parameter to kernel, do different activity while booting and power-off).
4. Basic Process management algorithms (Any from FCFS , SJF , SRTN, RR , multilevel Queue scheduling)
5. Process synchronization algorithms like producer consumer problem , dining philosopher problem
6. Implementing Various page replacement policies: FIFO, Optimal, LRU, LFU
7. Implementation of Disk scheduling algorithms like FCFS,SSTF,SCAN ,CSCAN,LOOK.
8. Implementing Various file allocation methods : Index Allocation , Contiguous allocation.
9. Simulating Paging and Segmentation
10. Implementation of System calls like printing a file, display file using Unix/Linux internals.
11. Study booting process of Windows 7 , Linux , and Unix.

*** Marked experiments are mandatory**

Course Code	Course/Subject Name	Credits
CPC503	**Structured and Object Oriented Analysis and Design**	**5**

Outcomes: Learner will be able to…

1. Understand and apply techniques to get the system requirements and present it in standard format.
2. Apply key modeling concepts to both the traditional structured approach and the object-oriented approach.
3. Construct the candidate system following design methodology.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 System overview, Types of Systems , 1.2 Key Differences Between Structured and Object-Oriented Analysis and Design 1.3 Role of the System Analyst 1.4 Systems Development Life Cycle	06
02	**System Analysis** 2.1 Business process Reengineering and the Zachman Framework, System Requirement, Stakeholders, Techniques for information gathering, Validating the requirements.	06
03	**Feasibility Analysis** 3.1 Feasibility Analysis, Tests for feasibility, Cost-Benefit Analysis, Feasibility analysis of candidate system. 3.2 The system Proposal.	06
04	**Modeling System Requirements** 4.1 Traditional Approach to Requirement: Data Flow Diagrams, Documentation of DFD Components. Information Engineering Models, 4.2 Object-Oriented Approach to Requirement: Object-Oriented Requirements, The System Activities, Identifying Input and Outputs, Identifying Object Behavior, Integrating Object-Oriented Models. 4.3 Evaluating Alternatives for requirements, Environment and Implementation	12
05	**System Design** 5.1 Moving To Design 5.2 The traditional Approach to design 5.3 The Object-Oriented Approach to design: Use Case REaliztion 5.4 Designing Database, Designing the User Interface, Designing System Interfaces, Controls and security	12
06	**Application Architecture** 6.1 IT Architecture, Application Architecture Strategies, Modeling Application Architecture for Information System. 6.2 Deployment using UML diagrams, Component and deployment diagram for various architectures.	06

List of Assignment:

Assignments can be based on following topics

1. Feasibility analysis
2. Design patterns.

Term Work:

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

- Laboratory work: ……………………………………….. (10) Marks.
- Mini Project presentation:…………………………………..(10) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: …………………………………………………. (25) Marks.

Oral exam will be based on the above syllabus and tLaboratory work.

Suggested Practical List:

1. Develop Requirement specification document of the selected / alloted project.
2. Develop DFD model (level-0, level-1 DFD and Data dictionary) of tselected / alloted project.
3. Develop UML Use case model for selected / alloted project. .
4. Develop sequence diagram selected / alloted project. .
5. Develop Class diagram selected / alloted project.
6. Develop prototype of your project selected / alloted project.
7. Draw system architecture diagram selected / alloted project.

Text Books:

1. System Analysis & Design by Satzinger, Jackson and Burd, Cengage Learning, 2007
2. System Analysis and Design Methods by Jeffery l. Whitten, Lonnie D Bentley, McGraw Hill, 7th edition.
3. System Analysis and Design by Alan Dennis, Barbara H. Wixom, Roberta M. Roth, Wiley India 4th edition

Reference Books:

1. Systems Analysis and Design by Kendall & Kendall, PHI Publication, 7th Edition.
2. Analysis and Design of Information Systems by James a. Senn, 2nd Edition, McGrawHill.
3. Object-Oriented Modeling and Design with UML by Michael Blaha, James Rumbaugh, Pearson Education Publication, 2nd Edition.
4. The Unified Modeling Language - User Guide by Grady Booch, James Rumbaugh, Ivar Jacobson, Pearson Education Publication.
5. Modern Systems Analysis and Design by Jeffrey A. Hoffer, Joey F. George, Joseph S. Valacich, Prabin K. Panigrahi, Pearson Education Publication, 4th Edition.
6. UML Distilled by Martin Fowler, Pearson Edition, 3rd Edition.

7. Object Oriented Systems Development Using the Modified Modeling Language by Ali Bahrami, Tata McGraw Hill Publication.
8. Appling UML and Patterns by Craig Larman, Pearson Education, 2nd Edition.

Course Code	Course/Subject Name	Credits
CPC504	**Computer Networks**	**4+1**

Objectives:

1. To provide students with an overview of the concepts and fundamentals of data communication and computer networks
2. To familiarize with the basic taxonomy and terminology of computer networking area.
3. To experience the designing and managing of communication protocols while getting a good exposure to the TCP/IP protocol suite.

Outcomes:

After completion of this course learner will be able to:

1. Conceptualize all the OSI Layers
2. Use appropriate network tools to build network topologies
3. Install and configure an open source tool NS2
4. Test simple protocols in a laboratory scenario

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 History and development of computer network, network application, network software and hardware components, topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services, reference models: layer details of OSI, TCP/IP models. Communication between layers.	06
02	**Physical Layer** 2.1 Guided Transmission Media: Twisted pair, Coaxial, Fiber optics. 2.2 Unguided media (Wireless Transmission): Radio Waves, Bluetooth, Infrared, Virtual LAN.	06
03	3.1 **Data Link Layer** DDL Design Issues, Functionalities of DLL, Flow control algorithms - Sliding Window, Error Detection & Correction techniques, SDLC, PPP, Framing. 3.2 **MAC Layer** Aloha protocols, Control Access Protocol, Carrier Sense Multiple Access(CSMA), Ethernet, Local Area Networks - Ethernet, Token ring, FDDI.	09
04	**Network layer** 4.1 Communication Primitives: Unicast, Multicast, Broadcast. IP Addressing, Subnetting, IPv4, IPv6, Routing algorithms : Link state routing, Distance Vector Routing, ARP, RARP, ICMP, Routing protocols - RIP, OSPF, BGP, IGRP, Congestion control algorithms: Open Loop congestion control, Closed Loop congestion control.	08

05	**Transport Layer** 5.1 The Transport Service: Transport service primitives, Berkeley Sockets, Connection management, UDP, TCP, Socket Programming (TCP & UDP), Socket Programming examples, TCP Flow control, TCP Congestion Control, Multiplexing.	08
06	**Application Layer** 6.1 DNS, HTTP, E-mail, SMTP, Telnet, FTP, Security-PGP-SSH.	06
07	**Network Management** 7.1 SNMP Concept, Management Components, SMI, MIB, SNMP Format, Messages.	04

Term Work:

Term work shall consist of minimum **12** experiments.
Journal must include at least 2 assignments.
The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
The distribution of marks for term work shall be as follows:

- Experiments: ………………………………………………… (15) Marks.
- Assignments:………………………………………………. (05) Marks.
- Attendance ……………………………………………….. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical exam will be based on the above syllabus.

Suggested Practicals:

1. Study of LAN Topology.
2. Study of various Network devices.
3. Building of any topology using Network tool.
4. Installation & Configuration of NS2 in Linux environment.
5. Basic wired & wireless topology in NS2.
6. Build class A & Class B Network using router in Network tool.
7. Implement subnetting concept using Network tool.
8. Write a program to implement find out class of a given IP address, subnet mask & first & last IP address of that block.
9. Write a program to build client-server model on different computers.
10. Congestion Control: Stop & Wait, Sliding Window & Selective Repeat, Go Back n.
11. Datalink Layer : Error Detection and correction, Flow Control, Framing
12. Network Layer : IP Addressing, Routing
13. Transport Layer : Socket Programming, Network Management/ Monitoring Tools.

Text Books:

1. A.S. Tanenbaum, “Computer Networks”, Pearson Education, Fourth Edition.
2. B.A. Forouzan, “Data Communications and Networking”, TMH, Fourth Edition.

Reference Books:

1. M. A. Gallo and W. M. Hancock, Computer Communications and Networking Technologies, Cengage Learning (Indian Edition), First Edition.
2. Natalia Olifer & Victor Olifer, “Computer Networks : Principles, Technologies & Protocols for Network Design”, Wiley India, 2011.
3. Computer Networks: A Systems Approach, Second Edition (The Morgan Kaufmann Series in Networking) Larry L.Peterson(Author),Bruce S.Davie(Author)
4. Computer Networking, 6e,James F. Kurose , Keith W. Ross.
5. An Engineering Approach To Computer Networking: Atm Networks, The Internet ...By Keshav

Course Code	Course/Subject Name	Credits
CPL502	**Business Communication & Ethics**	**2**

Objectives:

1. To inculcate in students professional and ethical attitude, effective communication skills, teamwork, skills, multidisciplinary approach and an ability to understand engineer’s social responsibilities.
2. 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.
3. To inculcate professional ethics and codes of professional practice
4. To prepare students for successful careers that meets the global Industrial and Corporate requirement’ provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.

Outcomes: A learner will be able to …..

1. communicate effectively in both verbal and written form and demonstrate knowledge of professional and ethical responsibilities
2. Participate and succeed in Campus placements and competitive examinations like GATE, CET.
3. Possess entrepreneurial approach and ability for life-long learning.
4. Have education necessary for understanding the impact of engineering solutions on Society and demonstrate awareness of contemporary issues.

Module	Detailed Contents	Hrs.
01	**Report Writing** 1.1 Objectives of report writing 1.2 Language and Style in a report 1.3 Types of reports 1.4 Formats of reports: Memo, letter, project and survey based	08
02	**Technical Proposals** 2.1 Objective of technical proposals 2.2 Parts of proposal	02
03	**Introduction to Interpersonal Skills** 3.1 Emotional Intelligence 3.2 Leadership 3.3 Team Buliding 3.4 Assertiveness 3.5 Conflict Resolution 3.6 Negotiation Skills 3.7 Motivation 3.8 Time Management	08
04	**Meetings and Documentation** 4.1 Strategies for conducting effective meetings 4.2 Notice 4.3 Agenda	02

	4.4 Minutes of the meeting	
05	**Introduction to Corporate Ethics and etiquettes** 5.1 Business Meeting etiquettes, Interview etiquettes, Professional and work etiquettes, Social skills 5.2 Greetings and Art of Conversation 5.3 Dressing and Grooming 5.4 Dinning etiquette 5.5 Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions)	02
06	**Employment Skills** 6.1 Cover letter 6.2 Resume 6.3 Group Discussion 6.4 Presentation Skills 6.5 Interview Skills	06

List of Assignment:

1. Report Writing (Synopsis or the first draft of the Report)
2. Technical Proposal (Group activity, document of the proposal)
3. Interpersonal Skills (Group activity and Role play)
4. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
5. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
6. Corporate ethics and etiquettes (Case study, Role play)
7. Cover Letter and Resume
8. Printout of the PowerPoint presentation

Term Work:

Term work shall consist of all assignments from the list. The distribution of marks for term work shall be as follows:

- Assignments: ………………………………………………… (20) Marks.
- Project Report Presentation……………………………….. (15) Marks.
- Group Discussion………………………………………… (10) Marks.
- Attendance ………………………………………………….(05) Marks

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, "*Organisational Behavior*" , Mc Graw Hill, edition
2. Lesiker and Petit, "*Report Writing for Business*" , Mc Graw Hill, edition
3. Huckin and Olsen, "*Technical Writing and Professional Communication*", Mc Graw 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. R.C Sharma and Krishna Mohan, "*Business Correspondence and Report Writing*",
7. B N Ghosh, "*Managing Soft Skills for Personality Development*", Tata McGraw Hill.Lehman, Dufrene, Sinha, "*BCOM*", Cengage Learning, 2nd edition
8. Bell . Smith,"Management Communication" Wiley India Edition,3rd edition.Dr.K.Alex ,"Soft Skills",S Chand and Company
9. Dr.K Alex,"Soft Skills",S Chand and Company

Course Code	Course/Subject Name	Credits
CPL501	**Web Technologies Laboratory**	2

Module	Detailed Contents	Lab Sessions
01	**Title:** Create HTML Forms. Use of various HTML Tag on Web Forms. **Concept:** Designing of effective web site, Introduction of different Web Technologies: HTML, and Different HTML Tag. **Objective:** objective of this module is to provide students an overview of the concepts Web Technologies, and HTML. **Scope:** Designing static client side web page using various HTML tags. **Technology:** HTML	01
02	**Title:** Use of CSS on HTML Form. **Concept:** Cascaded Style Sheets **Objective:** In this module student will learn, defining a CSS and unstaring its purpose different syntax and types of CSS. **Scope:** Creating web pages and use CSS to control the layout pages. **Technology:** HTML with Cascade Style Sheet.	01
03	**Title:** Use of Java Script functions on Web Forms and Use of Dynamic HTML Page. **Concept:** Scripting Languages, Dynamic web pages **Objective:** in this lab student will learn how to define client side scripting and understand its advantages and disadvantages. Embedding JavaScript code into HTML document using script tag, and will understand dynamic HTML. **Scope:** Create animation using JavaScript. **Technology:** HTML with JavaScript.	02
04	**Title:** Creation of Web page with the help of Quanta Plus /Aptana /Kompozer. **Concept:** Web development Environment **Objective:** This module students will learn how will introduce editors for development of web pages. **Scope:** Development of web pages using any web tool. **Technology:** Quanta Plus /Aptana /Kompozer	03

05	**Title:** Write an XML file marksheet.xml representing your semester mark sheet**.** **Concept:** Extensible Mark up Language (XML) **Objective:** is to learn about basics of XML and how it can be used to store information away from the mechanism of processing or formatting of such data. Will also learn how to build simple XML files and be able to manipulate and refer to them. **Scope:** is to creating an XML file in that it must include basic syntax of an XML doc and DTD for the same.	03
06	**Title:** server side scripting. Use HTML form to accept the two numbers N1 and N2 and using PHP program display only prime numbers in between N1 and N2. **Concept:** Server side scripting**,** introduction to PHP **Objective:** this lab gives a basic introduction of to PHP and dynamic programming on the server side. **Scope:** creating a server side script using PHP, decisions, looping **Technology:** PHP, HTML	03

Term work Assessment:

Term work will consist of small assignments testing all the technologies included in syllabus and a Mini project solving an appropriate problem using the above technology

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

- Assignments: ……………………………………………… (20) Marks.
- Project Report Presentation……………………………….. (15) Marks.
- Group Discussion.………………………………………… (10) Marks.
- Attendance …………………………………………………(05) Marks

TOTAL: ……………………………………………………. (50) Marks.

End Semester Examination:
Oral examination is to be conducted by pair of internal and external examiners based on the mini projects undertaken by student grooups.

Text Books:

1. Ralph Moseley ,M.T. Savaliya "Developing Web Applications ", Willy India,Second Edition , ISBN:978-81-265-3867-6
2. "Web Technology Black Book ",Dreamtech Press, First Edition, ISBN 978-7722-997

Course Code		Credits
CPC601	**System Programming Compiler Construction**	05

Objectives:

1. To help students appreciate the role and functioning of various system programs over application program
2. To initiate an understanding of compilers in general and brief about phases of compiler.
3. To provide a theoretical framework for optimizing the code.
4. To familiarize and encourage the students to use various software tools for Developing System programs.

Outcomes: Learner will be able to…

1. Identify different system software
2. Use Lex tool used for generating lexical analyser.
3. Write macros as and when required to increase readability and productivity
4. Design hand written lexical analyzer
5. Design new language structures with the help of grammars
6. Appreciate the role of Operating System functions such as memory management as pertaining to run time storage management
7. Appreciate role of Intermediate Code Generation in connection with language designing
8. Apply optimization principles on given code
9. Implement various parser types and use YACC.

Module	Detailed Contents	Hours
01	**System Software** 1.1 Concept, introduction to various system programs such as assemblers, loaders , linkers ,macro processors, compilers, interpreters, operating systems, device drivers	01
02	**Assemblers** 2.1 General Design Procedure , Design of Assembler (Single Pass – Assembler IBM PC , multi pass Assembler - IBM 360/370 Processor), Statement of Problem , Data Structure , format of Databases , Algorithm , Look for modularity	06
03	**Macros & Macro processors** 3.1 Macro instructions, Features of Macro facility, Design of 2 pass macroprocessor	04
04	**Loaders and Linkers** 4.1 loader schemes, Design of Absolute loader , Design of Direct linking loader	04
05	**Software Tools** 5.1 Software Tools for Program development, Editors: Types of Editors , Design of Editor ,Debug Monitors	02
06	**Compilers** 6.1 Introduction to Compilers, Phases of a compiler, comparison of	02

	compilers and interpreters.	
07	**Lexical Analysis** 7.1 Role of a Lexical analyzer, input buffering, specification and recognition of tokens, Designing a lexical analyzer generator, Pattern matching based on NFA's.	02
08	**Syntax Analysis** 8.1 Role of Parser, Top-down parsing, Recursive descent and predictive parsers (LL), Bottom-Up parsing, Operator precedence parsing, LR, SLR and LALR parsers.	08
09	**Syntax Directed Translation** 9.1 Syntax directed definitions, Inherited and Synthesized attributes, Evaluation order for SDDs , S attributed Definitions , L attributed Definitions	3
10	**Intermediate Code Generation** 10.1 Intermediate languages: declarations, Assignment statements, Boolean expression, case statements, back patching , procedure calls.	04
11	**Code Generation** 11.1 Issues in the design of Code Generator **,** Basic Blocks and Flow graphs, code generation algorithm , DAG representation of Basic Block	04
12	**Code Optimization** 12.1 Principal sources of Optimization, Optimization of Basic Blocks , Loops in Flow graph **,**Peephole Optimization	03
13	**Run Time storage** 13.1 Storage Organization **,** storage allocation strategies, parameter passing , Symbol table , introduction to garbage collection and compaction	04
14	**Compiler-compilers** 14.1 JAVA compiler environment, YACC compiler-compiler	01

Term Work:

Journal should include at least 10 experiments (out of which at least 7 from suggested list below) and at least 2 assignments.   .
The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): ……………………….. (15) Marks.
- Assignment:………..…………………………………… (05) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

Practical examination will be conducted based on above syllabus

Theory Examination:

In question paper, weight age of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

Text Books:

1. J. J Donovan: Systems Programming Tata McGraw Hill Publishing Company
2. A. V. Aho, R. Shethi and J.D. Ulman; Compilers - Principles, Techniques and Tools, *Pearson Education*
3. A. V. Aho, R. Shethi, Monica Lam , J.D. Ulman : Compilers - Principles, Techniques and Tools , Pearson Education , Second Edition.
4. D. M Dhamdhere: Systems programming, *Tata McGraw Hill*

Reference Books:

1. lex & yacc, 2nd Edition by John R. Levine, Tony Mason & Doug Brown O'Reilly

2. D.M. Dhamdhere : Systems programming ,*Tata McGraw Hill*

Syllabus for LAB

Experiments can be conducted based on the suggested topics below:

However list is not limited to mentioned topics.

Use of Open source tools is suggested.

1. Lexical analyzer tool : flex
2. Parser generator tool : Yacc.
3. Find first() , follow() set of given grammer
4. removing left recursion direct as well as indirect given the set of production rule
5. Assemblers : 2 pass Assembler .
6. Macroprocessor : 2 pass Macro processor.
7. Syntax Analysis : (any 1 of LL(1) , LR(0) , LR(1) , LALR(1) , operator precedence parser.)
8. Create your library in Linux environment and using it.
9. Code Generation algorithm.
10. Code Optimization techniques.
11. Study ld command in Unix/Linux.

Course Code	Course/Subject Name	Credits
CPC602	**Software Engineering**	05

Objectives:

The main objective is to introduce to the students about the product that is to be engineered and the process that provides a framework for the engineering technology.

1. To provide knowledge of software engineering discipline.
2. To analyze risk in software design and quality.
3. To introduce the concept of advance software methodology.

Outcomes: Learner will be able to…

1. Students will demonstrate basic knowledge in software engineering.
2. Students will be able to plan, design, develop and validate the software project.
3. Students will be apply advance software methodology to create high quality WebApps.
4. Students will have an understanding of impact of sound engineering principles.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Software Engineering Process Paradigms 1.2 Process Models – Incremental and Evolutionary models, 1.3 Typical Application for each model, 1.4 Agile methodology 1.5 Process and Project Metrics.	06
02	**Software project scheduling, Control & Monitoring** 2.1 Software estimation – Empirical estimation models – Cost/Effort estimation 2.2 Planning – Work breakdown Structure, Gantt Chart. Discuss schedule and cost slippage.	04
03	**Risk Management** 3.1 Risk Identification, Risk Assessment, Risk Projection, RMMM	04
04	**Software Configuration Management** 4.1 Software Configuration items, SCM process, Identification of objects in software configuration, version and change control, configuration audit , status reporting, SCM standards and SCM issues.	04
05	**Software Design Specification** 5.1 Software Design – Abstraction , Modularity 5.1 Software Architecture – Effective modular design, Cohesion and Coupling, Example of code for cohesion and coupling. 5.2 User Interface Design – Human Factors, Interface standards, Design	08

	Issues – User Interface Design Process.	
06	**Software Quality** 6.1 Software Quality Assurance – Software standards , Quality metrics Software Reliability ,Quality Measurement and Metrics	04
07	**Software Testing** 7.1 Basic concept and terminology, Verification & validation, White Box Testing- Path Testing, Control Structures Testing , DEF-USE testing, 7.2 Black Box Testing –BVA Integration, Validation and system testing. 7.3 OO testing methods-Class Testing, Interclass testing, testing architecture, Behavioral testing. 7.4 Software Maintenance – Reverse Engineering.	12
08	**Web Engineering** 8.1 For web based applications – attributes, analysis and design, testing. 8.2 Security Engineering, 8.3 Service-Oriented Software Engineering. 8.4 Test Driven Development 8.5 Software engineering with aspects	06

Term Work:

Term work shall consist of at least 10 Laboratory assignments and two written tests.

The final certification and acceptance of Term Work ensures the satisfactory performance of laboratory Work and Minimum Passing in the term work.

Practical/Oral examination:

Oral examination will be conducted based on above syllabus.

Suggested List of Experiments:

1. SRS in IEEE format for any case study.
2. Use project management tool to schedule project plan.
3. RMMM plan for case study.
4. Develop test cases for white box testing.
5. Assignment / code for stubs and drivers.
6. Change specifications and make different versions using any SCM tool.
7. For one scenario- Implement TDD

Text Books:

1. Roger Pressman, Software Engineering: A Practitioners Approach, (6th Edition), McGraw Hill, 2010

2. Ian Somerville, Software Engineering, 9th edition, Addison Wesley, 2011

Reference Books:

1. Eric J. Braude and Micheal E. Bernstein, Software Engineering Modern Approach, 2nd edition, Wiley, 2011.
2. Ali Behforooz Fredrick Hudson, Software Engineering Fundamentals, Oxford University Press, 2006.
3. James F. Peters and Witold Pedrycz, " Software Engineering – An Engineering Approach", Wiley.
4. Mouratidis and Giorgini. "Integrating Security and Software Engineering – Advances and Future", IGP. ISBN – 1-59904-148-0

Course Code	Course/Subject Name	Credits
CPC603	**Distributed Databases**	05

Objectives:

1. To introduce principles and foundations of distributed databases, including architecture, design issues, integrity control, query processing and optimization, transactions, and concurrency control.
2. To enable students to understand the difference between different database system and integrate the.

Outcomes: Learner will be able to…

1. Design and implement distributed database for enterprise application.
2. Provides solutions for heterogeneous database
3. Use XML for schema integration.

Module	Detailed Contents	Hrs.
01	**Concept and Overview Distributed Database system** 1.1 What is Distributed Database System (DDBS), Features of DDBS, promises of DDBS, Design issue in DDBS, Distributed DBMS architecture: Client/server System, Peer-to-Peer, Mutli-Database system.	08
02	**Distributed Database Design** 2.1 Distributed database design concept, objective of Data Distribution, Data Fragmentation, The allocation of fragment , Transparencies in Distributed Database Design	08
03	**Distributed Transaction and concurrency control** 3.1 Basic concept of Transaction management, objective Distributed transaction management, Model for Transaction management 3.2 Distributed Concurrency control: Objective, concurrency control anomalies, Distributed Serializability, Locking based algorithm, Timestamp based algorithm.	08
04	**Distributed Deadlock and Recovery** 4.1 Introduction to Deadlock, Distributed Deadlock prevention, avoidance, detection and recovery, Two-Phase and Three-Phase Commit Protocol.	06
05	**Distributed query processing and optimization** 5.1 Concept, objective, and phases of distributed query processing; join strategies in fragment relation , Global query optimization	04
06	**Heterogeneous Database** 6.1 Architecture of Heterogeneous Database, Database Integration: Schema Translation and schema Integration, Query processing issues in Heterogeneous database.	06

07	**XML** 7.1 XML for data integration, structure of XML, XML document schema, Querying and Transformation, storage of XML data, XML application.	08

Term Work:

Assign a case study for group of 2/3 students and each group to perform the following experiments on their case-study:

- Creation of centralized database (Global Schema).
- Perform Fragmentation (PHF, DHF, VF, and HF) and allocation in DDBS design.
- Implementation of concurrency control.
- Implementations of two phase or three phases commit protocol.
- Implementations of three deadlock detection.
- Simulation of distributed query processor.
- Implementation of query optimization.
- Implementation any two experiment on XML

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

- Laboratory work (experiments/assignments): ………….. (10) Marks.
- Course project:……………………………………… (10) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

An oral exam will be held based on the above syllabus.

Text Books:

1. Chhanda Ray , "Distributed Database System", Pearson Education India.
2. A. Siberschatz, H. Korth, "Database System", Six Edition, Mc-Graw Hill.
3. Seed K. Rahimi and Frank S. Haug, "Distributed Database Management System", Wiley India.

Reference Books:

1. M. Tamer Ozsu , Patrick Valduriez, “Principles of Distributed Database”, Pearson Education India.
2. Elmasri and Navathe, “Fundamentals of Database Systems”, 6^{th} Edition, Pearson Education India.

Course Code	Course/Subject Name	Credits
CPC604	**Mobile Communication and Computing**	05

Objectives:

1. To introduce the basic concepts and principles in mobile computing. This includes the 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.

Outcomes: Learner will be able to…

1. Understand GSM and CDMA Cellular architecture.
2. Setup and configure wireless access points.
3. Use Network Simulator tool to simulate mobile network.
4. Implement small android based applications.

Module	Detailed Contents	Hrs.
01	**Introduction to Mobile Computing** 1.1 Wireless Communication, Applications, Cellular Systems, Antennas, satellite system, GEO, LEO, MEO, GPRS:-Architecture, Network nodes, GPRS support nodes.	05
02	**GSM cellular telephony-architecture and system aspects** 2.1 Introduction, Basic GSM architecture, Basic radio transmission parameters of the GSM system, Logical channel description, GSM time hierarchy, GSM burst structures, Description of the call set-up procedure, Handover, Ensuring privacy and authentication of a user, Modifications and derivatives of GSM	08
03	**Mobile Network** 3.1 Mobile IP, IP Packet Delivery, Agent Advertisement and Discovery, Registration, Tunneling and Encapsulation, Optimization, Reverse Tunneling, Mobile TCP, Fast Retransmit/ Fast Recovery, Transmission/Timeout Freezing, Selective Retransmission.	06
04	**Third and Fourth Generation Systems** 4.1 W-CDMA, CDMA 2000; Improvements on Core Networks; Quality of Services in 3G ; Wireless Local Loop; Wireless Local Loop Architecture; Deployment Issues; TR-45 Service Description; Wireless Local Loop technologies. TETRA, UMTS and IMT-2000;UMTS Basic Architecture, UTRA FDD mode, UTRA TDD mode, 4G Architecture, Comparison between 3G and 4G.	06
05	**Mobility Management** 5.1 Co- channel Interference, Mobility: Types of Handoffs; Location Management, HLR-VLR scheme, Hierarchical scheme, Predictive Location management schemes, cellular IP, PSTN.	04

06	**Wireless Local Area Networks** 6.1 Introduction, Types of WLANs, Hidden station problem, HIPERLAN Type 1: HIPERLAN/1 MAC sublayer, HIPERLAN/1 CAC layer, HIPERLAN/1 physical layer. IEEE 802.11 WLAN standards: IEEE 802.11 physical layer, IEEE 802.11 MAC sublayer. IEEE 802.11 and HIPERLAN standards for 5 GHz band: HIPERLAN/2 physical layer, HIPERLAN /2 data link control layer. Bluetooth: Introduction, User Scenario, Architecture, protocol.	08
07	**Introduction to Android** 7.1 Layers, android components, mapping application to process. Android development basics. Hardware tools, Software tools, Android SDK features	05
08	**Security Issues In Mobile Computing** 8.1 Security Issues, Authentication, Encryption, Cryptographic Tools: Hash, Message Authentication Code (MAC), Digital Signature, Certificate. Secure Socket Layer (SSL). Characteristics of SIM, Equipment Identification.	06

Term Work:

Term work shall consist of minimum assignments and course project. The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/assignments): ………….. (20) Marks.
- Attendance ……………………………………. (05) Marks

TOTAL: ………………………………………………….. (25) Marks.

Practical/Oral examination:

Practical exam will be held based on the above syllabus.

Suggested Laboratory Exercises of Mobile Computing:

1. Setup & Configuration of Wireless Access Point (AP)
2. Implementation of WLAN : Ad Hoc & Infrastructure Mode
3. Implementation of Bluetooth Protocol and Applications
4. GSM modem study (Android based mobile) and SMS client-server application
5. Implementation of Mobile Network using Network Simulator (NS2)
6. Mobile Internet and WML
7. J2ME Program for Mobile Node Discovery
8. Mobile protocol study using GNS3.
9. Design and Program Income Tax and Loan EMI Calculator for Mobile Phones.
10. Wireless Network Security: kismet and Netstumbler

Text Books:

1. Jochen Schilller ,"Mobile Communication ", Addision wisely,Pearson Education
2. Krzysztof Wesolowski, "Mobile Communication Systems", Wiley publication
3. W. Frank Ableson,Robi sen, Chris King, " Android IN ACTION ", Third Edition, Dreamtech Press
4. Mobile Computing By Rajkamal (Oxford).

Reference Book:

1. Uwe Hansmann, Lothar Merk, Martin S. Nicklous, Thomas Stober, "Principles of Mobile Computing", Springer
2. Rappaort, "Wireless Communcations Principles and Practices"
3. Yi Bang Lin, "Wireless and Mobile Network Architecture", John Wiley
4. P. Nicopolitidis, "Wireless Networks", John Wiley
5. K. Pahlavan, P.Krishnamurthy, "Principles of Wireless Networks"
6. Introduction to Wireless Telecommunication System and Networks by Mullet (Cengage Learning).
7. Beginning for Android 4 Application Development By Wei- Meng Lee, Wiley –India Edition.

Course Code	Course/Subject Name	Credits
CPE6011	**Operations Research**	**02**

Outcomes: Learner will be able to

1. model and solve problem using linear programming techniques
2. Implement algebric solution using simplex method
3. Define transportation model and apply transportation algorithm in a known situation.
4. Use montecarlo simulation technique.
5. Use the spreadsheet as a tool effectively for OR topics

Module	Detailed Contents	Hrs.
01	**What is Operations Research** 1.1 Introduction.	02
02	**Modeling with Linear Programming** 2.1 Two-Variable LP Model 2.2 Graphical LP Solution 2.2.1 Solution of a Maximization Model 2.2.2 Solution of a Minimization Model 2.3 Computer Solution with Solver and AMPL 2.3.1 LP solution with Excel Solver 2.3.2 LP Solution with AMPL 2.4 Linear Programming Applications 2.4.1 Investment 2.4.2 Product Planning and Inventory Control 2.4.3 Manpower Planning 2.4.4 Urban Development Planning 2.4.5 Blending and Refining 2.4.6 Additional LP Applications	07
03	**The Simplex Method and Sensitivity Analysis** 3.1 LP Model in Equation Form 3.2 Transition from Graphical to Algebraic Solution 3.3 The Simplex Method 3.3.1 Iterative Nature of the Simplex Method 3.3.2 Computational details of the Simplex algorithm 3.3.3Summary of the Simplex Method 3.4Artificial Starting Solution 3.4.1 M-Method 3.4.2 Two-Phase Method 3.5 Special Cases in the Simplex Method 3.5.1 Degeneracy 3.5.2 Alternative Optima 3.5.3 Unbounded Solution	06

	3.5.4 Infeasible Solution 3.6 Sensitivity Analysis 3.6.1 Graphical Sensitivity Analysis 3.6.2 Algebraic Sensitivity Analysis – Changes in the Right-hand side 3.6.3 Algebraic Sensitivity Analysis – Objective function 3.6.4 Sensitivity Analysis with Tora, Solver, and Ampl 3.7 Computational issues in Linear Programming	
04	**Duality and Post-Optimal Analysis** 4.1 Definition of the Dual Problem 4.2 Primal-Dual Relationships 4.2.1 Review of Simplex Matrix Operations 4.2.2 Simplex Tableau Layout 4.2.3 Optimal Dual Solution 4.2.4 Simplex Tableau Computations 4.3 Economic Interpretation of Duality 4.3.1 Economic Interpretation of Dual Variables 4.3.2 Economic Interpretation of Dual Constraints 4.4 Additional Simplex Algorithms 4.4.1 Dual Simplex Algorithm 4.4.2 Generalized Simplex Algorithm	05
05	**Transportation Model and Its Variants** 5.1 Definition of the Transportation Model 5.2 Nontraditional Transportation Models 5.3 The Transportation Algorithm 5.3.1 Determination of the Starting Solution 5.3.2 Iterative Computations of the Transportation Algorithm 5.3.3 Simplex Method Explanation of the Method of Multipliers 5.4 The Assignment Model 5.4.1 The Hungarian Method 5.4.2 Simplex Explanation of the Hungarian Method	05
06	**Decision Analysis** 6.1 Decision Making under Certainty – Analytic Hierarchy Process (AHP) 6.2 Decision Making under Risk 6.2.1 Decision Tree-Based Expected Value Criterion 6.2.2 Variants of the Expected Value Criterion 6.3 Decision under Uncertainty	03
07	**Stimulation Modeling** 7.1 Monte Carlo Simulation 7.2 Types of Simulation	02

	7.3 Elements of Discrete Event Simulation 7.3.1 Generic Definition of Events 7.3.2 Sampling from Probability Distributions	
08	**Nonlinear Programming Algorithms** 8.1 Unconstrained Algorithms 8.1.1 Direct Search Method 8.1.2 Gradient Method 8.2 Constrained Algorithms 8.2.1 Separable Programming 8.2.2 Quadratic Programming	03
09	**Introduction to spreadsheet model**	02

List of Assignment:

Atleast **15** assignments based on the above syllabus; Assignments to also include progams wherever applicable.

Term Work:

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

- Laboratory work (assignments): …………….…….. (25) Marks.
- Case Study Presentations (to be done during semester):… (15) Marks.
- Attendance ………………………………………. (10) Marks

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. Taha, Hamdy A. "Operations Research" Pearson, 2011.
2. N.D. Vhora " Quantitative Techniques in Management" TMH , 3rd edition

Course Code	Course/Subject Name	Credits
CPE6012	**Software Project Management**	**02**

Outcomes: Learner will be able to…

1. Learner will be able to define characteristics of a project,
2. Learner will be able to appreciate project management principles, risk in environment and the management challenges for effective project management.
3. Learner will be able to apply the project management principles across all phases of a project.
4. Learner will be able to demonstrate use of tools and techniques for the management of a project plan, monitor and controlling a project schedule and budget, tracking project progress.

Module	Detailed Contents	Hrs.
01	**An overview of IT Project Management** 1.1 Introduction, the state of IT project management, context of project management, need of project management, project goals, project life cycle and IT development, extreme project management, PMBOK.	02
02	**Conceptualizing and Initializing the IT Project** 2.1 An information technology project methodology (ITPM), project feasibility, request for proposal (RFP), the business case, project selection and approval, project contracting, IT governance and the project office.	04
03	**The Human Side of Project Management** 3.1 Introduction, organization and project planning, the project team, the project environment.	02
04	**Developing the Project Charter and Project Plan** 4.1 Introduction, project management process, project integration management, the project charter, project planning framework, the contents of a project plan, the planning process. 4.2 The Work Breakdown Structure (WBS), the linear responsibility chart, multidisciplinary teams.	04
05	**The Scope Management Plan** 5.1 Introduction, scope planning, project scope definition, project scope verification, scope change control.	04
06	**The Project ís Schedule, Budget and Risk Management** 6.1 Introduction, developing the project schedule, project management software tools, methods of budgeting, developing the project budget, improving cost estimates, finalizing the project schedule and budget. 6.2 IT project risk management planning process, identifying IT project risks, risk analysis and assessment, risk strategies, risk monitoring, and	08

	control, risk responses and evaluation.	
07	**Allocating Resources to the Project** 7.1 Resource loading, resource leveling, allocating scarce resources to projects and several projects, Goldrattís critical chain.	03
08	**The Project Communication Plan** 8.1 Introduction, monitoring and controlling the project, the project communications plan, project metric, project control, designing the control system, the plan-monitor-control cycle, data collection and reporting, reporting performance and progress, information distribution.	02
09	**Managing Change, Resistance and Conflicts**	02
10	**Managing Project Procurement and Outsourcing** 10.1 Introduction, project procurement management, outsourcing.	02
11	**Project Leadership and Ethics** 11.1 Introduction, project leadership, ethics in projects, multicultural projects.	01
12	**The Implementation Plan and Project Closure** 12.1 Introduction, project implementation, administrative closure, project evaluation, project audit.	02

Term Work:

Term work shall consist of at least **10** assignments covering all topics and course project by using appropriate tool. The distribution of marks for term work shall be as follows:

1. Assignments: …………......................... (25) Marks.
2. Case study presentations **(to be done during semester)**:...... (15)
3. Attendance:... (10)

TOTAL: …………………………………………………. (50) Marks.

The final certification and acceptance of TW ensures the satisfactory Performance of laboratory Work and Minimum Passing in the term work.

Suggested Assignment List

In practical, a group of maximum three students should be formed. Each group is supposed to complete all lab experiments on the case study given by the subject teacher. In lab experiments students can used the tools like MsWord to prepare document whereas MsProject to preparing WBS, N/w diagram, PERT, CPM, Variance analysis etc.

1. Project and System's Management
2. Feasibility study document
3. Project Proposal
4. Project Planning
5. Activity Planning
6. Analyzing the project network diagram
7. Cost estimation and budgeting
8. Risk management
9. Performance analysis of project
10. Project evaluation and closure

Text Book:

1. "Information Technology Project Management", Jack T. Marchewka, 3rd edition, Wiley India, 2009.

Reference Books:

1. S. J. Mantel, J. R. Meredith and etl.. "Project Management" 1st edition, Wiley India, 2009.
2. John M. Nicholas, "Project Management for Business and Technology", 2nd edition, Pearson Education.
3. Joel Henry, "Software Project Management, A real-world guide to success", Pearson Education, 2008.
4. Gido and Clements, "Successful Project Management", 2nd edition, Thomson Learning.
5. Hughes and Cornell, "Software Project Management", 3rd edition, Tata McGraw Hill
6. Joseph Phillips, "IT Project Management", 2nd edition, Tata McGraw Hill
7. Robert K. Wyzocki and Rudd McGary, "Effective Project Management", 3rd edition, Wiley
8. Brown, K.A. Project Management, McGraw Hill, 2002.
9. E-Book – Project Management Body of Knowledge.
10. Dinsmore, P. C. (Ed.). (1993) The AMA Handbook of Project Management. AMACOM

Course Code	Course/Subject Name	Credits
CPE6013	**Elective – Foreign Language – German**	02

Course Code	Course/Subject Name	Credits
CPE6014	**Elective – Foreign Language – French**	02

Objectives:

1. To introduce German language in a holistic manner. The texts and exercises are aimed at developing the students' skills of reading, writing, listening and speaking. The course is divided into units with a thematic and grammatical progression. Scenarios from everyday life and formulated in a manner suitable and especially interesting for beginners. However since most of the students would want to do this course for professional advancement this course scenarios from the professional life are introduced in simple but engaging manner.

Outcomes: Learner will be able to…

1. read and understand simple German / French text
2. Describe basic family structure , culture and work culture
3. Draft e-mails and create simple presentations

Module	Detailed Contents	Hrs.
01	Basic Grammar, pronunciation and basic expression	08
02	**Communication** 2.1 Greetings , begining of conversation, Introduction of oneself , numbers , counting and dates	08
03	Reading , Comprehension and writing - (Type of Text) Dialogs, Monologs , Biodata,	05
04	Family Structures Culture Computer and Multimedia Work culture	10
05	**Corporate communication** 5.1 Emails , Technical Reports , Making presentations	05

Term Work:

Term work shall consist of minimum **10** assignments of different difficulty level based on above syllabus. The distribution of marks for term work shall be as follows:

- Laboratory work (assignments): ………………..….. (25) Marks.
- Presentation:………………………………………………(15) Marks.
- Attendance ………………………………………. (10) Marks

TOTAL: ……………………………………………………. (50) Marks.

References:

For German

1. German Conversation Demystified with Two Audio CDs / Edition by Ed Swick
1. German Conversational: Learn to Speak and Understand French with Pimsleur Language Programs Audio CD – Audiobook by Pimsleur

For French

2. French Conversational: Learn to Speak and Understand French with Pimsleur Language Programs Audio CD – Audiobook by Pimsleur

Subject Code	Subject Name	Credits
CPL605	**Network Programming Laboratory**	02

Laboratory Course Outcomes:

Learner will be able to :

1. Configure Linux Network
2. View and edit routing tables
3. Configure Linux Router
4. Configure Linux FTP server
5. Install and Configure DNS server
6. Install and configure web server

Module	Detailed content	Hours
1	Study of Networking Commands (Ping, Tracert, TELNET, nslookup, netstat, ARP, RARP) and Network Configuration Files.	2
2	Linux Network Configuration. i. Configuring NIC's IP Address. ii. Determining IP Address and MAC Address using if-config command. iii. Changing IP Addess using ifconfig. iv. Static IP Address and Configuration by Editing. v. Determining IP Address using DHCP. vi. Configuring Hostname in /etc/hosts file.	4
3	Setting up multiple IP Addresses on a single LAN.	2
4	Using netstat and route commands to do the following. i. View current routing table. ii. Add and delete routes. iii. Change default gateway.	2
5	Using GUI configuration Tools to add /configure Ethernet Card.	2
6	Configuring Linux as a router by enabling IP Forwarding.	2
7	Configuring remote login Services, telnet & ssh. i. To install and configure TELNET server. ii. To set up SSH and connect to remote machine.	2

8	To configure Linux FTP server using VSFTPD. i. Set up anonymous access of FTP server. ii. Enable individual logins and add FTP users with Read- only access. iii. Transfer Files.	2
9	To install and configure DNS server.	2
10	To install and configure Web server.	2
11	Design TCP iterative Client and Server application to reverse the given input sentence.	2
12	Design TCP concurrent Client and Server application to reverse the given input sentence.	2
13	Design TCP Client and Server application to transfer file.	2
14	Design a TCP concurrent Server to convert a given text into upper case using multiplexing system call “select”.	2
15	Design a TCP concurrent Server to echo given set of sentences using Poll functions.	2
16	Design UDP Client and Server application to reverse the given input sentence.	2
17	Design UDP Client Server to transfer a file.	2
18	Design using Poll Client Server application to multiplex TCP and UDP requests for 60converting a given text into upper case.	2
19	Design a RPC application to add and subtract a given pair of integers.	2
20	Program to determine the host ByteOrder	2
21	Program to set and get socket options	2

Format of Laboratory Course:

The format for the Laboratory Course is

1. Atlease 8 small experiments based on above syllabus
2. One group Miniproject

A group of 3 students ; 4 Batches per class.

The scope of the miniproject should be such that it completes in 15 hours of actual working.

Termwork Assessment:

Laboratory Experiment: 10
Mini Project presentation : 10
Attendance : 05

End Semester Examination:

Oral examination is to be conducted by pair of internal and external examiners

AC 7/6/2014
Item 4.27

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Computer Engineering (Final Year – Sem. VII & VIII),
Revised course

(REV- 2012) from Academic Year 2015 - 16,
Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

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) 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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble:

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the 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. 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.

The Program Educational Objectives finalized for undergraduate program in Computer Engineering are listed below:

1. To prepare Learner's with a sound foundation in the mathematical, scientific and engineering fundamentals
2. To prepare Learner's to use effectively modern tools to solve real life problems
3. To equip Learner's with broad education necessary to understand the impact of computer Technology in a global and social context
4. To encourage , motivate and prepare Learner's for Lifelong-learning
5. To inculcate professional and ethical attitude, good leadership qualities and commitment to social responsibilities

In addition to above 2 to3 more program educational objectivesof their own may be added by affiliated Institutes.

The Program outcomes are the skils and ability that Learner will demonstrate upon completion of undergraduate degree program in Computer Engineering. Few may be listed as follows:

1. Ability to effectively apply knowledge of computing and mathematics to computer science problems.
2. Ability to design, implement and evaluate computer-based components, systems, processes or programs to meet desired needs and specifications.
3. Ability and skills to effectively use state-of-the-art techniques and computing tools for analysis, design, and implementation of computing systems.
4. Ability to function effectively as a member of a team assembled to undertake a common goal.
5. An understanding of professional, ethical, legal, security, and social issues and responsibilities.

6. Ability to communicate effectively to both technical and non-technical audiences.
7. The ability to successfully pursue professional development thru lifelong learning

In addition to Program Educational Objectives, for each course of undergraduate program,Course Objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

Dr. Prachi Gharpure

Chairperson, Adhoc Board of Studies in Computer Engineering,

University of Mumbai, Mumbai

Program Structure B.E. Computer Engineering

Fourth Year (Computer) (Semester VII)

(REV 2012)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CPC701	Digital Signal Processing	4	2	-	4	1	-	5
CPC702	Cryptography and System Security	4	2	-	4	1	-	5
CPC703	Artificial Intelligence	4	2	-	4	1	-	5
CPE7042X	Elective-II	4	2	-	4	1	-	5
CPP701	Project I	-	6#	-	-	3	-	3
CPL701	Network Threats and Attacks Laboratory	-	4	-	-	2	-	2
	Total	**16**	**18**	**-**	**16**	**9**	-	**25**

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			End Sem Exam	Exam Duration (in Hrs)	TW	oral	Total
		Test 1	Test 2	Avg					
CPC701	Digital Signal Processing	20	20	20	80	03	25	-	125
CPC702	Cryptography and System Security	20	20	20	80	03	25	25	150
CPC703	Artificial Intelligence	20	20	20	80	03	25	25	150
CPE7042X	Elective-II	20	20	20	80	03	25	25	150
CPP701	Project I	-	-	-	-	-	50	50	100
CPL701	Network Threats and Attacks Laboratory	-	-	-	-	-	25	50	75
	Total	**-**	**-**	**80**	**320**	-	**175**	**175**	**750**

Program Structure for B.E. Computer Engineering

Second Year (Computer) (Semester VIII)

(REV 2012)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CPC801	Data Warehouse and Mining	4	2	-	4	1	-	5
CPC802	Human Machine Interaction	4	2	-	4	1	-	5
CPC803	Parallel and distributed Systems	4	2	-	4	1	-	5
CPE803X	Elective-III	4	2	-	4	1	-	5
CPP802	Project II	-	12 #	-	-	6	-	6
CPL801	Cloud Computing Laboratory	-	2	-	-	1	-	1
	Total	**16**	**22**	**-**	**16**	**11**	-	**27**

Course Code	Course Name	Examination Scheme							
		Internal Assesment							
		Internal Assesment			End Sem Exam	Exam Duration (in Hrs)	TW	oral	Tot
		Test 1	Test 2	Avg					
CPC801	Data Warehouse and Mining	20	20	20	80	03	25	25	150
CPC802	Human Machine Interaction	20	20	20	80	03	25	25	150
CPC803	Parallel and distributed Systems	20	20	20	80	03	25	25	150
CPE803X	Elective-III	20	20	20	80	03	25	25	150
CPP802	Project II	-	-	-	-	-	50	50	100
CPL801	Cloud Computing Laboratory	-	-	-	-	-	25	-	25
	Total			80	320		175	150	725

 # Indicate workload for Learner and not for Faculty in semester VII and VIII

Elective II Sem 7

System Group	**CPE7021**	Advance Algorithms
	CPE7022	Computer Simulation and Modeling
Electronics Group	**CPE7023**	Image Processing
Software Group	**CPE7024**	Software Architecture
	CPE7025	Soft Computing
DB Group	**CPE7026**	ERP and Supply Chain Management

Elective III - Sem 8

Electronics Group	**CPE8031**	Machine Learning
Digital Group	**CPE8032**	Embedded Systems
Network Group	**CPE8033**	Adhoc wireless networks
	CPE8034	Digital Forensic
DB Group	**CPE8035**	Big data Analytics

Course Code	Course/Subject Name	Credits
CPC701	**Digital Signal Processing**	5

Objectives:

1. To learn the fundamental concepts of Digital Signal Processing.
2. To explore the properties of DFT in mathematical problem solving.
3. To illustrate FFT calculations mathematically and develop FFT based DSP algorithms.
4. To introduce DSP processor for real time signal processing application

Outcomes: Learner will be able to…

1. To understand the concept of DT Signal and perform signal manipulation
2. To perform analysis of DT system in time domain
3. To develop FFT flow-graph and Fast DSP Algorithms.
4. To design DSP system for Real Time Signal Processing.

Module	Detailed Contents	Hrs.
01	**Discrete Time Signal** 1.1 Introduction to Digital Signal Processing, Discrete Time Signals, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations(shifting, addition, subtraction, multiplication), Classification of Signals, Linear Convolution formulation(without mathematical proof), Circular Convolution formulation(without mathematical proof), Matrix Representation of Circular Convolution, Linear by Circular Convolution. Auto and Cross Correlation formula evaluation,	12
02	**Discrete Time System** 2.1 Introduction to Discrete Time System, Classification of DT Systems (Linear/Non Linear, Causal/Non Causal, Time Invariant/Time Variant Systems, Stable/ Unstable), BIBO Time Domain Stability Criteria. LTI system, Concept of Impulse Response and Step Response. 2.2 Concept of IIR System and FIR System, Output of IIR and FIR DT system using Time Domain Linear Convolution formula Method.	08
03	**Discrete Fourier Transform** 3.1 Introduction to DTFT, DFT, Relation between DFT and DTFT, 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. 3.2 Transfer function of DT System in frequency domain using DFT. Linear and Circular Convolution using DFT. Response of FIR system calculation in frequency domain using DFT.	08
04	**Fast Fourier Transform** 4.1 Radix-2 DIT-FFT algorithm, DIT-FFT Flowgraph for N=4, 6 & 8, Inverse	06

	FFT algorithm. Spectral Analysis using FFT, Comparison of complex and real, multiplication and additions of DFT and FFT.	
05	**DSP Algorithms** 5.1 Carls' Correlation Coefficient Algorithm, Fast Circular Convolution Algorithm, Fast Linear Convolution Algorithm, Linear FIR filtering using Fast Overlap Add Algorithm and Fast Overlap Save Algorithm,	08
06	**DSP Processors and Application of DSP** 6.1 Need for Special architecture of DSP processor, Difference between DSP processor & microprocessor, A general DSP processor TMS320C54XX series, Case study of Real Time DSP applications to Speech Signal Processing and Biomedical Signal Processing.	06

List of Experiments:

Implementation of programs must be either in C or C++ only. Application can be developed using open source simulation software such as Scilab. A List of compulsory eight experiments is given below. Additional experiments within the scope of the syllabus can be added.

1. Sampling and Reconstruction

Aim:

To study sampling and reconstruction of signal

Objective:

Develop a program to sample a continuous time signal and convert it to Discrete Time Signal.

Problem Definition:

1. Sample the input signal and display first 50 samples. Calculate data rate and bit rate.
2. Reconstruct the original signal and display the original and reconstructed signals.
3. Vary the sampling frequency and observe the change in the quality of reconstructed signal.

---

2. To perform Discrete Correlation

Aim:

To study mathematical operation Correlation and measure degree of similarity between two signals

Objective:

1. Write a function to find correlation operation.
2. Calculate correlation of a DT signals and verify the results using mathematical formulation.
3. Measure the degree of similarity using Carl's Correlation Coefficient formula in time domain.

Input Specifications:

1. Length of first Signal L and signal values.
2. Length of second Signal M and signal values.

Problem Definition:

1. Find auto correlation of input signal. What is the significance of value of output signal value at n=0?.
2. Find auto correlation of delayed input signal.
3. Find cross correlation of input signal and delayed input signal,
4. Find cross correlation of input signal and scaled delayed input signal.
5. Compare the resultant signals. Give your conclusion.
6. Take two input finite length DT signals and develop a function to find Carl's Correlation Coefficient value. Determine the degree of similarity of two signals from the calculated Carl's Correlation Coefficient value.

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3. To perform Discrete Convolution

Aim:

The aim of this experiment is to study mathematical operation such as Linear convolution, Circular convolution, Linear convolution using circular convolution.

Objective:

1. Develop a function to find Linear Convolution and Circular Convolution
2. Calculate Linear Convolution, Circular Convolution, Linear Convolution using Circular Convolution and verify the results using mathematical formulation.
3. Conclude on aliasing effect in Circular convolution

Input Specifications:

1. Length of first Signal L and signal values.
2. Length of second Signal M and signal values.

Problem Definition:

1. Find Linear Convolution and Circular Convolution of L point sequence x[n] and M point sequence h[n].
2. Find Linear Convolution of L point sequence x[n] and M point sequence h[n] using Circular convolution.
3. Give your conclusion about No of values in linearly convolved signal, and Aliasing effect in Circular Convolution.

---

4. To perform Discrete Fourier Transform

Aim:
The aim of this experiment is to study magnitude spectrum of the DT signal.

Objective:

1. Develop a function to perform DFT of N point signal
2. Calculate DFT of a DT signal and Plot spectrum of the signal.
3. Conclude the effect of zero padding on magnitude spectrum.
4. Calculate the number of real multiplications and real additions required to find DFT.

Input Specifications:

1. Length of Signal N
2. Signal values

Problem Definition:

1. Take any four-point sequence x[n].

- Find DFT X[k].
- Compute number of real multiplications and real additions required to find X[k].
- Plot Magnitude Spectrum of the signal.

2. Append the input sequence by four zeros. Find DFT and plot magnitude spectrum. Repeat the same by appending the sequence by eight zeros. Observe and compare the magnitude spectrum. Give your conclusion.

---

5. To perform Fast Fourier Transform

Aim:
To implement computationally fast algorithms.

Objective:
1. Develop a program to perform FFT of N point signal.
2. Calculate FFT of a given DT signal and verify the results using mathematical formulation.
3. Illustrate the computational efficiency of FFT.

Input Specifications:

- Length of Signal N
- Signal values

Problem Definition:
Take any eight-point sequence x[n].

- Find FFT X[k].
- Write number of real multiplications and real additions involved in finding X[k].

---

6. Filtering of long Data Sequence

Aim:

To perform filtering of Long Data Sequence using Overlap Add Method and Overlap Save Method.

Objective:

Develop a function to implement Fast Overlap Add and Fast Overlap Save Algorithm using FFT.

Input Specifications:

1. Length of long data sequence and signal values.
2. Length of impulse response M and coefficient values of h[n].

Problem Definition:

Find the output of a Discrete Time system using Fast Overlap Add Method OR Fast Overlap Save Method.

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7. Real Time Signal Processing

Aim:

To perform real time signal processing using TMS320 Processor.

Objective:

Study real time signal processing.

Input Specifications:

1. Real Time Speech Signal

Problem Definition:

1) Capture the real time audio signal.
2) Filter it by convolving input signal with the impulse response of FIR filter using Fast Overlap Add filtering Algorithm OR Fast Overlao Save Filtering Algorithm.
3) Observe the quality of output signal.

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8. Application of Digital Signal Processing

Aim:

To implement any Signal Processing operation on one dimensional signal.

Objective:
To develop application of signal processing.

Input Specifications:
One dimensional signal.

Rules:

1. Number of students in one Group : min - 2 max -3
2. Decide one DSP application of your choice. Collect the information related to the application from the published granted patents. Download the related published papers from the standard refereed journals and conferences.
3. Develop a block diagram of the proposed system and flowchart of proposed system algorithm, implement it using Scilab/C, C++ language and obtain the appropriate results.
4. Prepare the three to four pages report on the mini project in IEEE paper format. Report should include Abstract, Introduction, Related Theory, Proposed System Design/Algorithm, Experimentation & Result Analysis, Conclusion, and References.

5.

Term Work:

- Term work shall consist of minimum **08** assignments and course project.
- Journal must include at least 1 assignment on each module and two quiz.
- The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

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

• Laboratory work (experiments): ……………..………..	(15)	Marks.
• Assignment:……………………………………..……	(05)	Marks.
• Attendance (Theory+ Practical)…………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Text Books :

1. Ashok Ambardar, 'Digital Signal Processing', Cengage Learning, 2007, ISBN : 978-81-315-0179-5.

2. Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital Signal Processing: A Practical Approach”, Pearson Education ISBN 0-201-59619- 9

3. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, ‘Digital Signal Processing’ TataMcgraw Hill Publication First edition (2010). ISBN 978-0-07-066924-6.

4. Avtar Signh, S.Srinivasan,”Digital Signal Processing’, Thomson Brooks/Cole, ISBN : 981-243-254-4

Reference Books :

1. B. Venkatramani, M. Bhaskar ,”Digital Signal Processor’, TataMcGraw Hill, Second Edition, (2001). ISBN : 978-0-07-070256-1.

2. Sanjit Mitra, ‘Digital Signal Processing : A Computer Based Approach’ , TataMcGraw Hill, Third Edition

3. Dr, Shaila Apte, “Digital Signal Processing,”, Wiley India, Second Edition,2013 ISBN : 978-81-2652142-5

4. Proakis Manolakis, ‘Digital Signal Processing : Principles, Algorithms and Applications’ Fourth 2007, Pearson Education, ISBN 81-317-1000-9.

5. Monson H. Hayes, “Schaums Outline of Digital Signal Processing’ McGraw Hill International second edition. ISBN : 978-00-7163509-7

Course Code	Course/Subject Name	Credits
CPC702	**Cryptography and System Security**	5

Objectives:

1. To provide students with contemporary knowledge in Cryptography and Security.
2. To understand how crypto can be used as an effective tools in providing assurance concerning privacy and integrity of information.
3. To provide skills to design security protocols for recognize security problems.

Outcomes: Learner will be able to…

1. Understand the principles and practices of cryptographic techniques.
2. Understand a variety of generic security threats and vulnerabilities, and identify & analyze particular security problems for given application.
3. Appreciate the application of security techniques and technologies in solving real-life security problems in practical systems.
4. Apply appropriate security techniques to solve security problem
5. Design security protocols and methods to solve the specific security problems.
6. Familiar with current research issues and directions of security.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Security Attacks, Security Goals, Computer criminals, Methods of defense, Security Services, Security Mechanisms	06
02	**Basics of Cryptography** 2.1 Symmetric Cipher Model, Substitution Techniques, Transportation Techniques, Other Cipher Properties- Confusion, Diffusion, Block and Stream Ciphers.	06
03	**Secret Key Cryptography** 3.1 Data Encryption Standard(DES), Strength of DES, Block Cipher Design Principles and Modes of Operations, Triple DES, International Data Encryption algorithm, Blowfish, CAST-128.	06
04	**Public Key Cryptography** 4.1 Principles of Public Key Cryptosystems, RSA Algorithm, Diffie-Hellman Key Exchange	04
05	**Cryptographic Hash Functions** 5.1 Applications of Cryptographic Hash Functions, Secure Hash Algorithm, Message Authentication Codes – Message Authentication Requirements and Functions, HMAC, Digital signatures, Digital Signature Schemes, Authentication Protocols, Digital Signature Standards.	06
06	**Authentication Applications** 6.1 Kerberos, Key Management and Distribution, X.509 Directory Authentication service, Public Key Infrastructure, Electronic Mail Security: Pretty Good Privacy, S/MIME.	06

07	**7.1 Program Security** Secure programs, Nonmalicious Program Errors, Malicious Software – Types, Viruses, Virus Countermeasures, Worms, Targeted Malicious Code, Controls against Program Threats. **7.2 Operating System Security** Memory and Address protection, File Protection Mechanism, User Authentication. **7.3 Database Security** Security Requirement, Reliability and Integrity, Sensitive data, Inference, Multilevel Databases **7.4 IDS and Firewalls** Intruders, Intrusion Detection, Password Management, Firewalls-Characteristics, Types of Firewalls, Placement of Firewalls, Firewall Configuration, Trusted systems.	08
08	**8.1 IP Security** Overview, Architecture, Authentication Header, Encapsulating Security Payload, Combining security Associations, Internet Key Exchange, Web Security: Web Security Considerations, Secure Sockets Layer and Transport Layer Security, Electronic Payment. **8.2 Non-cryptographic protocol Vulnerabilities** DoS, DDoS, Session Hijacking and Spoofing, Software Vulnerabilities-Phishing, Buffer Overflow, Format String Attacks, SQL Injection.	06

Term Work:

Term work should consist of at least 10experiments, 2 assignments based on above theory syllabus.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
The distribution of marks for term work shall be as follows:

- Laboratory work (experiments): ………….……….. (15) Marks.
- Assignment:…………………………………..…… (05) Marks.
- Attendance (Theory+ Practical)……………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

Practical Exam will be based on above syllabus.

Syllabus for Practical

Suggested topics for experiment but not limited to:

1. RSA and MD5 algorithms.
2. Packet Analyzer.

3. IPSec
4. Spoofing
5. PGP(Pretty Good Privacy)
6. Port Scanning
7. Vulnerability scanner
8. Buffer Overflow
9. Intrusion Detection System
10. Password cracking
11. Firewall
12. SSL

Theory Examination:

1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

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

Text Books:

1. Cryptography and Network Security: Principles and Practice 5th edition, William Stallings, Pearson.
2. Network Security and Cryptography 2nd edition, Bernard Menezes, Cengage Learning.
3. Cryptography and Network, 2nd edition, Behrouz A Fourouzan, Debdeep Mukhopadhyay, TMH.

Reference Books:

1. Cryptography and Network Security by Behrouz A. Forouzan, TMH
2. Security in Computing by Charles P. Pfleeger, Pearson Education.
3. Computer Security Art and Science by Matt Bishop, Addison-Wesley.

Course Code	Course/Subject Name	Credits
CPC703	**Artificial Intelligence**	5

Objectives:

1. To conceptualize the basic ideas and techniques underlying the design of intelligent systems.
2. To make students understand and Explore the mechanism of mind that enable intelligent thought and action.
3. To make students understand advanced representation formalism and search techniques.
4. To make students understand how to deal with uncertain and incomplete information.

Outcomes: Learner will be able to

1. Ability to develop a basic understanding of AI building blocks presented in intelligent agents.
2. Ability to choose an appropriate problem solving method and knowledge representation technique.
3. Ability to analyze the strength and weaknesses of AI approaches to knowledge– intensive problem solving.
4. Ability to design models for reasoning with uncertainty as well as the use of unreliable information.
5. Ability to design and develop the AI applications in real world scenario.

Module	Detailed Contents	Hrs
01	**Introduction to Artificial Intelligence** 1.1 Introduction , History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI.	04
02	**Intelligent Agents** 2.1 Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agent.	04
03	**Problem solving** 3.1 Solving problem by Searching : Problem Solving Agent, Formulating Problems, Example Problems. 3.2 Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS) , Depth Limited Search, Depth First Iterative Deepening(DFID), Informed Search Methods: Greedy best first Search ,A* Search , Memory bounded heuristic Search. 3.3 Local Search Algorithms and Optimization Problems: Hill-climbing search Simulated annealing, Local beam search,	14

	Genetic algorithms. 3.4 Adversarial Search: Games, Optimal strategies, The minimax algorithm , Alpha-Beta Pruning.	
04	**Knowledge and Reasoning** 4.1 Knowledge based Agents, The Wumpus World, The Propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining. 4.2 Knowledge Engineering in First-Order Logic, Unification, Resolution, Introduction to logic programming (PROLOG). 4.3 **Uncertain Knowledge and Reasoning:** Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Inference in belief network.	12
05	**Planning and Learning** 5.1The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning. 5.2 Learning: Forms of Learning, Inductive Learning, Learning Decision Tree. 5.3 Expert System: Introduction, Phases in building Expert Systems, ES Architecture, ES vs Traditional System.	10
06	**Applications** 6.1 Natural Language Processing(NLP), Expert Systems.	04

Term Work:

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.

There will be at least two assignments covering the above syllabus.

Practical/Oral examination:

Practical examination based on the above syllabus will be conducted.

List of AI Practical / Experiments

All the programs should be implemented in C/C++/Java/Prolog under Windows or Linux environment. Experiments can also be conducted using available open source tools.

1. One case study on NLP/Expert system based papers published in IEEE/ACM/Springer or any prominent journal.

2. Program on uninformed and informed search methods.

3. Program on Local Search Algorithm.

4. Program on Optimization problem.

5. Program on adversarial search.

6. Program on Wumpus world.

7. Program on unification.

8. Program on Decision Tree.

Any other practical covering the syllabus topics and subtopics can be conducted.

Reference Books (Practicals):

1. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
2. Elaine Rich and Kevin Knight "Artificial Intelligence "Third Edition
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
4. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers.

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach “Second Edition" Pearson Education.
2. Saroj Kaushik “Artificial Intelligence” , Cengage Learning.
3. George F Luger “Artificial Intelligence” Low Price Edition , Pearson Education., Fourth edition.

Reference Books:

1. Ivan Bratko “PROLOG Programming for Artificial Intelligence”, Pearson Education, Third Edition.
2. Elaine Rich and Kevin Knight “Artificial Intelligence” Third Edition
3. Davis E.Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y., 1989.
4. Hagan, Demuth, Beale, “Neural Network Design” CENGAGE Learning, India Edition.
5. Patrick Henry Winston , “Artificial Intelligence”, Addison-Wesley, Third Edition.
6. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers.
7. N.P.Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press.

Course Code	Course/Subject Name	Credits
CPE7021	**Advanced Algorithms**	5

Objectives:

1. To teach fundamentals of analysis of algorithm at depth
2. To provide in depth study of advanced data structures and its uses
3. To teach analysis of problems from different domains

Outcomes: Learner will be able to…

1. Identify and use suitable data structures for given problem from different domains
2. Appreciate the role of Graph algorithms in solving variety of problems
3. Appreciate the role of Optimization by using linear programing
4. Analyze the various algorithms from different domains

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Asymptotic notations Big O, Big Θ,Big Ω,o ,ω notations ,Proofs of master theorem, applying theorem to solve problems	03
02	**Advanced Data Structures** 2.1 Red-Black Trees: properties of red-black trees , Insertions , Deletions 2.2 B-Trees and its operations 2.3 Binomial Heaps: Binomial trees and binomial heaps, Operation on Binomial heaps	09
03	**Dynamic Programing** 3.1 matrix chain multiplication, cutting rod problem and its analysis	06
04	**Graph algorithms** 4.1 Bellman ford algorithm, Dijkstra algorithm, Johnson's All pair shortest path algorithm for sparse graphs	06
05	**Maximum Flow** 5.1 Flow networks , the ford Fulkerson method ,max bipartite matching , push Relabel Algorithm , The relabel to front algorithm	08
06	**Linear Programing** 6.1 Standard and slack forms, Formulating problems as linear programs, simplex algorithm, Duality, Initial basic feasible solution	08
07	**Computational Ggeometry** 7.1 Line Segment properties, Determining whether any pair of segment intersects, finding the convex hull, Finding the closest pair of points.	08

Term Work:

Term work should consist of at least 6 experiments, 2 assignments based on above theory syllabus.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

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

• Laboratory work (experiments): ……………..………..	(15)	Marks.
• Assignment:……………………………………..……	(05)	Marks.
• Attendance (Theory+ Practical)…………………….	(05)	Marks
TOTAL: …………………………………………………….	**(25)**	**Marks.**

Practical/Oral examination:

Oral examination based on above syllabus will be conducted

Syllabus for Practical

Suggested topics for experiment but not limited to:

1. Red – black trees and its various operations
2. Binomial Heaps and its various operations
3. Dynamic programing: matrix chain multiplication , cutting rod example
4. Bellman ford , Johnson's algorithm for sparse graphs
5. Ford Fulkerson algorithm , push relabel to front methods
6. Finding closest pair of points, Determining the convex hull
7. Implementation of Simplex algorithm

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. Rajsekaran. "Fundamentals of computer algorithms" University press

Course Code	Course/Subject Name	Credits
CPE7023	**Image Processing**	5

Objectives:

1. To learn the fundamental concepts of Digital Image Processing and Video Processing .
2. To understand basic image enhancement and segmentation techniques.
3. To illustrate Image Transform calculations mathematically and develop fast transform algorithm
4. To learn Image Compression and Decompression Techniques

Outcomes: Learner will be able to…

1. Understand the concept of Digital Image and Video Image.
2. Explain image enhancement and Segmentation technique.
3. Develop fast image transform flowgraph
4. Solve Image compression and decompression techniques
5. Perform Binary Image Processing Operations

Module	Detailed Contents	Hrs.
01	**Digital Image and Video Fundamentals** 1.1 Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization, Representation of Digital Image, Connectivity, Image File Formats : BMP, TIFF and JPEG. Colour Models (RGB, HSI, YUV) Introduction to Digital Video, Chroma Sub-sampling, CCIR standards for Digital Video	06
02	**Image Enhancement** 2.1 Gray Level Transformations, Zero Memory Point Operations, Histogram Processing, Neighbourhood Processing, Spatial Filtering, Smoothing and Sharpening Filters. Homomorphic Filtering	09
03	**Image Segmentation and Representation** 3.1 Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique, Image Representation and Description, Chain Code, Polygonal Representation, Shape Number, Moments.	09
04	**Image Transform** 4.1 Introduction to Unitary Transform, Discrete Fourier Transform(DFT), Properties of DFT, Fast Fourier Transform(FFT), Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete Cosine Transform(DCT), Discrete Wavelet Transform(DWT),	09
05	**Image Compression** 5.1 Introduction, Redundancy, Fidelity Criteria, 5.2 Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM,	09

	5.3 Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG, MPEG-1.	
06	**Binary Image Processing** 6.1 Binary Morphological Operators, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Connected Component Labeling, Iterative Algorithm and Classical Algorithm	06

Term Work:

Term work should consist of at least 08 experiments.
Journal must include at least 1 assignment on each module and two quiz.
The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

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

- Laboratory work (experiments): ………….……….. (15) Marks.
- Assignment:…………………………………..…… (05) Marks.
- Attendance (Theory+ Practical)……………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

Oral exam will be based on the above syllabus

Practicals

Implementation of programs must be either in C or C++ only. A List of experiments is given below. Input can be Monochrome OR Colour Image. Additional experiments within the scope of the syllabus can be added.

1. Image Enhancement [Any two techniques]
   (1) using Zero Memory Point Operations.
   (2) using Histogram Processing Technique
   (3) using Spatial Filtering [Smoothing Filters/ Sharpening Filters]
   (4) using Homomorphic Filtering

2. Image Segmentation [Any two techniques]

(1) Horizontal and Vertical Line Detection
(2) Edge Detection
(3) Split and Merge Technique
(4) Edge Linking using Hough Transform

3. Image Compression and De-compression [Any two techniques]
(1) Arithmetic Coding and Decoding
(2) Huffman Coding and Decoding
(3) IGS Quantization/ Vector Quantization based Compression and De-compression
(4) Transform based Image Compression and De-compression [FFT/ FHT/DCT/ DWT]

4. Binary Image Processing [Any two techniques]
 (1) Opening followed by Closing
 (2) Hit or Miss Transform
 (3) Thinning/Thickening/ Region Fillling / Boundary Extraction
 (4) Connected Component Algorithm

Text Books :

1. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition, 2009,

2. S. Jayaraman, E.Esakkirajan and T.Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009,

3. Anil K. Jain, "Fundamentals and Digital Image Processing", Prentice Hall of India Private Ltd, Third Edition

4. S. Sridhar, "Digital Image Processing", Oxford University Press, Second Edition, 2012.

5. Robert Haralick and Linda Shapiro, "Computer and Robot Vision", Vol I, II, Addison Wesley, 1993.

Reference Books:

1. Dwayne Phillps, "Image Processing in C", BPB Publication, 2006

2. B. Chandra and D.Dutta Majumder, "Digital Image Processing and Analysis", Prentice Hall of India Private Ltd, 2011

3. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", Prentice Hall of India Private Ltd, Third Edition

4. Fred Halshall, "Multimedia Communications: Applications, Networks Protocols and Standards,", Pearson Education 2001

5. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach", Pearson Education, Limited, 2011

Course Code	Course/Subject Name	Credits
CPE7024	**Software Architecture**	5

Outcomes:
Software architecture is foundational to the development of large, practical software-intensive applications.
After successful completion of this course learner will be able to:

- Visualize the architectural concepts in development of large, practical software-intensive applications.
- Rather than focusing on one method, notation, tool, or process, this new course widely surveys software architecture techniques, enabling us to choose the right tool for the job at hand.

Module	Detailed Contents	Hrs.
01	**Basic Concepts** 1.1 Concepts of Software Architecture 1.2 Models. 1.3 Processes. 1.4 Stakeholders	03
02	**Designing Architectures** 2.1 The Design Process. 2.2 Architectural Conception. 2.3 Refined Experience in Action: Styles and Architectural Patterns. 2.4 Architectural Conception in Absence of Experience.	02
03	**Connectors** 3.1 Connectors in Action: A Motivating Example. 3.2 Connector Foundations. 3.3 Connector Roles. 3.4 Connector Types and Their Variation Dimensions. 3.5 Example Connectors.	06
04	**Modeling** 4.1 Modeling Concepts. 4.2 Ambiguity, Accuracy, and Precision. 4.3 Complex Modeling: Mixed Content and Multiple Views. 4.4 Evaluating Modeling Techniques. 4.5 Specific Modeling Techniques.	04
05	**Analysis** 5.1 Analysis Goals. 5.2 Scope of Analysis. 5.3 Architectural Concern being Analyzed. 5.4 Level of Formality of Architectural Models.	08

	5.5 Type of Analysis. 5.6 Analysis Techniques.	
06	**Implementation and Deployment** 6.1 Concepts. 6.2 Existing Frameworks. 6.3 Software Architecture and Deployment. 6.4 Software Architecture and Mobility.	04
07	**Conventional Architectural styles** 7.1 Pipes and Filters 7.2 Event- based, Implicit Invocation 7.3 Layered systems 7.4 Repositories 7.5 Interpreters 7.6 Process control	05
08	**Applied Architectures and Styles** 8.1 Distributed and Networked Architectures. 8.2 Architectures for Network-Based Applications. 8.3 Decentralized Architectures. 8.4 Service-Oriented Architectures and Web Services.	08
09	**Designing for Non-Functional Properties** 9.1 Efficiency. 9.2 Complexity. 9.3 Scalability and Heterogeneity. 9.4 Adaptability. 9.5 Dependability.	04
10	**Domain-Specific Software Engineering** 10.1 Domain-Specific Software Engineering in a Nutshell. 10.2 Domain-Specific Software Architecture. 10.3 DSSAs, Product Lines, and Architectural Styles.	04

Term Work:

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

- Laboratory work (experiments):…………………….. (20) Marks.
- Attendence:…….……………………………………… (05) Marks.

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

An Oral examination is to be conducted based on the above syllabus

Topics For Experiment:

1. Modeling using xADL
2. Analysis - Case study
3. Visualization using xADL 2.0
4. Integrate software components using a middleware
5. Use middleware to implement connectors
6. Wrapper to connect two applications with different architectures
7. Creating web service
8. Architecture for any specific domain

Books:

Text Books:

1. "Software Architecture: Foundations, Theory, and Practice" by Richard N. Taylor, Nenad Medvidovic, Eric Dashofy, ISBN: 978-0-470-16774-8
2. M. Shaw: Software Architecture Perspectives on an Emerging Discipline, Prentice-Hall.
3. Len Bass, Paul Clements, Rick Kazman: Software Architecture in Practice, Pearson.

References:

1. "Pattern Oriented Software Architecture" by Frank Buchnan et al, Wiley India.
2. "The Art of Software Architecture" by Stephen T. Albin.

Course Code	Course/Subject Name	Credits
CPE7025	**Soft Computing**	5

Objectives:

1. To Conceptualize the working of human brain using ANN.
2. To become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems.
3. To introduce the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience.
4. To provide the mathematical background for carrying out the optimization and familiarizing genetic algorithm for seeking global optimum in self-learning situation.

Outcomes: Learner will be able to…

1. Ability to analyze and appreciate the applications which can use fuzzy logic.
2. Ability to design inference systems.
3. Ability to understand the difference between learning and programming and explore practical applications of Neural Networks (NN).
4. Ability to appreciate the importance of optimizations and its use in computer engineering fields and other domains.
5. Students would understand the efficiency of a hybrid system and how Neural Network and fuzzy logic can be hybridized to form a Neuro-fuzzy network and its various applications.

Module	**Detailed Contents**	**Hours**
01	**Introduction to Soft Computing** 1.1 Soft computing Constituents, Characteristics of Neuro Computing and Soft Computing, Difference between Hard Computing and Soft Computing, Concepts of Learning and Adaptation.	**04**
02	**Neural Networks** **2.1 Basics of Neural Networks:** Introduction to Neural Networks, Biological Neural Networks, McCulloch Pitt model, **2.2 Supervised Learning algorithms:** Perceptron (Single Layer, Multi layer), Linear separability, Delta learning rule, Back Propagation algorithm, **2.3 Un-Supervised Learning algorithms:** Hebbian Learning, Winner take all, Self Organizing Maps, Learning Vector Quantization.	**14**

03	**Fuzzy Set Theory** 3.1 Classical Sets and Fuzzy Sets, Classical Relations and Fuzzy Relations, Properties of membership function, Fuzzy extension principle, Fuzzy Systems- fuzzification, defuzzification and fuzzy controllers.	**14**
04	**Hybrid system** 4.1 Introduction to Hybrid Systems, Adaptive Neuro Fuzzy Inference System(ANFIS).	**04**
05	**Introduction to Optimization Techniques** **5.1 Derivative based optimization-** Steepest Descent, Newton method. **5.2 Derivative free optimization-** Introduction to Evolutionary Concepts.	**06**
06	**Genetic Algorithms and its applications:** 6.1 Inheritance Operators, Cross over types, inversion and Deletion, Mutation Operator, Bit-wise Operators, Convergence of GA, Applications of GA.	**06**

Term Work:

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

- Laboratory work (experiments/case studies): ………….. (15) Marks.
- Assignments:………………………………………… (05) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

Oral examination will be based on the above syllabus.

PRACTICALS:

All the programs should be implemented in C/C++/Java/MATLAB under Windows or Linux environment. Experiments can also be conducted using available open source tools like OCTAVE and SCILAB

LIST OF SC PRACTICAL / EXPERIMENTS

1. One case study on Fuzzy/Neural/GA based papers published in IEEE/ACM/Springer or any prominent journal.

2. To implement Fuzzy Sets.

3. To implement Fuzzy Relations.
4. To implement Fuzzy Controllers.
5. To implement Basic Neural Network learning rules.
6. To implement any Supervised Learning algorithm.
7. To implement any Unsupervised Learning algorithm.
8. To implement a simple application using Genetic Algorithm.

Any other practical covering the syllabus topics and subtopics can be conducted.

Reference Books (for practicals) :

1. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
2. S.Rajasekaran and G.A.Vijayalakshmi Pai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning.
3. Hagan, Demuth, Beale,"Neural Network Design" CENGAGE Learning, India Edition.
4. Satish Kumar, “Neural Networks –A classroom approach”, Second Edition,TMH Publication.

Text Books:

1. Timothy J.Ross "Fuzzy Logic With Engineering Applications" Wiley.
2. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
3. S.Rajasekaran and G.A.Vijayalakshmi Pai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning.
4. J.-S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
5. Jacek.M.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House.

Reference Books:

1. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
2. Zimmermann H.S "Fuzzy Set Theory and its Applications" Kluwer Academic Publishers.
3. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
4. Hagan, Demuth, Beale, "Neural Network Design" CENGAGE Learning, India Edition.

Course Code	Course/Subject Name	Credits
CPE7026	**Enterprise Resource Planning and Supply Chain Management (ERP & SCM)**	5

Objectives:

1. To understand the technical aspects of ERP and SCM systems.
2. To understand the steps and activities in the ERP and SCM life cycle.
3. To identify and describe typical functionality in an ERP and SCM system.
4. To understand tools and methodology used for designing ERP and SCM for an Enterprise.

Outcomes: Learner will be able to…

1. To conceptualize the basic structure of ERP and SCM
2. To identify implementation strategy used for ERP and SCM.
3. To apply design principles for various business module in ERP and SCM.
4. To apply different emerging technologies for implementation of ERP and SCM.

Module	Detailed Contents	Hours
Enterprise Resource Planning		
01	**Introduction** 1.1 What is an Enterprize, Introduction to ERP, Need for ERP, Structure of ERP, Scope and Benefits, Typical business processes.	02
02	**ERP and Technology** 2.1 ERP and related technologies, Business Intelligence, E-business and E-commerce, Business Process Reengineering,	04
03	**ERP and Implementation** 3.1 ERP implementation and strategy, Implementation Life cycle, Pre-implementation task, requirement definition , implementation methodology.	06
04	**ERP Business Modules** 4.1 Modules: Finance, manufacturing, human resources, quality management, material management, marketing. Sales distribution and service.	08
05	**Extended ERP** 5.1 Enterprise application Integration (EAI), open source ERP, cloud ERP.	04
Supply Chain Management (SCM)		
06	**Introduction and strategic decisions in SCM**	08

	6.1 Introduction to SCM, Generic Types of supply chain, Major Drivers of Supply chain, Strategic decisions in SCM, Business Strategy, CRM strategy, SRM strategy, SCOR model.	
07	**Information Technology in SCM** 7.1 Types of IT Solutions like Electronic Data Inter change (EDI), Intranet/ Extranet, Data Mining/ Data Warehousing and Data Marts, E-Commerce, E- Procurement, Bar coding, RFID, QR code.	06
08	**Mathematical modelling for SCM** 8.1 Introduction, Considerations in modelling SCM systems, Structuring the logistics chain, overview of models: models on transportation problem, assignment problem, vehicle routing problem, Model for vendor analysis, Make versus buy model.	06
09	**Agile Supply Chain** 9.1 Introduction, Characteristics of Agile Supply Chain, Achieving Agility in Supply Chain.	02
10	**Cases of Supply Chain** 10.1 Cases of Supply Chain like, News Paper Supply Chain, Book Publishing, Mumbai Dabbawala, Disaster management, Organic Food, Fast Food.	02

Term Work:

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

- Mini project:……………………………….………… (20) Marks.
- Attendance …………………………...……………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Practical/Oral examination:

Oral examination will be based on the above syllabus.

The lab will be conducted on mini project which may be conducted on the following:

1) Simulating business processes of an Enterprise.
2) Designing a web portal for an Enterprise using E-business Models.
3) E-procurement model.
4) Open source ERP
5) Cloud ERP
6) Business process agility
7) SCM model.
8) Implementing Business Intelligence
9) Any other relevant topics covering the syllabus.

Text Books:

1. Enterprise Resource Planning : concepts & practices, by V.K. Garg & N.K. Venkatakrishnan ; PHI.
2. Supply Chain Management Theories & Practices: R. P. Mohanty, S. G. Deshmukh, - Dreamtech Press.
3. ERP Demystified: II Edition, by Alexis Leon,McGraw Hill .
4. Enterprise wide resource planning: Theory & practice: by Rahul Altekar,PHI.

Reference Books:

1. ERP to E^2 ERP: A Case study approach, by Sandeep Desai, Abhishek Srivastava, PHI.

2. Managerial Issues of ERP system, by David Olson, McGraw Hill.

Course Code	Course/Subject Name	Credits
CPE7022	**Computer Simulation and Modeling**	5

Course Objectives:

This course presents an introduction to discrete event simulation systems. Emphasis of the course will be on modeling and the use of simulation languages/software to solve real world problems in the manufacturing as well as services sectors. The course discusses the modeling techniques of entities, queues, resources and entity transfers in discrete event environment. The course will teach the students the necessary skills to formulate and build valid models, implement the model, perform simulation analysis of the system and analyze results properly. The "theory" of simulation involves probability and statistics, thus a good background in probability and statistics is a required prerequisite

Course Outcomes:

1. Apply simulation concepts to achieve in business, science, engineering, industry and services goals
2. Demonstrate formulation and modeling skills.
3. Perform a simulation using spreadsheets as well as simulation language/package
4. Generate pseudorandom numbers using the Linear Congruential Method
5. Evaluate the quality of a pseudorandom number generator using statistical tests
6. Analyze and fit the collected data to different distributions

Module	Detailed Contents	Hours
	Computer Simulation and Modeling	
01	Introduction to Simulation. Simulation Examples. General Principles	15
02	Statistical Models in simulation. Queuing Models	08
03	Random Number Generation. Testing random numbers (Refer to Third edition) Random Variate Generation: Inverse transform technique, Direct Transformation for the Normal Distribution, Convolution Method, Acceptance-Rejection Technique (only Poisson Distribution).	09

04	Analysis of simulation data : Input Modeling ,Verification, Calibration and Validation of Simulation , Models , Estimation of absolute performance.	12
05	Application : Case study on 1. Processor and Memory simulation 2. Manufacturing & Material handling	04

Text Books:

Discrete Event System Simulation; Third Edition, Jerry Banks, John Carson, Barry Nelson, and David M. Nicol, Prentice-Hall

Discrete Event System Simulation; Fifth Edition, Jerry Banks, John Carson, Barry Nelson, and David M. Nicol, Prentice-Hall

References:

4. System Modeling & Analysis; Averill M Law, 4^{th} Edition TMH.
5. Principles of Modeling and Simulation; Banks C M , Sokolowski J A; Wiley
6. System Simulation ; Geoffrey Gordon ; EEE
7. System Simulation with Digital Computer; Narsing Deo, PHI

Term work:

Laboratory work: 10 marks

Mini Simulation Project presentation: 10 marks

Attendance : 5 marks

Suggested Practical List (If Any):

Perform simulation exercises given in the text book (third edition) using spreadsheets and/or simulation language/package

5. Queue- single server, multi-server, classic case- dump truck
6. Inventory – Lead time=0, lead time fixed, lead time probabilistic
7. Reliability problem
8. Tutorials on statistical models
9. Random number generate and test
10. Goodness of fit test
11. Output analysis – Point estimate and Confidence Interval

Simulation: Real World Examples – can be in the field of business, transportation, medical, computing, manufacturing and material handling- Presentation to be taken.

Practical/Oral examination:

Oral examination will be based on the above syllabus.

Course Code	Course/Subject Name	Credits
CPL701	**Network threats and attacks Laboratory**	02

Outcomes: After completion of this Laboratory course learner will be able To

1. Use network-based tools for network analysis
2. Use techniques for Network scaning
3. Identify network vulnerability
4. Use tools to simulate intrusion detection system
5. To understand and install a firewall

Module	Detailed Contents
01	**1.1 Title:** Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars. **Objective:** Objective of this module to how to gather information about the networks by using different n/w reconnaissance tools. **Scope:** Network analysis using network based tools **Technology**: Networking
02	**2.1 Title:** Study of packet sniffer tools like wireshark, ethereal, tcpdump etc. You should be able to use the tools to do the following 1. Observer performance in promiscuous as well as non-promiscous mode. 2. Show that packets can be traced based on different filters. **Objective:** Objective of this module is to observer the performanance in promiscuous & non-promiscous mode & to find the packets based on different filters. **Scope:** Packet grapping, message and protocol analysis **Technology:** Networking
03	**3.1 Title:** 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, etc. **Objective:** objective of this module to learn nmap installation & use this to scan different ports. **Scope:** used for ip spoofing and port scanning **Technology**: Networking

04	**4.1 Title:** Detect ARP spoofing using open source tool ARPWATCH. **Objective:** Objective of the module to find ARP spoofing using open source. **Scope**: Ip spoofing using arp packaging tool **Technology:** Networking
05	**5.1 Title:** Use the Nessus tool to scan the network for vulnerabilities. **Objective:** Objective of the module is scan system and network analysis. **Scope:** It used for system analysis, security and process analysis **Technology:** Networking
06	**6.1 Title:** Implement a code to simulate buffer overflow attack. **Objective:** Objective of the module Is to check buffer overflow in an NS2 environment **Scope:** It uses to analyse memory overflow attack **Technology**: Networking
07	**7.1 Title:** Set up IPSEC under LINUX **Objective:** Objective of the module for implementing security vulnerabilities **Scope:** to study different ipsec tools. **Technology**: Networking
08	**8.1 Title:** Install IDS (e.g. SNORT) and study the logs. **Objective:** Simulate intrusion detection system using tools such as snort **Scope:** It is used for intrusion detection system vulnerability scans **Technology:** Networking
09	**9.1 Title:** Use of iptables in linux to create firewalls. **Objective:** To study how to create and destroy firewall security parameters. **Scope:** system security and network security **Technology**: Networking
10	**10.1 Title:** Mini project **Objective:** To implement Networking concepts

	Scope: To understand Network & system tools **Technology:** Networking

Term Work:

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

- Lab Assignments:.. (10)
- Mini project:……………………………….………… (10) Marks.
- Attendance ………………………...……………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Oral examination:

Oral examination is to be conducted by pair of internal and external examiners based on above syllabus and the mini projects done.

References:

1. Network Security Assessment by Chris McNab, O'Reilly
2. Network Security Hacks, Andrew Lockhart, O'Reilly
3. The Web Application Hacker's Handbook 2nd Edition by Dafydd Stuttard & Marcus Pinto,Wiley Publication(2014).
4. Securing the Virtual Environment by Davi Ottenheimer & Matthew Wallace,Willey Publication(2012).

Course Code	Course/Subject Name	Credits
CPC801	**Data Warehousing and Mining**	5

Objectives:

1. To study the methodology of engineering legacy databases for data warehousing and data mining to derive business rules for decision support systems.
2. To analyze the data, identify the problems, and choose the relevant models and algorithms to apply.

Outcomes: Learner will be able to…

1. Enable students to understand and implement classical algorithms in data mining and data warehousing; students will be able to assess the strengths and weaknesses of the algorithms, identify the application area of algorithms, and apply them.
2. Students would learn data mining techniques as well as methods in integrating and interpreting the data sets and improving effectiveness, efficiency and quality for data analysis.

Module	Detailed Contents	Hrs.
01	**Introduction to Data Warehousing** 1.1 The Need for Data Warehousing; Increasing Demand for Strategic Information; Inability of Past Decision Support System; Operational V/s Decisional Support System; Data Warehouse Defined; Benefits of Data Warehousing ;Features of a Data Warehouse; The Information Flow Mechanism; Role of Metadata; Classification of Metadata; Data Warehouse Architecture; Different Types of Architecture; Data Warehouse and Data Marts; Data Warehousing Design Strategies.	04
02	**Dimensional Modeling** 2.1 Data Warehouse Modeling Vs Operational Database Modeling; Dimensional Model Vs ER Model; Features of a Good Dimensional Model; The Star Schema; How Does a Query Execute? The Snowflake Schema; Fact Tables and Dimension Tables; The Factless Fact Table; Updates To Dimension Tables: Slowly Changing Dimensions, Type 1 Changes, Type 2 Changes, Type 3 Changes, Large Dimension Tables, Rapidly Changing or Large Slowly Changing Dimensions, Junk Dimensions, Keys in the Data Warehouse Schema, Primary Keys, Surrogate Keys & Foreign Keys; Aggregate Tables; Fact Constellation Schema or Families of Star.	06
03	**ETL Process** 3.1 Challenges in ETL Functions; Data Extraction; Identification of Data Sources; Extracting Data: Immediate Data Extraction, Deferred Data Extraction; Data Transformation: Tasks Involved in Data Transformation, Data Loading: Techniques of Data Loading, Loading the Fact Tables and Dimension Tables Data Quality; Issues in Data Cleansing.	06
04	**Online Analytical Processing (OLAP)**	04

	4.1 Need for Online Analytical Processing; OLTP V/s OLAP; OLAP and Multidimensional Analysis; Hypercubes; OLAP Operations in Multidimensional Data Model; OLAP Models: MOLAP, ROLAP, HOLAP, DOLAP;	
05	**Introduction to data mining** 5.1 What is Data Mining; Knowledge Discovery in Database (KDD), What can be Data to be Mined, Related Concept to Data Mining, Data Mining Technique, Application and Issues in Data Mining	02
06	**Data Exploration** 6.1 Types of Attributes; Statistical Description of Data; Data Visualization; Measuring similarity and dissimilarity.	02
07	**Data Preprocessing** 7.1 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.	04
08	**Classification** 8.1 Basic Concepts; **Classification methods:** 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naïve Bayes' Classifier. **8.2 Prediction**: Structure of regression models; Simple linear regression, Multiple linear regression. **8.3 Model Evaluation & Selection: A**ccuracy and Error measures, Holdout, Random Sampling, Cross Validation, Bootstrap; Comparing Classifier performance using ROC Curves. **8.4 Combining Classifiers**: Bagging, Boosting, Random Forests.	06
09	**Clustering** 9.1 What is clustering? Types of data, Partitioning Methods (K-Means, K-Medoids) Hierarchical Methods(Agglomerative , Divisive, BRICH), Density-Based Methods (DBSCAN, OPTICS)	06
10	**Mining Frequent Pattern and Association Rule** 10.1 Market Basket Analysis, Frequent Itemsets, Closed Itemsets, and 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; Mining closed and maximal patterns; Introduction to Mining Multilevel Association Rules and Multidimensional Association Rules; From Association Mining to Correlation Analysis, Pattern Evaluation Measures; Introduction to Constraint-Based Association Mining.	08

Term Work:

Term work should consist of at least of the following:

1. One case study given to a group of 3 /4 students of a data mart/ data warehouse.
    a. Write Detail Statement Problem and creation of dimensional modeling (creation star and snowflake schema)
    b. Implementation of all dimension table and fact table
    c. Implementation of OLAP operations.

2. Implementation of classifier like Decision tree, Naïve Bayes, Random Forest using any languages like Java

3. Use WEKA to implement like Decision tree, Naïve Bayes, Random Forest

4. Implementation of clustering algorithm like K-means, K- Medoids, Agglomerative, Divisive using languages any like Java, C# , etc.

5. Use WEKA to implement the following Clustering Algorithms – K-means, Agglomerative, Divisive.

6. Implementation Association Mining like Apriori, FPM using languages like Java, C#, etc.

7. Use WEKA to implement Association Mining like Apriori, FPM.

8. Use R tool to implement Clustering/Association Rule/ Classification Algorithms.

9. Detailed study of any one BI tool like Oracle BI, SPSS, Clementine, and XLMiner etc. (paper Assignment)

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

An oral exam will be held based on the above syllabus

Text Books:

1) Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3rd Edition

2) Paulraj Ponniah, “Data Warehousing: Fundamentals for IT Professionals”, Wiley India
3) Reema Theraja “Data warehousing”, Oxford University Press.
4) M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education

Reference Books:

1) Randall Matignon, "Data Mining using SAS enterprise miner ", Wiley Student edition.
2) Alex Berson , S. J. Smith, “Data Warehousing, Data Mining & OLAP” , McGraw Hill.
3) Vikram Pudi & Radha Krishna, “Data Mining”, Oxford Higher Education.
4) Daniel Larose, “Data Mining Methods and Models”, Wiley India.

Course Code	Course/Subject Name	Credits
CPC802	**Human Machine Interaction**	5

Objectives:

1. To stress the importance of a good interface design.
2. To understand the importance of human psychology in designing good interfaces.
3. To motivate students to apply HMI in their day – to – day activities.
4. To bring out the creativity in each student – build innovative applications that are user friendly.
5. To encourage students to indulge into research in Machine Interface Design.

Outcomes: Learner will be able to…

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 criticise existing interface designs, and improve them.
5. To Design application for social and technical task.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Introduction to Human Machine Interface, Hardware, software and operating environment to use HMI in various fields. 1.2 The psychopathology of everyday things – complexity of modern devices; human-centered design; fundamental principles of interaction; Psychology of everyday actions- how people do things; the seven stages of action and three levels of processing; human error;	10
02	**Understanding goal directed design** 2.1 Goal directed design; Implementation models and mental models; Beginners, experts and intermediates – designing for different experience levels; Understanding users; Modeling users – personas and goals.	08
03	**GUI** 3.1 benefits of a good UI; popularity of graphics; concept of direct manipulation; advantages and disadvantages; characteristics of GUI; characteristics of Web UI; General design principles.	08
04	**Design guidelines** 4.1 perception, Gesalt principles, visual structure, reading is unnatural, color, vision, memory, six behavioral patterns, recognition and recall, learning, factors affecting learning, time.	08
05	**Interaction styles** 5.1 menus; windows; device based controls, screen based controls;.	06
06	**Communication** 6.1 text messages; feedback and guidance; graphics, icons and images; colours.	08

Term Work:

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.**

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

Laboratory:

Students are free to choose any tool that they feel appropriate for a given experiment. Each experiment will involve research about a certain category of people, and then developing an appropriate interface.

Students are expected to perform at least eight experiments from the given list.

LIST OF HMI PRACTICAL / EXPERIMENTS

1. Know your client –

   a. Children (4-5 years of age): An application to teach math.

   b. Teenagers: Design a digital diary for young teens to help them overcome various social pressures they deal with during their teen years. The diary should also be like a self help tool which would help them deal with incidents like bullying, peer pressure, etc.. This is an open project and you can think in any direction to make the children sail through their teen years while trying to discover life around them.

   c. Older generation: Folks from the older generation has been very wary of using their credit card on the Internet. They have various concerns when it comes to paying their bills. Also because of their old age, it will be beneficial for them to use the internet and pay their phone, electricity, gas, etc. bills

   d. Rural people: ATVM for train ticketing in rural area

2. Understand the trouble of interacting with machines - Redesign interfaces of home appliances like microwave oven, land-line phone, fully automatic washing machine.

3. Learn HCI design principles – heuristic evaluation: Identify 5 different websites catering to one specific goal (eg. Goal – on-line shopping and 5 different websites – ebay, amazon, flipkart, zovi, myntra) and perform a competitive analysis on them to understand how each one caters to the goal, the interactions and flow of the payment system and prepare a report on the same..

4. Learn the importance of menus and navigation – website redesign: News websites like CNN are always cluttered with information. It takes the user a few minutes to find his way through and maybe more minutes to look for some specific information. Redesign the news websites to make it look less cluttered, provide relevant information (a person sitting in Russia should not get US news as top news), intelligently dig information that he might be interested in based on his searches on the web.

5. Learn the importance of connecting humans – service design : How often have you found yourself waiting at the airport for a flight that is delayed or you've missed it and the next one is 4 hours from now, or waiting for a connecting flight? Design an experience for passengers to deal with the long waiting hours.

6. Learn the use of statistical graphics – expense tracker: Matt is a young engineer who just finished his summer internship at a leading Software Company in the United States. He has never been independent in handling his own finances and after this internship his father has asked him to start managing his money on his own. He is looking for a tool/app/software that would help him budget his finances, create goals and track them, categorize and track his credit card spending and also get insights on the various types of categories he's spending on. Design a tool/app/software that would help Matt manage his personal finances given the above requirement.

7. Learn the importance of graphics – way finding: Design a map for someone who is new to the city/town/village and is trying to understand how to commute from one place to another (inspired by New York Subway Maps, London Subway Maps)

8. Icon designing: Choose a unique domain, design a few icons and show how it can be accommodated on an interface.

9. Understand the need of colors and animation – web site for an artist: A celebrity in some form of art like music, dance, painting, martial arts, etc (not actors). This site will be used to display his works and should portray his character.

10. Understand the various input methods available for interaction – concept generation: Study the various technologies for typing – standard keyboards QWERTY, T9 (predictive text), multi-touch (SYWPE, etc.), gestures and brainstorm on the various ways in which you could improve one of the existing technologies. You could choose any of the different input types.

11. Any other new relevant topics covering the above syllabus.

Text Books:

1. Alan Dix, J. E. Finlay, G. D. Abowd, R. Beale “Human Computer Interaction”, Prentice Hall.
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.

Reference Books:

1. Donald A. Norman, “The design of everyday things”, Basic books.
2. Rogers Sharp Preece, “Interaction Design:Beyond Human Computer Interaction”, Wiley.
3. Guy A. Boy “The Handbook of Human Machine Interaction”, Ashgate publishing Ltd.

Course Code	Course/Subject Name	Credits
CPC803	**Parallel and Distributed Systems**	5

Objectives:

1. To provide students with contemporary knowledge in parallel and distributed systems
2. To equip students with skills to analyze and design parallel and distributed applications.
3. To provide master skills to measure the performance of parallel and distributed algorithms

Outcomes: Learner will be able to…

1. Apply the principles and concept in analyzing and designing the parallel and distributed system
2. Reason about ways to parallelize problems.
3. Gain an appreciation on the challenges and opportunities faced by parallel and distributed systems.
4. Understand the middleware technologies that support distributed applications such as RPC, RMI and object based middleware.
5. Improve the performance and reliability of distributed and parallel programs.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Parallel Computing, Parallel Architecture, Architectural Classification Scheme, Performance of Parallel Computers, Performance Metrics for Processors, Parallel Programming Models, Parallel Algorithms.	06
02	**Pipeline Processing** 2.1 Introduction, Pipeline Performance, Arithmetic Pipelines, Pipelined Instruction Processing, Pipeline Stage Design, Hazards, Dynamic Instruction Scheduling,	06
03	**Synchronous Parallel Processing** 3.1 Introduction, Example-SIMD Architecture and Programming Principles, SIMD Parallel Algorithms, Data Mapping and memory in array processors, Case studies of SIMD parallel Processors	06
04	**Introduction to Distributed Systems** 4.1 Definition, Issues, Goals, Types of distributed systems, Distributed System Models, Hardware concepts, Software Concept, Models of Middleware, Services offered by middleware, Client Server model.	06
05	**Communication** 5.1 Layered Protocols, Remote Procedure Call, Remote Object Invocation, Message Oriented Communication, Stream Oriented Communication	04
06	**Resource and Process Management** 6.1 Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach, Introduction to process management, process migration, Threads, Virtualization, Clients, Servers, Code Migration	06
07	**Synchronization**	08

	7.1 Clock Synchronization, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measure, Non Token based Algorithms: Lamport Algorithm, Ricart–Agrawala's Algorithm, Maekawa's Algorithm 7.2 Token Based Algorithms: Suzuki-Kasami's Broardcast Algorithms, Singhal's Heurastic Algorithm, Raymond's Tree based Algorithm, Comparative Performance Analysis.	
08	**Consistency and Replication** 8.1 Introduction, Data-Centric and Client-Centric Consistency Models, Replica Management. **Distributed File Systems** 8.2 Introduction, good features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Network File System(NFS), Andrew File System(AFS), Hadoop Distributed File System and Map Reduce.	06

Term Work:

Term work should consist of at least 10 experiments, 2 assignments based on above theory syllabus.

The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

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

- Laboratory work (experiments): ……………………….. (15) Marks.
- Assignments: …………………………………………… (05) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral Examination will be based on above syllabus

Syllabus for Practical

Suggested topics for experiment but not limited to:

1. Load Balancing Algorithm.
2. Scalability in Distributed Environment
3. Client/server using RPC/RMI.
4. Inter-process communication
5. Election Algorithm.
6. Distributed Deadlock.
7. Name Resolution protocol.
8. Clock Synchronization algorithms.
9. Mutual Exclusion Algorithm.
10. Group Communication.
11. CORBA architecture.
12. Parallel Algorithms.
13. Message Passing Interface.

Text Books

1. M.R. Bhujade, “Parallel Computing”, 2nd edition, New Age International Publishers 2009.
2. Andrew S. Tanenbaum and Maarten Van Steen, “Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education, Inc., 2007, ISBN: 0-13-239227-5.

Reference Books

1. George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems: Concepts and Design” (4th Edition), Addison Wesley/Pearson Education.
2. Pradeep K Sinha, “Distributed Operating Systems : Concepts and design”, IEEE computer society press

Course Code	Course/Subject Name	Credits
CPE8031	**Elective-III Machine Learning**	5

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 support vector machine and Dimensionality reduction Techniques.

Outcomes: Learner will be able to…

1. Ability to analyze and appreciate the applications which can use Machine Learning Techniques.
2. Ability to understand regression, classification, clustering methods.
3. Ability to understand the difference between supervised and unsupervised learning methods.
4. Ability to appreciate Dimensionality reduction techniques.
5. Students would understand the working of Reinforcement learning.

Module	Detailed Contents	Hrs.
01	**Introduction to Machine Learning** 1.1 What is Machine Learning?, Key Terminology, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, How to choose the right algorithm, Steps in developing a Machine Learning Application.	06
02	**Learning with Regression** 2.1 Linear Regression, Logistic Regression.	04
03	**Learning with trees** 3.1 Using Decision Trees, Constructing Decision Trees, Classification and Regression Trees (CART).	08
04	**Support Vector Machines(SVM)** 4.1 Maximum Margin Linear Separators, Quadratic Programming solution to finding maximum margin separators, Kernels for learning non-linear functions.	06
05	**Learning with Classification** 5.1 Rule based classification, classification by backpropoagation, Bayesian Belief networks, Hidden Markov Models.	06
06	**Dimensionality Reduction** 6.1 Dimensionality Reduction Techniques, Principal Component Analysis, Independent Component Analysis.	06
07	**Learning with Clustering** 7.1 K-means clustering, Hierarchical clustering, Expectation Maximization	06

	Algorithm, Supervised learning after clustering, Radial Basis functions.	
08	**Reinforcement Learning** 8.1 Introduction, Elements of Reinforcement Learning, Model based learning, Temporal Difference Learning, Generalization, Partially Observable States.	06

Term Work:

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

- Laboratory work (experiments): ………..…………….. (15) Marks.
- Assignments:……….……………………………… (05) Marks.
- Attendance ……………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

LIST OF ML PRACTICAL / EXPERIMENTS

1. To implement Linear Regression

2. To implement Logistic Regression

3. To implement ID3.

4. To implement Support Vector Machine.

5. To implement Bayesian Classification.

6. To implement K-Nearest Neighbour.

7. To implement k-means Clustering.

8. To implement Agglomerative Clustering.

Any other practical covering the syllabus topics and subtopics can be conducted.

Text Books:

1. Peter Harrington “Machine Learning In Action”, DreamTech Press
2. Ethem Alpaydın, “Introduction to Machine Learning”, MIT Press
3. Tom M.Mitchell “Machine Learning” McGraw Hill
4. Stephen Marsland, “Machine Learning An Algorithmic Perspective” CRC Press

Reference Books:

1. William W.Hsieh, “Machine Learning Mehods in the Environmental Sciences”, Cambridge
2. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers
3. Margaret.H.Dunham, “Data Mining Introductory and Advanced Topics”, Pearson Education

Course Code	Course/Subject Name	Credits
CPE8032	**Elective-III Embedded Systems**	5

Objectives:

1. Develop, among students, an understanding of the technologies behind the embedded computing systems; and to differentiate between such technologies.
2. Make aware of the capabilities and limitations of the various hardware or software components.
3. Evaluate design tradeoffs between different technology choices.
4. Complete or partial design of such embedded systems

Outcomes: Learner will be able to…

1. Describe the special requirements that are imposed on embedded systems
2. Describe the key properties of microprocessor and digital signal processor
3. Sketch a design of an embedded system around a microprocessor or DSP
4. Explain how microprocessor, memory, peripheral components and buses interact in an embedded system
5. Evaluate how architectural and implementation decisions influence performance and power dissipation
6. Produce efficient code for embedded systems
7. Point out the role of the compiler in the embedded system design process
8. Define the properties of a real-time operating system
9. Estimate the requirement for additional hardware for optimized performance
10. Understand and distinguish between the RISC and the Advanced RISC architecture
11. Utilize embedded systems to perform operations such as signal processing in real time
12. Develop drivers for external peripheral devices as per requirement.

Module	Detailed Contents	Hrs.
01	**Introduction to computational technologies** 1.1 Review of computation technologies (ARM, RISC, CISC, PLD, SOC), architecture, event managers, hardware multipliers, pipelining. Hardware/Software co-design. Embedded systems architecture and design process.	08
02	**Program Design and Analysis** 2.1 Integrated Development Environment (IDE), assembler, linking and loading. Program-level performance analysis and optimization, energy and power analysis and program size optimization, program validation and testing. Embedded Linux, kernel architecture, GNU cross platform tool chain. Programming with Linux environment.	08
03	**Process Models and Product development life cycle management** 3.1 State machine models: finite-state machines (FSM), finite-state machines with data-path model (FSMD), hierarchical/concurrent state machine	08

	model (HCFSM), program-state machine model (PSM), concurrent process model. Unified Modeling Language (UML), applications of UML in embedded systems. IP-cores, design process model. Hardware software co-design, embedded product development life cycle management.	
04	**High Performance 32-bit RISC Architecture** 4.1 ARM processor family, ARM architecture, instruction set, addressing modes, operating modes, interrupt structure, and internal peripherals. ARM coprocessors, ARM Cortex-M3.	08
05	**Processes and Operating Systems** 5.1 Introduction to Embedded Operating System, multiple tasks and multiple processes. Multi rate systems, preemptive real-time operating systems, priority-based scheduling, inter-process communication mechanisms. Operating system performance and optimization strategies. Examples of real-time operating systems.	08
06	**Real-time Digital Signal Processing (DSP)** 6.1 Introduction to Real-time simulation, numerical solution of the mathematical model of physical system. DSP on ARM, SIMD techniques. Correlation, Convolution, DFT, FIR filter and IIR Filter implementation on ARM. Open Multimedia Applications Platform (OMAP)	08

Term Work:

Term work should consist of at least 10 practicals and one mini project. Objective type term work test shall be conducted with a weightage of 10 marks.

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

- Laboratory work (experiments/projects): ……….…….. (10) Marks.
- Mini project: …………………………………………… (10) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

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

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

Oral examination will be based on the above syllabus.

List of Experiments:

Topic-1: Troubleshooting Tools [Any One]

In-Circuit Emulator (ICE) and In-Circuit Debugger (ICD), Logic Analyzer, Spectrum Analyzer, Pattern generator and Digital Storage Oscilloscope.

Topic -2: ARM Processors & Interfaces [Any Four]

LEDs and Keyboard Interface, LCD Interface, Counting external events with on chip counters, Real Time Clock (RTC), Pulse Width Modulation (PWM), Relay and Buzzer Control for alarm events, Stepper Motor Control , On chip ADC/DAC SPI / I2C / UART Interface, Bluetooth/Zig-bee interface.

Topic-3: Real-time Signal Processing ARM-DSP [Any Two]

Real-time physical model simulation, Correlation, convolution, DFT, FIR or IIR design, Real-time DAS and GUI using PC and ARM, Design with Programmable Logic Devices (CPLD/FPGA).

Topic-4: Device Driver Development [Any One]

Drivers for CAN, Drivers for USB, Drivers for Ethernet, SVGA, Drivers for Graphics TFT LCD.

Topic-5: Real Time Operating System (RTOS) [Any Two]

RTLinux , MicroC/OS_II, VxWorks, WIN CE, QNX, Palm OS, Symbian OS, Android OS or equivalent OS.

Text Books:

1. Embedded Systems an Integrated Approach – Lyla B Das, Pearson
2. Computers as Components – Marilyn Wolf, Third Edition Elsevier
3. Embedded Systems Design: A Unified Hardware/Software Introduction – Frank Vahid and Tony Givargis, John Wiley & Sons
4. An Embedded Software Primer – David E. Simon – Pearson Education Sough Asia
5. ARM System Developer's Guide Designing and Optimizing System Software – Andrew N. Sloss, Dominic Sysmes and Chris Wright – Elsevier Inc.

Reference Books:

1. Embedded Systems, Architecture, Programming and Design – Raj Kamal – Tata McGraw Hill
2. Embedded Linux – Hollabaugh, Pearson Education

3. Embedded Realtime Systems Programming – Sriram V Iyer, Pankaj Gupta – Tata McGRaw Hill.
4. Fundamentals of Microcontrollers and Applications in Embedded Systems – Ramesh Gaonkar – Penram International Publishing (India) Pvt. Ltd.
5. Embedded / Real-Time Systems: Concepts, Design & Programming – Dr. K. V. K. K. Prasad – Dreamtech Press, India.

Course Code	Course/Subject Name	Credits
CPE8033	**Elective-III Adhoc Wireless Networks**	5

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.

Outcomes: Learner will be able to…

1. Define characteristics and features of Adhoc Networks
2. Appreciate the designing of MAC protocol for Adhoc networks
3. Implement few protocols
4. Apply security principles for routing

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Introduction to wireless Networks. Characteristics of Wireless channel, Issues in Ad hoc wireless networks, Adhoc Mobility Models:- Indoor and outdoor models. 1.2 Adhoc Networks: Introduction to adhoc networks – definition, characteristics features, applications.	04
02	**MAC Layer** 2.1 MAC Protocols for Ad hoc wireless Networks: Introduction, Issues in designing a MAC protocol for Ad hoc wireless Networks, Design goals and Classification of a MAC protocol, Contention based protocols with reservation mechanisms. 2.2 Scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15, 802.16, HIPERLAN.	10
03	**Network Layer** 3.1 Routing protocols for Ad hoc wireless Networks: Introduction, Issues in designing a routing protocol for Ad hoc wireless Networks, Classification of routing protocols, Table driven routing protocol, On-demand routing protocol. 3.2 Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.	10
04	**Transport Layer** 4.1 Transport layer protocols for Ad hoc wireless Networks: Introduction, Issues in designing a transport layer protocol for Ad hoc wireless Networks, Design goals of a transport layer protocol for Ad hoc wireless	07

	Networks, Classification of transport layer solutions, TCP over Ad hoc wireless Networks, Other transport layer protocols for Ad hoc wireless Networks.	
05	**Security** 5.1 Security: Security in wireless Ad hoc wireless Networks, Network security requirements, Issues & challenges in security provisioning, Network security attacks, Key management, Secure routing in Ad hoc wireless Networks.	07
06	**QoS** 6.1 Quality of service in Ad hoc wireless Networks: Introduction, Issues and challenges in providing QoS in Ad hoc wireless Networks, Classification of QoS solutions, MAC layer solutions, network layer solutions.	07

Term Work:

- Term work should consist of at least 12 experiments.
- 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.
- Assignment:…………..……………………………… (05) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project

Practical/Oral examination:

oral examination based on above syllabus will be conducted

Suggested Practicals for Adhoc Wireless

1. Installation of NS2 in Ubuntu 12.04 Linux.
2. Build and exchange data in simple infrastructure and Adhoc network by using personal computer and Android based mobile.
3. 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.

4. Implement wireless network. Capture data frame and identify fields using NS2.
5. Configure Wireless Access Point (WAP) and build different networks.
6. Implement Mobile device as a wireless access point.
7. Communicate between two different networks which has following specifications:
   a. One network has Class A network with “Tora protocol”
   b. Second has Class B network “AODV protocol”

Practical exam will be based on the above syllabus.

Text Books:

1. Siva Ram Murthy and B.S.Manoj, “Ad hoc Wireless Networks Architectures and protocols”, 2nd edition, Pearson Education, 2007
2. Charles E. Perkins, “Adhoc Networking”, Addison – Wesley, 2000
3. C. K. Toh,”Adhoc Mobile Wireless Networks”, Pearson Education, 2002

Reference Books:

1. Matthew Gast, “802.11 Wireless Networks: The Definitive Guide”, 2nd Edition, O'Reilly Media, April 2005.
2. Stefano Basagni, Marco Conti, Silvia Giordan and Ivan Stojmenovic, “Mobile Adhoc Networking”, Wiley-IEEE Press, 2004.
3. Mohammad Ilyas, “The handbook of Adhoc Wireless Networks”, CRC Press, 2002

Course Code	Course/Subject Name	Credits
CPE8034	**Elective-III Digital Forensics**	5

Objectives:

1. To focus on the procedures for identification, preservation, and extraction of electronic evidence, auditing and investigation of network and host system intrusions, analysis and documentation of information gathered, and preparation of expert testimonial evidence.
2. To provide hands on experience on various forensic tools and resources for system administrators and information system security officers.

Module	Detailed Contents	Hrs.
01	**Introduction:** 1.1 Introduction of Cybercrime: Types, The Internet spawns crime, Worms versus viruses, Computers' roles in crimes, Introduction to digital forensics, Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response, Phase after detection of an incident.	09
02	**Initial Response and forensic duplication** 2.1 Initial Response & Volatile Data Collection from Windows system - Initial Response & Volatile Data Collection from Unix system - Forensic Duplication: Forensic duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic. 2.2 Duplicate/Qualified Forensic Duplicate of a Hard Drive.	08
03	**Preserving and Recovering Digital Evidence** 3.1 File Systems: FAT, NTFS - Forensic Analysis of File Systems - Storage Fundamentals: Storage Layer, Hard Drives Evidence Handling: Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure.	09
04	**Network Forensics** 4.1 Intrusion detection; Different Attacks in network, analysis Collecting Network Based Evidence - Investigating Routers - Network Protocols - Email Tracing- Internet Fraud.	07
05	**System investigation** 5.1 Data Analysis Techniques - Investigating Live Systems (Windows & Unix) Investigating 5.2 Hacker Tools - Ethical Issues – Cybercrime.	08
06	**Bodies of law** 6.1 Constitutional law, Criminal law, Civil law, Administrative regulations, Levels of law: Local laws, State laws, Federal laws, International laws , Levels of culpability: Intent, Knowledge, Recklessness, Negligence Level and burden of proof : Criminal versus civil cases ,Vicarious liability, Laws related to computers: CFAA, DMCA, CAN Spam, etc.	07

Term Work:

- Term work should consist of at least 12 experiments.
- 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.
- Assignment: …………………………………………… (05) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project.

Practical/Oral examination:

Oral exam will be based on the above syllabus.

Text Books:

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGrawHill, 2006
2. Peter Stephenson, "Investigating Computer Crime: A Handbook for Corporate Investigations", Sept 1999
3. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools and Technology", Academic Press, 1st Edition, 2001

References:

1. Skoudis. E., Perlman. R. Counter Hack: A Step-by-Step Guide to Computer Attacks and Effective Defenses.Prentice Hall Professional Technical Reference. 2001
2. Norbert Zaenglein, "Disk Detective: Secret You Must Know to Recover Information From a Computer", Paladin Press, 2000
3. Bill Nelson, Amelia Philips and Christopher Steuart, “Guide to computer forensics investigation “Course technology, 4th edition

Course Code	Course/Subject Name	Credits
CPE8035	**Elective III - Big Data Analytics**	5

Objectives:

1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql Map-Reduce.
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.

Outcomes: Learner will be able to…

1. Understand the key issues in big data management and its associated applications in intelligent business and scientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

Module	Detailed Contents	Hrs.
01	**Introduction to Big Data** 1.1 Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Case Study of Big Data Solutions.	03
02	**Introduction to Hadoop** 2.1 What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; Physical Architecture; Hadoop limitations.	03
03	**NoSQL** 3.1 What is 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	04
04	**MapReduce and the New Software Stack** **4.1 Distributed File Systems :** Physical Organization of Compute Nodes, Large-Scale File-System Organization. **4.2 MapReduce:** The Map Tasks, Grouping by Key, The Reduce Tasks,	06

	Combiners, Details of MapReduce Execution, Coping With Node Failures. **4.3 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, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step.	
05	**Finding Similar Items** 5.1 Applications of Near-Neighbor Search, Jaccard Similarity of Sets, Similarity of Documents, Collaborative Filtering as a Similar-Sets Problem . 5.2 **Distance Measures:** Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance.	03
06	**Mining Data Streams** **6.1 The Stream Data Model**: A Data-Stream-Management System, Examples of Stream Sources, Stream Querie, Issues in Stream Processing. **6.2 Sampling Data in a Stream** : Obtaining a Representative Sample , The General Sampling Problem, Varying the Sample Size. **6.3 Filtering Streams**: The Bloom Filter, Analysis. **6.4 Counting Distinct Elements in a Stream** The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . **6.5 Counting Ones in a Window**: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.	06
07	**Link Analysis** 7.1 PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. 7.2 Topic sensitive Page Rank, link Spam, Hubs and Authorities.	05
08	**Frequent Itemsets** **8.1 Handling Larger Datasets in Main Memory** Algorithm of Park, Chen, and Yu, The Multistage Algorithm, The Multihash Algorithm. **8.2 The SON Algorithm and MapReduce** **8.3 Counting Frequent Items in a Stream** Sampling Methods for Streams, Frequent Itemsets in Decaying Windows	05
09	**Clustering** 9.1 CURE Algorithm, Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries	05

10	**Recommendation Systems** 10.1 A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	04
11	**Mining Social-Network Graphs** 11.1 Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities, SimRank, Counting triangles using Map-Reduce	04

Term Work:

Assign a case study for group of 2/3 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 ………………………………………. (05) Marks

TOTAL: ……………………………………………………. (25) Marks.

Internal Assessment:

Internal Assessment consists of two tests. Test 1, an Institution level central test, is for 20 marks and is to be based on a minimum of 40% of the syllabus. Test 2 is also for 20 marks and is to be based on the remaining syllabus. Test 2 may be either a class test or assignment on live problems or course project.

Practical/Oral examination:

An oral exam will be held based on the above syllabus.

Suggested Practical List: Students will perform at least 8 programming exercises and implement one mini-project. The students can work in groups of 2/3.

1. Study of Hadoop ecosystem
2. programming exercises on Hadoop
3. programming exercises in No SQL
4. Implementing simple algorithms in Map- Reduce (3) - Matrix multiplication, Aggregates, joins, sorting, searching etc.
5. Implementing any one Frequent Itemset algorithm using Map-Reduce
6. Implementing any one Clustering algorithm using Map-Reduce
7. Implementing any one data streaming algorithm using Map-Reduce
8. 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 etc.

Text Books:

1. Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press,
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

Course Code	Course/Subject Name	Credits
CPL801	**Cloud Computing Laboratory**	1

Outcomes: Learner will be able to…

1. Appreciate cloud architecture
2. Create and run virtual machines on open source OS
3. implement Infrastructure , storage as a Service**.**
4. Install and appreciate security features for cloud

Module	Detailed Contents	Lab Session
01	**Title:** Study of Cloud Computing & Architecture. **Concept:** Cloud Computing & Architecture. **Objective:** Objective of this module is to provide students an overview of the Cloud Computing and Architecture and different types of Cloud Computing **Scope:** Cloud Computing & Architecture Types of Cloud Computing . **Technology:** ---	**01**
02	**Title:** Virtualization in Cloud. **Concept:** Virtualization **Objective:** In this module students will learn, Virtualization Basics, Objectives of Virtualization, and Benefits of Virtualization in cloud. **Scope:** Creating and running virtual machines on open source OS. **Technology:** KVM, VMware.	**02**
03	**Title:** Study and implementation of Infrastructure as a Service . **Concept:** Infrastructure as a Service**.** **Objective:** In this module student will learn Infrastructure as a Service and implement it by using OpenStack. **Scope:** Installing OpenStack and use it as Infrastructure as a Service . **Technology:** Quanta Plus /Aptana /Kompozer	**02**
04	**Title:** Study and installation of Storage as Service.	**02**

	Concept: Storage as Service (SaaS) **Objective:** is that, students must be able to understand the concept of SaaS , and how it is implemented using ownCloud which gives universal access to files through a web interface. **Scope:** is to installation and understanding features of ownCloud as SaaS**.** **Technology:** ownCloud	
05	**Title:** Implementation of identity management. **Concept:** Identity Management in cloud **Objective:** this lab gives an introduction about identity management in cloud and simulate it by using OpenStack **Scope:** installing and using identity management feature of OpenStack **Technology:** OpenStack	**02**
06	**Title:** Write a program for web feed. **Concept:** Web feed and RSS **Objective:** this lab is to understand the concept of form and control validation **Scope:** Write a program for web feed **Technology:** PHP, HTML	**02**
07	**Title:** Study and implementation of Single-Sing-On. **Concept:** Single Sing On (SSO),openID **Objective:** is to understand the concept of access control in cloud and single sing on (SSO), Use SSO and advantages of it, and also students should able to implementation of it. **Scope:** installing and using JOSSO **Technology:** JOSSO	**02**
08	**Title:** Securing Servers in Cloud. **Concept:** Cloud Security **Objective:** is to understand how to secure web server, how to secure data directory and introduction to encryption for own cloud.	**02**

	Scope: Installing and using security feature of ownCloud **Technology:** ownCloud	
09	**Title:** User Management in Cloud. **Concept:** Administrative features of Cloud Managenet ,User Management **Objective:** is to understand how to create, manage user and group of users accounts. **Scope:** Installing and using Administrative features of ownCloud **Technology:** ownCloud	**02**
10	**Title:** Case study on Amazon EC2. **Concept:** Amazon EC2 **Objective:** in this module students will learn about Amazon EC2. Amazon Elastic Compute Cloud is a central part of Amazon.com's cloud computing platform, Amazon Web Services. EC2 allows users to rent virtual computers on which to run their own computer applications	**01**
11	**Title:** Case study on Microsoft azure. **Concept:** Microsoft Azure **Objective:** students will learn about Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, for building, deploying and managing applications and services through a global network of Microsoft-managed datacenters. How it work, different services provided by it. **Technology:** Microsoft azure	**01**
12	**Title:** Mini project. **Concept:** using different features of cloud computing creating own cloud for institute, organization etc. **Objective:** is student must be able to create own cloud using different features which are learned in previous practices. **Scope:** creating a cloud like social site for institute. **Technology:** any open system used for cloud	**05**

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 presentation: ………………………………… (05) Marks.
- Attendance ………………………………………. (05) Marks

TOTAL: …………………………………………… (25) Marks.

Text Books:

1. Enterprise Cloud Computing by Gautam Shroff, Cambridge,2010
2. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley - India, 2010 , ISBN:978-0-470-58987-8
3. Getting Started with OwnCloud by Aditya Patawar , Packt Publishing Ltd, 2013
4. www.openstack.org

Course Code	Course/Subject Name	Credits
CP701 / CP802	**Project I/ II**	**3 / 6**

Guidelines for Project

- Students should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem.
- Students should attempt solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

- Project I should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
  - Breadth and depth of literature survey
- Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

- Project II should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiners approved by the University of Mumbai
- Students should be motivated to publish a paper based on the work in Conferences/students competitions

Electronics and Telecommunication

Sr. No.	Subject Code	Subject Name	Count
1	ETL301	Analog Electronics I Laboratory	1
2	ETL302	Digital Electronics Laboratory	1
3	ETL303	Circuits and Measurements Laboratory	1
4	ETSL304	Object Oriented Programming Methodology Laboratory	1
5	ETL401	Analog Electronics II Laboratory	1
6	ETL402	Microprocessors and Peripherals Laboratory	1
7	ETL403	Software Simulation Laboratory	1
8	ETS506	Business Communication and Ethics	1
9	ETL501	Microcontrollers and Applications Laboratory	1
10	ETL502	Communication Engineering Laboratory I	1
11	ETL503	Communication Engineering Laboratory II	1
12	ETL504	Mini Project I	1
13	ETL601	Discrete Time Signal Processing Laboratory	1
14	ETL602	Communication Engineering Laboratory III	1
15	ETL603	Communication Engineering Laboratory IV	1
16	ETL604	Mini Project II	1
17	ETL701	Image and Video Processing Laboratory	1
18	ETL702	Advanced communication Engineering. Laboratory I	1
19	ETL703	Advanced communication Engineering. Laboratory II	1
20	ETEL70X	Elective	1
21	ETP701	Project (Stage I)	1
22	ETL801	Wireless Networks Laboratory	1
23	ETL802	Satellite communication and Networks Laboratory	1
24	ETL803	Internet and Voice Communication Laboratory	1
25	ETEL80X	Elective Laboratory	1
26	ETP801	Project (Stage II)	1
		Total	26

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Electronics & Telecommunication Engineering
(Second Year – Sem. III & IV), Revised course
(REV- 2012) from Academic Year 2012 -13.

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

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) 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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble:

The engineering education in India in general is expanding in manifolds. Now, the challenge is to ensure its quality to the stakeholders along with the 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. An engineering program must ensure that its graduates understand the basic concepts of science and mathematics, have gone through one engineering field in dept of appreciate and use its methodologies of analyses and design, and have acquired skills for life-long learning.

An engineering program must therefore have a mission statement which is in conformity with program objectives and program outcomes that are expected of the educational process. The outcomes of a program must be measureable and must be assessed regularly through proper feedback for improvement of the programme. There must be a quality assurance process in place within the Institute to make use of the feedback for improvement of the programme. The curriculum must be constantly refined and updated to ensure that the defined objectives and outcomes are achieved. Students must be encouraged to comment on the objectives and outcomes and the role played by the individual courses in achieving them. 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.

I, as Chairman, Board of Studies in Electronics and Telecommunication Engineering University of Mumbai, happy to state here that, Program Educational Objectives were finalized in a meeting where more than 20 members from different Institutes were attended, who were either Heads or their representatives of Electronics and Telecommunication Engineering Department. The Program Educational Objectives finalized for undergraduate program in Electronics and Telecommunication Engineering are listed below;

- To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies.
- To prepare students to demonstrate an ability to identify, formulate and solve electronics and telecommunication engineering problems.
- To prepare students to demonstrate ability to design electrical and electronics systems and conduct experiments, analyze and interpret data.
- To prepare students to demonstrate for successful career in industry to meet needs of Indian and multi-national companies.
- To develop the ability among students to synthesize data and technical concepts from applications to product design.
- To provide opportunity for students to work as part of teams on multidisciplinary projects.
- To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.

In addition to above more program educational objectives of their own may be added by affiliated Institutes.

In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner’s point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

Dr. Udhav Bhosle
Chairman, Board of Studies in Electronics and Telecommunication Engineering

Programme structure B.E.(Electronics & Telecommunication)
S.E. (Electronics & Telecommunication) Sem III

Sub Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETS301	Applied Mathematics III	04	--	01	04	--	01	05
ETC302	Analog Electronics I	04	--	--	04	--	--	04
ETC303	Digital Electronics	04	--	--	04	--	--	04
ETC304	Circuits and Transmission Lines	04	--	--	04	--	--	04
ETC305	Electronic Instruments and Measurements	04	--	--	04	--	--	04
ETS306	Object Oriented Programming Methodology	--	--	--	--	--	--	--
ETL301	Analog Electronics I Laboratory	--	02	--	--	01	--	01
ETL302	Digital Electronics Laboratory	--	02	--	--	01	--	01
ETL303	Circuits and Measurements Laboratory	--	02	--	--	01	--	01
ETSL304	Object Oriented Programming Methodology Laboratory	--	*04	--	--	01	--	01
Total		20	10	01	20	04	01	25

*-Out of four hours, 2 hours theory shall be taught to entire class followed by 2 hrs. practical in batches.

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 & Test 2					
ETS301	Applied Mathematics III	20	20	20	80	25	--	--	125
ETC302	Analog Electronics I	20	20	20	80	--	--	--	100
ETC303	Digital Electronics	20	20	20	80	--	--	--	100
ETC304	Circuits and Transmission Lines	20	20	20	80	--	--	--	100
ETC305	Electronic Instruments and Measurements	20	20	20	80	--	--	--	100
ETS306	Object Oriented Programming Methodology	--	--	--	--	--	--	--	--
ETL301	Analog Electronics I Laboratory	--	--	--	--	25	25	--	50
ETL302	Digital Electronics Laboratory	--	--	--	--	25	25	--	50
ETL303	Circuits and Measurements Laboratory	--	--	--	--	25	--	--	25
ETSL304	Object Oriented Programming Methodology Laboratory	--	--	--	--	25	50	--	75
Total		--	--	100	400	125	100	--	725

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETS 301	Applied Mathematics III	04	--	01	04	-	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETS 301	Applied Mathematics III	20	20	20	80	25	--	--	125

Course pre-requisite:
FES 101: Applied Mathematics I
FES 201: Applied Mathematics II

Course objectives:

- To provide students with a sound foundation in Mathematics and prepare them for graduate studies in Electronics and Telecommunication Engg.
- To provide students with mathematics fundamental necessary to formulate, solve and analyze engg. problems.
- To provide opportunity for students to work as part of teams on multi disciplinary projects.

Course outcomes:

- Students will demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable.
- Students will demonstrate an ability to identify formulate and solve electronics and telecommunication Engg. problem using Applied Mathematics.
- Students will show the understanding of impact of Engg. Mathematics on Telecom Engg.
- Students who can participate and succeed in competitive exams like GATE, GRE.

Module No.	Unit No.	Topics	Hrs.
1. 0		**Laplace Transform**	12
	1.1	**Laplace Transform (LT) of Standard Functions:** Definition. unilateral and bilateral Laplace Transform, LT of *sin(at), cos(at),* e^{at}, t^{n} , *sinh(at), cosh(at), erf(t),* Heavi-side unit step, dirac-delta function, LT 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, initial and final value theorem, Parsavel's identity	
	1.3	**Inverse Laplace Transform:** Partial fraction method, long division method, residue method	
	1.4	**Applications of Laplace Transform:** Solution of ordinary differential equations	
2.0		**Fourier Series**	10
	2.1	**Introduction:** Definition, Dirichlet's conditions, Euler's formulae	
	2.2	**Fourier Series of Functions:** Exponential, trigonometric functions, even and odd functions, half range sine and cosine series	
	2.3	Complex form of Fourier series, orthogonal and orthonormal set of functions, Fourier integral representation	
3.0		**Bessel Functions**	08
	3.1	**Solution of Bessel Differential Equation:** Series method, recurrence relation, properties of Bessel function of order +1/2 and -1/2	
	3.2	Generating function, orthogonality property	
	3.3	Bessel Fourier series of functions	
4.0		**Vector Algebra**	12
	4.1	**Scalar and Vector Product**: Scalar and vector product of three and four vectors and their properties	
	4.2	**Vector Differentiation:** Gradient of scalar point function, divergence and curl of vector point function	
	4.3	**Properties:** Solenoidal and irrotational vector fields, conservative vector field	
	4.4	**Vector Integral:** Line integral, Green's theorem in a plane, Gauss' divergence theorem, Stokes' theorem	
5.0		**Complex Variable**	10
	5.1	**Analytic Function:** Necessary and sufficient conditions, Cauchy Reiman equation in polar form	
	5.2	Harmonic function, orthogonal trajectories	
	5.3	**Mapping:** Conformal mapping, bilinear transformations, cross ratio, fixed points, bilinear transformation of straight lines and circles	
		Total	**52**

Text books:

1. P. N. Wartikar and J. N. Wartikar, *"A Text Book of Applied Mathematic",* Vol. I & II, Vidyarthi Griha Prakashan
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication

Reference Books:

1. B. S. Tyagi, *"Functions of a Complex Variable,"* Kedarnath Ram Nath Publication
2. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
3. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
4. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
5. Murry R. Spieget, *"Vector Analysis",* Schaum's outline series, Mc-Graw Hill Publication

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

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.

Term Work/ Tutorial:
At least 08 assignments covering entire syllabus must be given during the '**class wise tutorial'**. The assignments should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per '**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	Tutorial	Total
ETC 302	Analog Electronics I	4	--	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETC 302	Analog Electronics I	20	20	20	80	--	--	--	100

Course pre-requisite:

- FEC102: Applied Physics I
- FEC105: Basic Electrical and Electronics Engineering

Course objectives:

- To understand physical operation of semiconductor devices
- To understand DC and AC models of semiconductor devices
- To apply concepts of DC and AC modeling of semiconductor devices for the design and analysis
- To verify the theoretical concepts through laboratory and simulation experiments.

Course outcomes:

After completion of this course students will be:

- Able to understand the current voltage characteristics of semiconductor devices.
- Able to understand and relate dc and ac models of semiconductor devices with their physical Operation.
- Able to perform design and analysis of electronic circuits
- Able to design analog system and components

Module No.	Unit No.	Topics	Hrs.
1.0		**Diodes and their Applications**	08
	1.1	**PN Junction Diode:** Diode current equation, effect of temperature on diode characteristics, breakdown mechanism, diode as a switch, small signal model	
	1.2	**Clippers and Clampers**: Voltage transfer characteristics, series and shunt clippers, single diode series and shunt clamper circuits	
	1.3	**Other PN junction devices:** Construction and operation of Varactor diode, photodiode, Schottkey diode	
2.0		**Field Effect Transistors**	08
	2.1	**Junction Field Effect Transistor (JFET):** Construction, working, regions of operation, transfer (V_{GS}, Vs, I_D) and output (V_{DS}, Vs, I_D) characteristics, Schockely equation	
	2.2	**Metal-Oxide Semiconductor Field Effect Transistor (MOSFET):** **E-MOSFET:** MOS capacitor, energy band diagram of MOS capacitor in accumulation, depletion and inversion region, concept of threshold voltage, operation of MOSFET, derivation of threshold voltage and drain current, body effect, channel length modulation **D-MOSFET**: Construction and working	
3.0		**DC Analysis of Transistor Circuits**	10
	3.1	**Bipolar Junction Transistor:** Review of BJT characteristics, DC load line and regions of operation, transistor as a switch, DC analysis of common BJT circuits, analysis and design of fixed bias, collector to base bias and voltage divider bias, stability factor analysis	
	3.2	**Junction Field Effect Transistor:** Analysis and design of self bias and voltage divider bias	
	3.3	**MOSFET:** DC load line and region of operation, common MOSFETs configurations, analysis and design of biasing circuits	
4.0		**Small Signal Analysis of BJT Amplifiers**	10
	4.1	**BJT CE Amplifier:** Understanding of amplification concept with reference to input/output characteristics, AC load line analysis, definition of amplifier parameters Z_i, Z_0, A_v and A_i, graphical analysis to evaluate parameters	
	4.2	**Small Signal mid Frequency Models:** Hybrid-pi model, early effect, h-parameter model	
	4.3	**Small Signal Analysis:** Small signal analysis (mid-frequency) (Z_i, Z_0, A_v and A_i) of CE, CB, and CC configurations using hybrid-pi model, comparison between CE, CB, and CC configurations with reference to parameters	
5.0		**Small Signal Analysis of FET Amplifiers**	08
	5.1	**JFET CS Amplifier:** Small signal equivalent circuit and analysis (mid-frequency) (Z_i, Z_0 and A_v)	
	5.2	**E-MOSFET Amplifier:** Graphical analysis to evaluate parameters, AC load line, small signal model, small signal (mid-frequency) analysis of CS, CD and CG amplifiers	
6.0		**Oscillators (no numericals)**	08
	6.1	**Concepts of Oscillator:** Concept of negative and positive feedback and conditions for oscillation	
	6.2	**RC oscillators**: Phase shift and Wein bridge	
	6.3	**LC Oscillators**: Hartley, Colpitts and Clapps	
	6.4	**Tuned Oscillator**: Twin-T oscillator and crystal oscillator	
		Total	**52**

Text Books:

1. Donald A. Neamen, *"Electronic Circuit Analysis and Design",* Tata McGraw Hill, 2^{nd} Edition
2. Adel S. Sedra, Kenneth C. Smith, and Arun N Chandorkar, *"Microelectronic Circuits Theory and Applications",* International Version, OXFORD International Students, Sixth Edition

Recommended Books:

1. Sung-Mo Steve Kang, and Yusuf Leblebici*, "CMOS Digital Integrated Circuits Analysis and Design",* TATA McGraw Hill,
2. S. Salivahanan*,* N. Suresh Kumar, *"Electronic Devices and Circuits",* Tata Mc-Graw Hill, 3^{rd} Edition
3. Jacob Millman*,* Christos C Halkias and Satyabrata G., *"Millman's Electronic Devices and Circuits",* Mc-Graw Hill, 3^{rd} Edition
4. Muhammad H. Rashid, *"Microelectronics Circuits Analysis and Design",* Cengage Learning, 2^{nd} Edition
5. Anil K. Maini and Varsha Agrawal*, "Electronic Devices and Circuits",* Wiley Publications

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

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	Tutorial	Total
ETC 303	Digital Electronics	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ETC303	Digital Electronics	20	20	20	80	-	-	-	100

Course objectives:

- To introduce the fundamental concepts and methods for design of various digital circuits.
- To build the skill of digital system design and testing used in various fields of computing, communication, automatic control of mechanisms and instrumentation.

Course outcomes:

After completion of course, students will be

- Able to distinguish between analog and digital signals & data.
- Able to analyze, transform & minimize combination logic circuits.
- Able to understand basic arithmetic circuits.
- Able to design and analyze sequential circuits.
- Able to design digital system and components.

Module No.	Unit No.	Topics	Hrs.
1.0		**Number Systems and Codes**	04
	1.1	**Arithmetic codes**: Review of number system, BCD code, Octal code, Hexa-decimal code, EX-3 code, Gray code, ASCII Code	
2.0		**Logic Gates and Combinational Logic Circuits**	16
	2.1	**DTL, TTL, ECL and CMOS gates:** Transfer characteristics, noise margin, fan-in, fan-out, introduction to their logic families, their transfer characteristics and noise margin	
	2.2	**Universal gates and combinational circuits**: Realization of basic gates using NAND and NOR gates, Boolean algebra, De Morgan's theorem, SOP and POS representation, K-map up to five variables, Quine-McClusky method, variable entered mapping	
	2.3	**Arithmetic circuits:** Adder, subtractor, carry look ahead adder, BCD adder, magnitude comparator, binary multiplier, series and parallel adder	
	2.4	**Multiplexer and de-multiplexer:** Boolean functions implementation using multiplexer and de-multiplexer, encoder and decoder, parity generator and checker	
3.0		**Sequential Logic Circuits**	16
	3.1	**Flip flops and registers:** RS, JK, T, D and master slave flip flops, conversion of flip flops, universal shift registers	
	3.2	**Counter design:** Asynchronous and synchronous counter, up/down counter, mod-N counter, pre-settable counter, skipping state counter	
	3.3	**Shift registers design:** SISO, SIPO, PISO, PIPO, shift left and shift right registers	
	3.4	**Applications of sequential circuits:** Frequency division, ring counter, Johnson counter, Moore and Mealy machine, state transition diagram, synthesis table	
	3.6	**State reduction techniques:** Row elimination and implication table methods	
4.0		**Different types of Memory**	06
	4.1	**Classification and characteristics of memory:** SRAM, DRAM, ROM, PROM, EPROM and FLASH memories	
5.0		**Introduction to Programmable Logic Devices**	10
	5.1	**CPLD and FPGA:** Architecture of CPLD and FPGA, Xilinx XC 9500 CPLD Series and Xilinx XC 4000 FPGA Series	
	5.2	**VHDL:** Data types, Structural Modeling using VHDL, attributes, data flow, behavioral, VHDL implementation of basic combinational and sequential Circuits	
	5.3	**Programmable Logic Devices:** PLA and PAL	
		Total	**52**

Text Books:

1. Morris Mano and Michael D. Ciletti, *"Digital Design"*, Pearson Education, Fourth Edition, 2008.
2. Malvino A.P. and Leach D.P., *"Digital Principles and Applications",* TMH, 6^{th} Edition

Reference Books:

1. John F. Warkerly, "*Digital Design Principles and Practices"*, Person Education, Fourth Edition, 2008. .
2. J. Bhaskar, *"VHDL Primer",* Prentice Hall, 3^{rd} Edition
3. William I. Fletchter, "*An Engineering Approach to Digital Design"*, PHI, Tenth Indian Reprint, 2001.
4. Norman Balabanian and Bradley Carlson, "*Digital Logic Design Principles"*, John Wiley & Sons, First Edition, 2011.
5. A. Anand Kumar, *"Fundamentals of Digital Circuits"*, PHI, Second Edition, 2012.
6. Charles H. Roth, *"Fundamentals of Logic Design"*, Jaico Publishing House, First Edition, 2004.
7. G. K. Kharate, *"Digital Electronics"*, Oxford University Press, First Edition, 2010
8. R. P. Jain, "*Modern Digital Electronics*", Tata McGraw Hill Education, Third Edition 2003.
9. Frank Vahid, "*Digital Design*", John Willy and Sons, First Edition, 2011.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

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	Tutorial	Total
ETC 304	Circuits and Transmission Lines	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ETC 304	Circuits and Transmission Lines	20	20	20	80	--	--	--	100

Course pre-requisite:

FEC 105: Basic electrical and electronics engineering

Partial fraction expansion, matrices, determinants calculus and differential equations,

Course objectives:

- To analyze and synthesize circuits and to become familiar with the propagation of signals through transmission lines.
- To analyze the circuits in time and frequency domain
- To study network functions, inter relationship among various circuit parameters, solve more complex network using these parameters.

Course outcomes:

- Through test, laboratory exercises and home assignment, students will be able to apply their knowledge in solving complex circuits.
- Students will be able to evaluate the time and frequency response which is useful in understanding behavior of electronic circuits and control system.
- Student will able to understand how the information in terms of voltage and current is transmitted through the transmission lines and importance of matching.

Module No.	Unit No.	Topics	Hrs.
1.0		**Electrical circuit analysis**	12
	1.1	**Analysis of DC circuits:** Analysis of circuits with and without controlled sources using generalized loop and node matrix methods and Source Transformation, Superposition, Thevenin, Norton, Millman theorems	
	1.2	**Magnetic circuits:** Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using loop analysis	
	1.3	**Tuned coupled Circuits:** Analysis of tuned coupled circuits	
2.0		**Time and frequency domain analysis**	10
	2.1	**Time domain analysis of R-L and R-C circuits:** Forced and natural response, time constant, initial and final values **Solution using first order equation for standard input signals:** Transient and steady state time response, solution using universal formula	
	2.2	**Time domain analysis of R-L-C Circuits:** Forced and natural response, effect of damping **Solution using second order equation for standard input signals:** transient and steady state time response	
	2.3	**Frequency domain analysis of RLC Circuits:** S-domain representation, applications of Laplace Transform in solving electrical networks, driving point and transfer Function, Poles and Zeros, calculation of residues by analytical and graphical method, analysis of ladder and lattice network **Response to standard signals:** Transient and steady state time response of R-L-C circuits	
3.0		**Synthesis of RLC circuits**	10
	3.1	**Positive real functions:** Concept of positive real function, testing for Hurwitz polynomials, testing for necessary and sufficient conditions for positive real functions	
	3.2	**Synthesis of RC, RL, LC and RLC circuits:** Properties and synthesis of RC, RL, LC driving point functions	
4.0		**Two port circuits**	10
	4.1	**Parameters:** Open circuits, short circuit, transmission and hybrid parameters, relationship among parameters, reciprocity and symmetry conditions.	
	4.2	Interconnections of two-port circuits, T & π representation.	
	4.3	Terminated two-port circuits.	
5.0		**Radio frequency transmission lines**	10
	5.1	**Transmission Line Representation:** T and Л representations, terminated transmission line, infinite line	
	5.2	**Parameters of radio frequency lines:** Propagation constant, attenuation constant, phase constant, group velocity, input impedance, characteristic impedance, reflection coefficient, standing wave ratio, VSWR, ISWR, S-parameters	
	5.3	**Smith Chart**: Impedance locus diagram, impedance matching	
		Total	**52**

Text Books

1. Franklin F Kuo, *"Network Analysis and Synthesis",* Wiley Toppan, 2nd.ed. 1966
2. W L Everitt and G E Anner, *"Communication Engineering",* Mc-GrawHill, New York, 3rd Edition, 1956

Reference Books

1. M E Van Valkenburg, *"Network Analysis",* Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000
2. K V V Murty and M S Kamth*, "Basic Circuit Analysis",* Jaico Publishing house, London
3. A Chakrabarti*, "Circuit Theory",* Dhanpat Rai & Co., Delhi, 6h Edition

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered for final Internal Assessment.

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	Tutorial	Total
ETC 305	Electronic Instruments and Measurements	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETC 305	Electronic Instruments and Measurements	20	20	20	80	--	--	--	100

Pre-requisites:
- Students are expected to have basic knowledge of analog and digital electronics

Course objectives:
- To understand basic functions and principle of working of sensors and components used in Electronic Measurement
- To understand principles of advanced electronic instruments and application in measurement of electronics parameters

Course outcomes:
- Students will learn measurement of physical parameters using various transducers and working of sensors.
- They will become familiar with basics of instruments and details of operation of measuring instruments and their applications.

Module No.	Unit No.	Topics	Hrs.
1. 0		**Principals of measurement**	06
	1.1	**Introduction to basic instruments:** Components of generalized measurement system, applications of instrument systems, static and dynamic characteristics of instruments, concepts of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration	
	1,2	**Errors in measurement:** Errors in measurement, classification of errors, remedies to eliminate errors	
2.0		**Sensors and transducers**	12
	2.1	**Basics of sensors and transducers:** Active and passive transducers, characteristics and selection criteria of transducers, working principle of Eddy-current sensors, Pizoelectric transducers, photoelectric and photo voltaic 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	
3.0		**Testing and measuring Instruments**	10
	3.1	**Analog multi-meter:** Multi-range measurement of voltage, current and resistance, specifications	
	3.2	**Measurement of resistance:** Kellvin's double bridge, Wheatstone bridge, and Megaohm bridge **Measurement of inductance:** Maxwell bridge and Hey bridge; **Measurement of capacitance:** Schering bridge **Q-Meter:** Operating principle and applications	
	3.3	**Energy and power meters:** Working of energy and power meter	
4.0		**Data Acquisition and Digital Instruments**	10
	4.1	**Data acquisition and converters**: single channel, multichannel and PC based DAS **A/D and D/A converters:** Types and specifications of A/D and D/A converters, Significance of X½ digit display	
	4.2	**Digital multi-meter:** Block diagram, multi range measurement of voltage, current and resistance, specifications	
5.0		**Oscilloscopes**	08
	5.1	**Cathode ray oscilloscope:** Block diagram based Study of CRO, specifications, controls, sweep modes, role of delay line, single- and dual-beam dual-trace CROs, chop and alternate modes	
	5.2	**Measurement using oscilloscope:** measurement of voltage, frequency, rise time, fall time and phase difference. Lissajous figures in detection of frequency and phase	
	5.3	**Digital storage oscilloscope (DSO):** Block diagram based study of DSO, study of features like roll, refresh, storage mode and sampling rate; applications of DSO	
6.0		**Signal analyzers**	06
	6.1	**Wave analyzers:** Introduction to harmonic, total harmonic distortion analyzer; block diagram and applications of wave analyzers	
	6.2	**Spectrum and network analyzers:** Block diagram and applications	
		Total	52

Text Books:

1. H. Oliver and J. M. Cage, "*Electronic Measurement and Instrumentation",* McGraw Hill, 3rd edition, 2008
2. C. S. Rangan, G.R. Sarma, and V.S.V. Mani, *"Instrumentation Devices and Systems",* Tata McGraw Hill, 9th edition, 2007

Reference Books:

1. T. S. Rathore, *"Digital Measurement Techniques",* Narosa Publishing House, New Delhi, 2nd Edition, 2003
2. W. Cooper and A. Helfric, "*Electronic Instrumentation and Measurement Techniques"*, PHI, 4th edition, 2009
3. H. S. Kalsi, *"Electronics Instrumentation",* Tata Mcgraw Hill, 2nd Edition, 2009

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered for final Internal Assessment.

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
ETS 306	Object Oriented Programming Methodology	--	--	--	--	--	--	--

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETS 306	Object Oriented Programming Methodology	--	--	--	--	--	--	--	--

Pre-requisites:
Course in Structured Programming Approach/ Any Programming Language

Course Objectives:
- To understand the concept of Object Oriented Programming
- To help student to understand use of programming language such as JAVA to resolve problems.
- To impart problems understanding, analyzing skills in order to formulate Algorithms.
- To provide knowledge about JAVA fundamentals: data types, variables, keywords and control structures.
- To understand methods, arrays, inheritance, Interface, package and multithreading and concept of Applet.

Course Outcomes:
- Students will be able to code a program using JAVA constructs.
- Given an algorithm a student will be able to formulate a program that correctly implements the algorithm.
- Students will be able to generate different patterns and flows using control structures and use recursion in their programs.
- Students will be able to use thread methods, thread exceptions and thread priority.
- Students will implement method overloading in their code.
- Students will be able to demonstrate reusability with the help of inheritance.
- Students will be able to make more efficient programs.

Module No.	Unit No.	Topic	Hrs.
1		**Fundamental concepts of object oriented programming**	**4**
	1.1	Overview of programming	
	1.2	Introduction to the principles of object-oriented programming: classes, objects, messages, abstraction, encapsulation, inheritance, polymorphism, exception handling, and object-oriented containers	
	1.3	Differences and similarity between C++ and JAVA	
2		**Fundamental of Java programming**	**4**
	2.1	Features of Java	
	2.2	JDK Environment & tools	
	2.3	Structure of Java program	
	2.4	Keywords , data types, variables, operators, expressions	
	2.5	Decision making, looping, type casting	
	2.6	Input output using scanner class	
3		**Classes and objects**	**6**
	3.1	Creating classes and objects	
	3.2	Memory allocation for objects	
	3.3	Passing parameters to Methods	
	3.4	Returning parameters	
	3.5	Method overloading	
	3.6	Constructor and finalize ( )	
	3.7	Arrays: Creating an array	
	3.8	Types of array : One dimensional arrays ,Two Dimensional array, string	
4		**Inheritance, interface and package**	**6**
	4.1	Types of inheritance: Single, multilevel, hierarchical	
	4.2	Method overriding, super keyword, final keyword, abstract class	
	4.3	Interface	
	4.4	Packages	
5		**Multithreading**	**4**
	5.1	Life cycle of thread	
	5.2	Methods	
	5.3	Priority in multithreading	
6		**Applet**	**2**
	6.1	Applet life cycle	
	6.2	Creating applet	
	6.3	Applet tag	
		Total	**26**

Text Books:

1. Rajkumar Buyya, "*Object-oriented programming with JAVA"*, Mcgraw Hill
2. E Balgurusamy, *"Programming with JAVA",* Tata McGraw Hill

Reference Books:

1. Herbert Schildt, *"The Complete Reference JAVA",* Tata McGraw Hill
2. Barry Holmes and Daniel T. Joyce, *"Object Oriented Programming with Java",* Jones & Bartlett Learning

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW	Tutorial	Total
ETL 301	Analog Electronics I Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETL 301	Analog Electronics I Laboratory	--	--	--	--	25	25	-	50

Term Work:
At least **10** experiments covering entire syllabus should be set to have well predefined inference and conclusion. 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.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per '**credit and grading'** system manual and should be added and averaged. Based on the 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	Tutorial	Total
ETL 302	Digital Electronics Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ETL302	Digital Electronics Laboratory	--	--	--	--	25	25	-	50

Term Work:
At least **10** experiments covering entire syllabus should be set to have well predefined inference and conclusion. 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.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per '**credit and grading'** system manual and should be added and averaged. Based on the 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
ETL 303	Circuits and Measurement Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETL 303	Circuits and Measurement Laboratory	--	--	--	--	25	--	--	25

Term Work:

At least **10** experiments (5 on Circuits and Transmission lines and 5 on Electronics Instruments and Measurements) covering entire syllabus should be set to have well predefined inference and conclusion. 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.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades converted into marks as per '**credit and grading'** System manual should be added and averaged. Based on this final term work grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETSL 304	Object Oriented Programming Methodology Laboratory	--	02+02*	--	--	01	--	01

*-Out of four hours, 2 hours theory shall be taught to entire class followed by 2 hrs. practical in batches.

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETSL 304	Object Oriented Programming Methodology Laboratory	--	--	--	--	25	50	-	75

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.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per **Credit and Grading** System manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

The Practical and oral examination will be based on entire syllabus.

Programme Structure B.E. (Electronics & Telecommunication)
S.E. (Electronics & Telecommunication) Sem IV

Sub Code	Subject Name	Teaching Scheme(Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETS401	Applied Mathematics IV	04	--	01	04	--	01	05
ETC402	Analog Electronics II	04	--	--	04	--	--	04
ETC403	Microprocessors and Peripherals	04	--	--	04	--	--	04
ETC404	Wave Theory and Propagation	04	--	--	04	--	-	04
ETC 405	Signals and Systems	04	--	01	04	-	01	05
ETC406	Control Systems	04	--	--	04	--	-	04
ETL401	Analog Electronics II Laboratory	--	02	--	--	01	--	01
ETL402	Microprocessors and Peripherals Laboratory	--	02	--	--	01	--	01
ETL403	Software Simulation Laboratory	--	02	--	--	01	--	01
Total		**24**	**06**	**02**	**24**	**03**	**02**	**29**

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETS401	Applied Mathematics IV	20	20	20	80	25	--	--	125
ETC402	Analog Electronics II	20	20	20	80	--	--	--	100
ETC403	Microprocessors and Peripherals	20	20	20	80	--	--	--	100
ETC404	Wave Theory and Propagation	20	20	20	80	--	--	--	100
ETC 405	Signals and Systems	20	20	20	80	25	--	--	125
ETC406	Control Systems	20	20	20	80	--	--	--	100
ETL401	Analog Electronics II Laboratory	--	--	--	--	25	25	--	50
ETL402	Microprocessors and Peripherals Laboratory	--	--	--	--	25	25	--	50
ETL403	Software Simulation Laboratory	--	--	--	--	25	25	--	50
Total		**--**	**--**	**120**	**480**	**125**	**75**	**--**	**800**

Subject Code	Subject Name	Teaching Scheme(Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETS 401	Applied Mathematics IV	04	--	01	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETS 401	Applied Mathematics IV	20	20	20	80	25	--	--	125

Course pre-requisite:

FE C 101 : Applied Mathematics I
FE C 201 : Applied Mathematics II
SE S 301 : Applied Mathematics III

Course objectives:
This course will present the method of calculus of variations (CoV), basic concepts of vector spaces, matrix theory, concept of ROC and residue theory with applications.

- To provide students with a sound foundation in mathematics and prepare them for graduate studies in Electronics and Telecommunication Engineering
- To provide students with mathematics fundamental necessary to formulate, solve and analyze engineering problems.
- To provide opportunity for students to work as part of teams on multi disciplinary projects.

Expected outcomes:
- Students will able to apply method of calculus of variations to specific systems, demonstrate ability to manipulate matrices and compute eigenvalues and eigenvectors, Identify and classify zeros, singular points, residues and their applications.
- Students will demonstrate an ability to identify formulate and solve Telecommunication Engineering problem using applied mathematics.
- Students who can participate and succeed in competitive exams like GATE, GRE.

Module No.	Unit No.	Topics	Hrs.
1. 0		**Calculus of variation**	**10**
	1.1	Euler 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	
2.0		**Linear algebra: vector spaces**	**12**
	2.1	**Vectors in n-dimensional vector space**: Properties, dot product, cross product, norm and distance properties in n-dimensional vector space.	
	2.2	Metric spaces, vector spaces over real field, properties of vector spaces over real field, subspaces.	
	2.3	Norms and normed vector spaces	
	2.4	Inner products and inner product spaces	
	2.5	The Cauchy-Schwarz inequality, orthogonal Subspaces, Gram-Schmidt process	
3.0		**Linear Algebra: Matrix Theory**	**15**
	3.1	Characteristic equation, Eigenvalues and Eigenvectors, properties of Eigenvalues and Eigenvectors	
	3.2	Cayley-Hamilton theorem, examples based on verification of Cayley-Hamilton theorem	
	3.3	Similarity of matrices, Diagonalisation of matrix	
	3.4	Functions of square matrix, derogatory and non-derogatory matrices	
	3.5	Quadratic forms over real field, reduction of quadratic form to a diagonal canonical form, rank, index, signature of quadratic form, Sylvester's law of inertia, value-class of a quadratic form of definite, semi-definite and indefinite	
	3.6	Singular Value Decomposition	
4.0		**Complex variables: Integration**	**15**
	4.1	**Complex Integration:** Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula	
	4.2	Taylor's and Laurent's series	
	4.3	Zeros, singularities, poles of f(z), residues, Cauchy's Residue theorem	
	4.4	Applications of Residue theorem to evaluate real Integrals of different types	
		Total	**52**

Text books:

1) A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune
2) Mathematical Methods in science and Engineering, A Datta (2012)
3) Higher Engg. Mathematics by Dr. B.S. Grewal, Khanna Publication

Reference Books:

1) Todd K.Moon and Wynn C. Stirling, Mathematical Methods and algorithms for Signal Processing, Pearson Education.
2) Kreyszig E., Advanced Engineering Mathematics, 9^{th} edition, John Wiley, 2006.
3) Linear Algebra- Hoffman & Kunze (Indian editions) 2002
4) Linear Algebra- Anton & Torres (2012) 9^{th} Indian Edition.
5) Complex Analysis – Schaum Series.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

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.

Term Work/Tutorial:
At least 08 assignments covering entire syllabus must be given during the **Class Wise Tutorial**. The assignments should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per **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	Tutorial	Total
ETC 402	Analog Electronics II	4	--	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETC 402	Analog Electronics II	20	20	20	80	-	-	--	100

Course Pre-requisite:

ETC : 302 – Analog Electronics I

Course Objective:

- To deliver the core concepts and reinforce the analytical skills learned in Analog Electronics I
- To motivate students to use MOS devices for designing and analyzing electronic Circuits which will help them to understand the fundamentals of VLSI design.

Expected Outcomes:

After completion of the course students will be able to

- Analyze and design multistage electronic Circuits.
- Differentiate between discrete and integrated biasing techniques.
- Differentiate between small signal and large signal Amplifiers.

Module No.	Unit No.	Topics	Hrs.
1.0		**Frequency Response of Amplifiers**	**14**
	1.1	**High Frequency Model:** High frequency hybrid-pi equivalent Circuits of BJT and MOSFET, Miller effect and Miller capacitance, gain bandwidth product	
	1.1	**Single Stage Amplifiers :** Effect of capacitors (coupling, bypass, load) on frequency response of single stage BJT (CE, CC,CB configurations) , MOSFET (CS,CG, CD configuration) amplifiers, low and high frequency response of BJT (CE, CB, CC) and MOSFET (CS, CG,CD) amplifiers	
	1.2	**Multistage Amplifier:** Low and high frequency response and mid – frequency analysis of multistage (CE-CE, CS-CS), cascode (CE-CB, CS-CG) Amplifiers, Darlington pair, design of two stage amplifiers	
2.0		**Differential Amplifiers**	**10**
	2.1	**BJT Differential Amplifiers:** Terminology and qualitative description, DC transfer characteristics, small signal analysis, differential and common mode gain, CMRR, differential and common mode input impedance	
	2.2	**MOSFET Differential Amplifiers:** DC transfer characteristics, small signal analysis, differential and common mode gain, CMRR, differential and common mode input impedance	
3.0		**Integrated Circuits Biasing Techniques**	**08**
	3.1	**Current Mirror:** Two transistor (BJT, MOSFET) current source, current relationship, output resistance.	
	3.2	**Improved Current Source:** Three transistor (BJT,MOSFET) current source	
	3.3	**Special Current Source:** Cascode (BJT, MOSFET) current source, Wilson and Widlar current sources	
4.0		**Power Amplifiers**	**8**
	4.1	**Power Devices:** Power BJTs, power MOSFETs, heat sinks	
	4.2	**Classification:** Class A, Class B, Class AB and Class C operation, and performance parameters	
	4.3	**Transformer and Transfomerless Amplifiers**: Transformer coupled Class A Amplifier, Class AB output stage with diode biasing, V_{BE} multiplier biasing, input buffer transistors, Darlington configuration	
5.0		**Fundamentals of Operational Amplifier**	**08**
	5.1	**Fundamentals of Op-amp:** characteristics of op-amp, high frequency effects on op-amp gain and phase, slew rate limitation,	
	5.2	**Applications of Op-amps:** Inverting and non-inverting amplifier, adder, abstractor, integrator, differentiator, active filters (first order low and high pass)	
6.0		**DC Regulated Power Supply**	**04**
	6.1	**Series and Shunt Regulator:** Regulator performance parameters, Zener shunt regulator, transistorized series and shunt regulator	
		Total	**52**

Text Books:

1. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill, 2nd Edition
2. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar, Microelectronic Circuits Theory and Applications, Fifth Edition, International Version, OXFORD International Students Sixth Edition

Recommended Books:

1. S. Salivahanan, N. Suresh Kumar,*"Electronic Devices and Circuits",* Tata McGraw Hill, 3rd Edition
2. Jacob Millman, Christos C Halkias, and Satyabratatajit, *"Millman's Electronic Devices and Circuits",* McGrawHill, 3rd Edition
3. Muhammad H. Rashid, *"Microelectronics Circuits Analysis and Design",* Cengage Learning, 2nd Edition
4. Jacob Milliman and Arvin Grabel, " Microelectronics" Tata McGrawHill, 2nd Edition
5. Anil K. Maini and Varsha Agrawal, *"Electronic Devices and Circuits",* Wiley Publications

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

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
ETC 403	Microprocessors and Peripherals	4	--	--	4	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETC403	Microprocessor and Peripherals	20	20	20	80	-	-	-	100

Course pre-requisite:

ETC 303 : Digital Electronics

Course objectives:

- To develop background knowledge and core expertise in microprocessor.
- To study the concepts and basic architecture of 8085, 8086, 80286, 80386, 80486 Pentium processor and Co-processor 8087.
- To know the importance of different peripheral devices and their interfacing to 8086.
- To know the design aspects of basic microprocessor.
- To write assembly language programs in microprocessor for various applications.

Course outcomes:

Students will learn

- The architecture and software aspects of microprocessor 8086
- Assembly language program in 8086 for various applications.
- Co-processor configurations.
- Various interfacing techniques with 8086 for various applications.
- Basic concepts of advanced microprocessors.

Module No.	Unit No.	Topics	Hrs.
1.0		**Architecture of 8085 and 8086 Microprocessor**	**08**
	1.1	8085 Architecture and pin configuration.	
	1.2	8086 Architecture and organization, pin configuration.	
	1.3	Minimum and Maximum modes of 8086.	
	1.4	Read and Write bus cycle of 8086.	
2.0		**Instruction set and programming of 8086**	**10**
	2.1	8086 Addressing modes.	
	2.2	8086 Instruction encoding formats and instruction set.	
	2.3	Assembler directives.	
	2.4	8086 programming and debugging of assembly language program.	
3.0		**Peripherals interfacing with 8086 and applications.**	**10**
	3.1	8086-Interrupt structure.	
	3.2	Programmable interrupt controller 8259A.	
	3.3	Programmable peripheral Interface 8255.	
	3.4	Programmable interval Timer 8254.	
	3.5	DMA controller 8257	
	3.6	Interfacing 8259A, 8255, 8254, 8257 with 8086 and their applications	
4.0		**ADC, DAC interfacing with 8086 and its application**	**08**
	4.1	Analog to Digital Converter (ADC) 0809	
	4.2	Digital to Analog Convertor (DAC) 0808	
	4.3	Interfacing ADC 0809, DAC 0808 with 8086 and their applications.	
	4.4	8086 based data Acquisition system.	
5.0		**8086 Microprocessor interfacing**	**10**
	5.1	8087 Math coprocessor, its data types and interfacing with 8086.	
	5.2	Memory interfacing with 8086 microprocessor	
6.0		**Advanced Microprocessors**	**06**
	6.1	Basic architectures of 80286, 80386, 80486 and Pentium processor.	
		Total	**52**

Text Books:
1. Gaonkar R.S.: “Microprocessor Architecture Programming and Applications with the 8085” Penram International Pub, 5th Edition.
2. John Uffenbeck: “8086/8088 family: “Design, Programming and Interfacing”, Prentice Hall, 2ndEdition
3. B. B. Brey: “The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro Processor”, Pearson Pub, 8th Edition

Reference Books:
1. Hall D.V: “Microprocessor and Interfacing Programming and Hardware”, Tata McGraw Hill, 2nd Edition.
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.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered for final Internal Assessment.

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
ETC 404	Wave Theory and Propagation	4	--	--	4	--	-	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETC 404	Wave Theory and Propagation	20	20	20	80	--	-	-	100

Course Pre-requisite
Vector Algebra, Vector Integral

Course Objective:

- To understand basic laws of electrostatics and magnetostatics in vector form.
- To understand the propagation of wave in different media like dielectric and conducting media by solving wave equation and find parameters of media.
- To calculate energy transported by means of electromagnetic waves from one point to another and to study polarization of waves.
- To solve electromagnetic problems using different numerical methods.
- To extend the students' understanding about the propagation of the waves by different types such as ground waves and space waves.
- To study the factors affecting the wave during its propagation.
- To understand sky wave propagation; related parameters such as MUF, skip distance and critical frequency.

Expected Outcomes:

- Ability to find nature of electric or magnetic field produced due to different charge distributions.
- Ability to understand working of different equipments based on electromagnetic used in day to day life.
- Knowledge of behavior of EM waves and travelling of waves in free space as well as media.
- Able to find conditions for loss of signal.
- Able to apply numerical methods for designing antennas.
- An ability to select proper parameters for propagation of the waves by considering the factors affecting.
- Any ability to identify and solve problems related to the propagation of waves.
- To understand the basics of wave propagation required for the study of antennas.

Module No.	Unit No.	Topics	Hrs.
1.0		**Basic Laws of electromagnetic & Maxwell's equations**	13
	1.1	**Fundamental laws of electromagnetic fields:** Coulomb's law, Gauss's law, Bio-Savart's law, Ampere's law, Poisson's and Laplace equations	
	1.2	**Boundary conditions:** Static electric and magnetic fields	
	1.3	**Maxwell's equations:** Integral and differential form for static and time varying fields and its interpretations	
	1.4	**Applications of electromagnetic fields:** Ink-jet printer, CRO, electromagnetic pump	
2.0		**Uniform plane wave equation and power balance**	08
	2.1	**Wave equation:** Derivation and its solution in Cartesian co-ordinates	
	2.2	**Solution of wave equations:** Partially conducting media, perfect dielectrics and good conductors, concept of skin dept	
	2.3	**Electromagnetic Power:** Poynting Vector and Power Flow in free space and in dielectric, conducting media	
3.0		**Plane Wave Propagation**	06
	3.1	**Polarization of wave;** Elliptical. Linear and Circular	
	3.2	**Propagation in different mediums:** Behavior of waves for normal and oblique incidence in dielectrics and conducting media, propagation in dispersive media	
4.0		**Computational Electromagnetics**	08
	4.1	**Finite Difference Method (FDM):**Neumann type and mixed boundary conditions, Iterative solution of finite difference equations, solutions using band matrix method	
	4.2	**Finite Element Method (FEM**): Triangular mesh configuration, Finite element discretization, Element governing equations, Assembling all equations and solving resulting equations	
	4.3	**Method of Moment (MOM):**Field calculations of conducting wire, parallel conducting wires and complicated geometries	
5.0		**Radio Wave Propagation**	10
	5.1	**Types of wave propagation:** Ground, space and surface wave propagation, tilt and surface waves, impact of imperfect earth and earth's behavior at different frequencies	
	5.2	**Space wave propagation:** Effect of imperfection of earth, curvature of earth, effect of interference zone, shadowing effect of hills and building, atmospheric absorption, Super-refraction, scattering phenomena, troposphere propagation and fading	
6.0		**Sky Wave Propagation**	07
	6.1	**Reflection and Refraction of waves**: Ionosphere and Earth magnetic field effect	
	6.2	**Measures of Ionosphere Propagation:** Critical frequency, Angle of incidence, Maximum unstable frequency, Skip distance, Virtual height, Variations in ionosphere and Attenuation and fading of waves in ionosphere	
		Total	**52**

Text Books:

1. J.A. Administer, *“Electromagnetic”*, McGraw Hill Companies, 2^{nd} Edition, 2006
2. Bhag Guru and Huseyin Hiziroglu, *“Electromagnetic field theory fundamentals”,* Cambridge University Press, 2^{nd} Edition, 2010.
3. J.D. Kraus, R.J. Marhefka, A.S. Khan *“Antennas & Wave Propagation”,* McGraw Hill Publications, 4^{th} Edition, 2011

Reference Books

1. R.K. Shevgaonkar, Electromagnetic Waves, TATA McGraw Hill Companies, 3^{rd} Edition, 2009
2. R.L. Yadava, Antenna & Wave Propagation, PHI Publications, 1^{st} Edition, 2011
3. Edward C. Jordan, Keth G. Balmin, Electromagnetic Waves & Radiating Systems, Pearson Publications, 2^{nd} Edition, 2006
4. Matthew N.D. SADIKU, Principles of Electromagnetics, Oxford International Student 4^{th} Edition, 2007
5. W.H. Hayt, J.A. Buck, Engineering Electromagnetics, McGraw Hill Publications, 7^{th} Edition, 2006.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered for final Internal Assessment.

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
ETC 405	Signals and Systems	04	--	01	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical And Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETC 405	Signals and Systems	20	20	20	80	25	--	--	125

Course pre-requisite :

ETS : 301 - Applied Mathematics III
ETC : 304 - Circuits and Transmission Lines

Course objectives:

- To introduce students to the idea of signal and system analysis and characterization in time and frequency domain.
- To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.

Course outcomes:

- Students will be able to understand significance of signals and systems in the time and frequency domains
- Students will be able to interpret and analyze signal and report results.
- Students will be able to evaluate the time and frequency response of continuous and discrete time, system which is useful in understanding behavior of Electronics circuits and communication systems.

"

Module No.	Unit No.	Topics	Hrs.
1.0		**Overview of signals and systems**	06
	1.1	**Introduction:** Signals, systems, examples of systems for controls and communication, sampling theorem, sampling of continuous time signals, elementary signals, exponential, sine, step, impulse, ramp, rectangular, triangular and 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 signals.	
2.0		**Time domain analysis of Continuous Time and Discrete Time systems**	12
	2.1	**Classification of systems:** Static and dynamic, time variant and time invariant, linear and nonlinear, causal and noncausal, stable and unstable systems.	
	2.2	**Linear Time Invariant (LTI) systems:** Representation of systems using differential /difference equation, Impulse, step and exponential response, system stability, examples on applications of LTI systems, convolution, impulse response of interconnected systems, auto-correlation, cross correlation, properties of correlation, analogy between correlation and convolution, total response of a system	
3.0		**Laplace Transform**	06
3.0	3.1	**Overview of Laplace Transform:** Laplace Transform and properties, relation between continuous time Fourier Transform and Laplace Transform, unilateral Laplace Transform.	
	3.2	**Analysis of continuous time LTI systems using Laplace Transform:** Transfer Function, causality and stability of systems, solution of differential equation using Laplace Transform.	
4.0		*z* **– Transform**	08
	4.1	*z*-Transform of finite and infinite duration sequences, relation between discrete time Fourier Transform and z-Transform, properties, Inverse *z*-Transform, one sided *z*–Transform.	
	4.2	**Analysis of discrete time LTI systems using z-Transform**: Transfer Function, causality and stability of systems, frequency response, relation between Laplace Transform and *z*–Transform.	
5.0		**Fourier series of continuous and discrete time signals**	10
	5.1	**Review of Fourier series:** trigonometric and exponential Fourier series representation of signals, magnitude and phase spectra, power spectral density and bandwidth. Gibbs phenomenon.	
	5.2	**Properties of Fourier Series:** Linearity, time shifting, time reversal, frequency shifting, time scaling, differentiation, symmetry. Parsevel's relation. Examples based on properties, analogy between Continuous Time Fourier Series (CTFS) and Discrete Time Fourier Series (DTFS).	
6.0		**Continuous Time Fourier Transform (CTFT) and Discrete Time Fourier Transform (DTFT)**	10
	6.1	**Fourier Transform:** Fourier Transform and Inverse Fourier Transform on periodic and non-periodic signals, limitations of Fourier Transform and need for Laplace and *z*-Transform	
	6.2	**Properties of Fourier Transform:** Linearity, time shifting, time reversal, frequency shifting, time and frequency scaling, modulation, convolution in time domain, differentiation in time domain, differentiation in frequency domain, symmetry. Parsevel's relation. Energy, power spectral density and bandwidth. Definition and problems on DTFT	
		Total	**52**

Text books

1. Nagoor Kani, Signals and Systems, Tata McGraw Hill, Third Edition, 2011.
2. B.P. Lathi, Principles of Linear Systems and Signals, Oxford, Second Edition, 2010.
3. Simon Haykin and Barry Van Veen, Signals and Sytems, 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) Narayana Iyer, 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. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice-Hall of India, Second Edition, 2002.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

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.

Term Work:
At least 08 assignments covering entire syllabus must be given during the "**Class Wise Tutorial"**. The assignments should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per "**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
ETC 405	Control Systems	04	-	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical And Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETC 405	Control Systems	20	20	20	80	--	--	--	100

Course pre-requisite*:*
Dynamics; Differential Educations; Laplace Transforms.

Course objectives:
Objectives of this course are:
- To teach the fundamental concepts of Control systems and mathematical modeling of the system.
- To study the concept of time response and frequency response of the system.
- To teach the basics of stability analysis of the system

Course outcomes:
The outcomes of this course are**:**
- Students will be able to derive the mathematical model of different type of the systems.
- Students will understand the basic concepts of control system.
- Students will understand the analysis of systems in time and frequency domain.
- Students will be able to apply the control theory to design the conventional controllers widely used in the industries.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Control System Analysis**	08
	1.1	**Introduction:** Open loop and closed loop systems, feedback and feed forward control structure, examples of control systems.	
	1.2	**Modeling:** Types of models, impulse response model, state variable model, transfer function model	
	1.3	**Dynamic Response:** Standard test signals, transient and steady state behavior of first and second order systems, steady state errors in feedback control systems and their types	
2.0		**Mathematical Modeling of Systems**	08
	2.1	**Transfer Function models of various systems:** Models of mechanical systems, models of electrical systems, block diagram reduction, signal flow graph, and the Mason's gain rule	
3.0		**State Variable Models**	12
	3.1	**State Variable Models of Various Systems:** State variable models of mechanical systems, state variable models of electrical systems	
	3.2	**State Transition Equation:** Concept of state transition matrix, properties of state transition matrix, solution of homogeneous systems, solution of non-homogeneous systems	
	3.3	**Controllability and Observability:** Concept of controllability, controllability analysis of LTI systems, concept of observability, observability analysis of LTI systems	
4.0		**Stability Analysis In Time Domain**	08
	4.1	**Concepts of Stability:** Concept of absolute, relative and robust stability, routh stability criterion	
	4.2	**Root Locus Analysis:** Root-locus concepts, general rules for constructing root-locus, root-locus analysis of control systems, design of lag and lead compensators	
5.0		**Stability Analysis In Frequency Domain**	08
	5.1	**Introduction**: Frequency domain specifications, response peak and peak resonating frequency, relationship between time and frequency domain specification of system, stability margins	
	5.2	**Bode plot:** Magnitude and phase plot; Method of plotting Bode plot; Stability margins on the Bode plots; Stability analysis using Bode plot.	
	5.3	**Nyquist Criterion:** Polar plots, Nyquist stability criterions; Nyquist plot; Gain and phase margins.	
6.0		**Optimal and Adaptive Control Systems**	08
	6.1	**Optimal control:** Performance measure for optimal control problems, the principle of optimality, concept of dynamic programming, fundamental of a single Function, Functions involving several independent Functions, constrained minimization of Functions	
	6.2	**Adaptive Control Systems:** Model reference adaptive control approach for controller design, Neuro-Fuzzy adaptive control (only concept)	
		Total	52

Text books:

1. Nagrath, M.Gopal, *"Control System Engineering"*, Tata McGraw Hill.
2. K.Ogata, *"Modern Control Engineering, Pearson Education",* IIIrd edition.
3. Benjamin C.Kuo, *"Automatic Control Systems, Eearson education"*, VIIth edition.

Reference Books:

1. Madam Gopal, Control Systems Principles and Design, Tata McGraw hill, 7th edition,1997.
2. Normon, Control System Engineering, John Wiley & sons, 3rd edition.
3. Curtis Johnson, Process Control Instrumentation Technology, Pearson education fourth edition.
4. Dhanesh N. Manik, *"Control Systems"*, Cengage Learning, 1st edition, 2012.
5. Sastry S. S., *"Adaptive Control"*, PHI.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

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	Tutorial	Total
ETL 401	Analog Electronics II Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical And Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETL 401	Analog Electronics II Laboratory	--	--	--	--	25	25	--	50

Term Work:
At least **10** experiments covering entire syllabus should be set to have well predefined inference and conclusion. 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.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades converted into marks as per **Credit and Grading** System manual should be added and averaged. Based on this final term work 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
ETL402	Microprocessors and Peripherals Laboratory	--	02	--	--	01	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETL402	Microprocessors and Peripherals Laboratory	--	--	--	--	25	25	--	50

Term Work:
At least **10** experiments covering entire syllabus should be set to have well predefined inference and conclusion. 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.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per '**credit and grading'** System manual and should be added and averaged. Based on the 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
ETL 403	Software Simulation Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical And Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ETL 403	Software Simulation Laboratory	--	--	--	--	25	25	-	50

Objectives

Students will demonstrate

- an ability to design a system and process as per needs/specifications.
- an ability to visualize and work on laboratory and multi disciplinary task.
- skills to use modern Engineering tools, software's and equipments to analyze problems.

Term Work:
At least 10 simulation based experiments from Analog Electronics, Digital Electronics, Circuits and Transmission, Microprocessor, Signals and Systems and Wave Theory and Propagation 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.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades converted into marks as per Credit and Grading System manual should be added and averaged. Based on this final term work grading and term work assessment should be done. It is advisable to use required application software for simulation based experiments. Use of open source software should be encouraged.

Practical and oral examination will be based on simulation experiments.

AC 7/6/2014

Item No. 4.21

UNIVERSITY OF MUMBAI

Bachelor of Engineering
Electronics and Telecommunication Engineering

Third Year Engineering

(Sem. V and Sem. VI), (Rev-2012)

effective from Academic Year 2014 -15

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

From Dean'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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean, Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble:
In the process of change in the curriculum there is a limited scope to have major changes in the fundamental subjects which are mainly part of second year of engineering. The exposure to the latest technology and tools used all over the world is given by properly selecting subjects and their hierarchy in pre-final and final year. Thus this syllabus is made to groom the undergraduate students best suited and competent in all respect with best possible efforts put in by the experts in framing detail contents of individual subjects.

The engineering education in India is expanding in manifolds and the main challenge is the quality education. All the stakeholders are very much concerned about it. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner.

An engineering program must ensure that its graduates understand the basic concepts of science and mathematics have gone through one engineering field and have acquired skills for life-long learning.

An engineering program must therefore have a mission statement which is in conformity with program objectives and program outcomes that are expected of the educational process. The outcomes of a program must be measureable and must be assessed regularly through proper feedback for improvement of the programme. There must be a quality assurance process in place within the institute to make use of the feedback for improvement of the programme. The curriculum must be constantly refined and updated to ensure that the defined objectives and outcomes are achieved. Students must be encouraged to comment on the objectives and outcomes and the role played by the individual courses in achieving them. In line with this Faculty of Technology, University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, the Chairman, Board of Studies in Electronics and Telecommunication Engineering University of Mumbai, am happy to state that, heads of the department and senior faculty from various Institutes took timely and valuable initiative to frame Program Educational Objectives as listed below.

- To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies.
- To prepare students to demonstrate an ability to identify, formulate and solve electronics and telecommunication engineering problems.
- To prepare students to demonstrate ability to design electrical and electronics systems and conduct experiments, analyze and interpret data.
- To prepare students to demonstrate for successful career in industry to meet needs of Indian and multi-national companies.
- To develop the ability among students to synthesize data and technical concepts from applications to product design.
- To provide opportunity for students to work as part of teams on multidisciplinary projects.
- To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.

These are the suggested and expected main objectives and individual affiliated institute may add further in the list. In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

At the end, I must extend my gratitude to all the experts who contributed to make curriculum competent at par with latest technological development in the field of Electronics and Telecommunication Engineering.

Dr. Udhav Bhosle
Chairman, Board of Studies in Electronics and Telecommunication Engineering

SEMESTER V

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC501	Microcontrollers and Applications	04	--	--	04	--	--	04
ETC502	Analog Communication	04	--	--	04	--	--	04
ETC503	Random Signal Analysis	04	--	01	04	--	01	05
ETC504	RF Modeling and Antennas	04	--	--	04	--	--	04
ETC505	Integrated Circuits	04	--	--	04	--	--	04
ETS506	Business Communication and Ethics	--	04 *	--	--	02	--	02
ETL501	Microcontrollers and Applications Laboratory	--	02	--	--	01	--	01
ETL502	Communication Engineering Laboratory I		02			01	--	01
ETL503	Communication Engineering Laboratory II	--	02	--	--	01	--	01
ETL504	Mini Project I	--	02	--	--	01	--	01
Total		**20**	**12**	**01**	**20**	**06**	**01**	**27**

*** Out of 4 hours, 2 hours class wise theory and 2 hours batch wise practical**

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. of Test 1 & Test 2					
ETC501	Microcontrollers and Applications	20	20	20	80	--	--	--	100
ETC502	Analog Communication	20	20	20	80	--	--	--	100
ETC503	Random Signal Analysis	20	20	20	80	25	--	--	125
ETC504	RF Modeling and Antennas	20	20	20	80	--	--	--	100
ETC505	Integrated Circuits	20	20	20	80	--	--	--	100
ETS506	Business Communication and Ethics	--	--	--	--	50	--	--	50
ETL501	Microcontrollers and Applications Laboratory	--	--	--	--	25	25	--	50
ETL502	Communication Engineering Laboratory I	--	--	--	--	25	25	--	50
ETL503	Communication Engineering Laboratory II	--	--	--	--	25	25	--	50
ETL504	Mini Project I	--	--	--	--	25	25	--	50
Total		**100**	**100**	**100**	**400**	**175**	**100**	**--**	**775**

SEMESTER VI

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC601	Digital Communication	04	--		04	--		04
ETC602	Discrete Time Signal Processing	04	--	--	04	--	--	04
ETC603	Computer Communication and Telecom Networks	04	--	--	04	--	--	04
ETC604	Television Engineering	04	--	--	04	--	--	04
ETC605	Operating Systems	04	--	--	04	--	--	04
ETC606	VLSI Design	04	--	--	04	--	--	04
ETL601	Discrete Time Signal Processing Laboratory	--	02	--	--	01	--	01
ETL602	Communication Engineering Laboratory III		02			01	--	01
ETL603	Communication Engineering Laboratory IV	--	02	--	--	01	--	01
ETL604	Mini Project II	--	02	--	--	01	--	01
Total		**24**	**08**	**--**	**24**	**04**	**--**	**28**

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical And Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. of Test 1 & Test 2					
ETC601	Digital Communication	20	20	20	80	--	--	--	100
ETC602	Discrete Time Signal Processing	20	20	20	80	--	--	--	100
ETC603	Computer Communication and Telecom Networks	20	20	20	80	--	--	--	100
ETC604	Television Engineering	20	20	20	80	--	--	--	100
ETC605	Operating Systems	20	20	20	80	--	--	--	100
ETC606	VLSI Design	20	20	20	80	--	--	--	100
ETL601	Discrete Time Signal Processing Laboratory	--	--	--	--	25	25	--	50
ETL602	Communication Engineering Laboratory III	--	--	--	--	25	25	--	50
ETL603	Communication Engineering Laboratory IV	--	--	--	--	25	25	--	50
ETL604	Mini Project II	--	--	--	--	25	25	--	50
Total		**120**	**120**	**120**	**480**	**100**	**100**	**--**	**800**

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Name</th><th colspan="3">Teaching Scheme</th><th colspan="4">Credits Assigned</th></tr>
<tr><th>Theory</th><th>Practical</th><th>Tutorial</th><th>Theory</th><th>TW/ Practical</th><th>Tutorial</th><th>Total</th></tr>
<tr><td>ETC501</td><td>Microcontroller & Applications</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th rowspan="3">Term Work</th><th rowspan="3">Practical</th><th rowspan="3">Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal assessment</th><th rowspan="2">End Sem. Exam</th></tr>
<tr><th>Test 1</th><th>Test 2</th><th>Ave. Of Test 1 and Test 2</th></tr>
<tr><td>ETC501</td><td>Microcontroller & Applications</td><td>20</td><td>20</td><td>20</td><td>80</td><td>-</td><td>-</td><td>-</td><td>100</td></tr>
</table>

Course Pre –requisite:
- ETC303: Digital electronics
- ETC403: Microprocessor and Peripherals

Course Objectives:
- To develop background knowledge and core expertise of microcontroller.
- To know the importance of different peripheral devices and their interfacing to microcontrollers.
- To know the design aspects of microcontrollers.
- To write assembly language programs of microcontrollers for various applications.

Course Outcomes: At the end of course, a student will be able to
- Draw and describe architecture of 8051 and ARM7 microcontroller.
- Interface various peripheral devices to the microcontrollers.
- Write assembly language program for microcontrollers.
- Design microcontroller based system for various applications.

Module No.		Topics	Hrs.
1.	**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.	**8051 Assembly Language Programming.**		**08**
	2.1	Instruction set	
	2.2	Addressing mode	
	2.3	Assembler directives	
	2.4	**Programs related to:** arithmetic, logical, delay, input, output port, serial communication, and interrupts	
3	**8051 Interfacing and Applications**		**12**
	3.1	Interfacing of display: LED, LCD, and seven segment display	
	3.2	Keyboard Interfacing	
	3.3	Interfacing of ADC and DAC (0808/09)	
	3.4	Stepper motor and relay	
	3.5	Connection to RS 232 for serial communication	
	3.6	Manual and auto reset	
	3.7	IR based wireless communication system design	
4		**ARM7: A 32-bit Microcontroller**	**08**
	4.1	The RISC design philosophy	
	4.2	Concept of Cortex-A, the Cortex-R, and the Cortex-M	
	4.3	Features of ARM Microcontroller	
	4.4	Operating modes	
	4.5	Architecture (ARM core dataflow model)	
	4.6	Registers	
	4.7	Current program status register	
	4.8	Pipeline	
	4.9	Exceptions, interrupt and vector table	
	4.0	Memory management	
	4.11	ARM7 processor families	
5		**ARM7 Programming**	**08**
	5.1	Instruction set for data processing, branching, load-store, software interrupt, and program status register	
	5.2	Addressing modes	
	5.3	Programming for ARM7	
6		**Introduction to Embedded Systems**	**04**
	6.1	Concepts of embedded systems	
	6.2	Optimizing design matrices and common design matrices	
	6.3	Study of embedded systems 1) Digital camera 2) Stepper motor controller	
		Total	**52**

Recommended 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. James A. Langbridge, "*Professional Embedded Arm Development*", Wrox, John Wiley Brand& Sons Inc., Edition 2014
6. Frank Vahid& tony Gavages "*Embedded system design – A unified hardware / software introduction*", Wiley publication, Third edition 2002.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETC502	**Analog Communication**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC502	**Analog Communication**	20	20	20	80	-	-	-	100

Course Pre–requisite:-
- ETC302: Analog Electronics-I
- ETC405: Signals and Systems

Course Objective: To teach students
- The fundamentals of basic communication system.
- Various modulation and demodulation techniques used in analog communication, noise handling and multiplexing.
- The working principles of transmitters and receivers used in analog communication systems.

Course Outcomes: After successful completion of the course students will able to
- The different modulation and demodulation techniques used in analog communication.
- Identify and solve basic communication problems, analyze transmitter and receivers.
- Detect the errors that occur due to noise during transmission.
- Compare and contrast advantages and limitations of analog communication systems.

Module No.		Topics	Hrs.
1		**Basics of Communication System**	**04**
	1.1	Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels	
	1.2	Types of noise, signal to noise ratio, noise figure, and noise temperature	
2		**Amplitude Modulation and Demodulation**	**12**
	2.1	Basic concept, signal representation, need for modulation	
	2.2	**S**pectrum, waveforms, modulation index, bandwidth, voltage distribution, and power calculation	
	2.3	**DSBFC**: Principles, modulating circuits, low level and high level transmitters **DSB suppressed carrier**:- Multiplier modulator, nonlinear modulator, and switching modulator, **Single Side Band (SSB):-**Principle, Filter method, phase shift method and third method Quadrature amplitude modulation (QAM), Independent sideband (ISB) and Vestigial Side Band (VSB) principles and transmitters	
	2.4	**Amplitude demodulation:** Diode detector, practical diode detector, and square law detector.	
	2.5	Applications of AM and use of VSB in broadcast television	
3		**Angle Modulation and Demodulation**	**14**
	3.1	**Frequency modulation (FM):** Basic concept, mathematical analysis, frequency spectrum of FM wave, sensitivity, phase deviation and modulation index, frequency deviation and percent modulated waves, bandwidth requirement of angle modulated waves, deviation ratio, narrow Band FM, and Wide Band FM.	
	3.2	Varactor diode modulator, FET reactance modulator, stabilized reactance modulator-AFC, Direct FM transmitter, indirect FM Transmitter, noise triangle in FM, pre-emphasis and de-emphasis.	
	3.3	**Phase modulation (PM): P**rinciple 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, Phase lock loop(PLL) FM demodulator, amplitude limiting and thresholding, comparison between FM demodulators, comparison between AM, FM and PM.	
	3.5	Applications of FM and PM	
4		**Radio Receivers**	**10**
	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		**Sampling Techniques**	**04**
	5.1	Theorem for low pass and band pass signals, proof with spectrum, Nyquist criteria	
	5.2	Sampling techniques, aliasing error, and aperture effect	
6		**Pulse Modulation and Demodulation**	**08**
	6.1	PAM, PWM, PPM generation and detection	
	6.2	Delta modulation, adaptive delta modulation, principle, generation and detection	
	6.3	TDM and FDM basic concepts and block diagram	
	6.4	Applications of pulse communication	
		Total	**52**

Recommended Books:

1. WayneTomasi, "*Electronics Communication Systems*", Pearson education, Fifth edition.
2. Kennedy and Davis, "*Electronics Communication System*", Tata McGraw Hill, Fourth edition.
3. B.P. Lathi, Zhi Ding,*"Modern Digital and Analog Communication system*", Oxford University Press, Fourth edition
4. Taub, Schilling and Saha, "*Taub's Principles of Communication systems*", Tata McGraw Hill,Third edition.
5. P. Sing and S.D. Sapre, "*Communication Systems: Analog and Digital*", Tata McGraw Hill,Third edition.
6. Simon Haykin, Michel Moher, "*Introduction to Analog and Digital Communication*", Wiley, Second edition.
7. Dennis Roddy and John Coolen, "*Electronic Communication*", Prentice Hall, Third Edition.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETC503	**Random Signal Analysis**	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC503	**Random Signal Analysis**	20	20	20	80	25	-	-	125

Course Pre –requisite:

- ETC 405: Signals and Systems
- ETC 401: Applied Mathematics IV

Course Objective: To teach students

- Random Variables and Random Process
- The design of the systems which involves randomness using mathematical analysis and computer simulations.

Course Outcome : At the end of the course, students will able to

- Apply theory of probability in identifying and solving relevant problems.
- Define and differentiate random variables and vector through the use of cumulative distribution function (CDF), probability density function (PDF), probability mass function (PMF) as well as joint, marginal and conditional CDF, PDF and PMF.
- Show probability and expectation computations using important discrete and continuous random variable types.
- Define and specify random processes and determine whether a given process is stationary or wide sense stationary.
- Determine the response of a linear time invariant system to such a random process.
- Describe basic concepts related to Markov chains and queuing theory and relate it to seal world applications.

Module No.		Overview of Probability Theory and Basics of Random Variables	Hrs.
1	1.1	Sample space, events, set operations, the notion and axioms of probability.	10
	1.2	Conditional probability, Joint probability, Baye's rule, Independence of events, Sequential Experiments.	
	1.3	Notion of random variable.	
	1.4	Continuous random variables, probability density function, probability distribution function, Uniform, Exponential and Gaussian continuous random variables and distributions.	
	1.5	Discrete random variables, probability mass function, probability distribution function, binomial, Poisson and geometric discrete random variables and distributions	
2		**Operations on One Random Variable**	07
	2.1	Functions of a random variable and their distribution and density functions.	
	2.2	Expectation, Variance and Moments of random variable.	
	2.3	Transformation of a random variable, Markov, Chebyshev and Chernoff bounds, characteristic functions, moment theorem	
3		**Multiple of Random Variables And Convergence**	08
	3.1	Vector random variables, Pairs of random variables, Joint CDF, Joint PDF Independence , Conditional CDF and PDF, Conditional Expectation	
	3.2	One function of two random variable, two functions of two random variables; joint moments, joint characteristic function, covariance and correlation-independent, uncorrelated and orthogonal random variables.	
4		**Sequence Of Random Variables And Convergence:**	05
	4.1	Random sequences, Limit theorems; Strong and weak laws of large numbers,	
	4.2	Central limit theorem and its significance.	
5		**Random Process**	10
	5.1	Random process: Definition, realizations, sample paths, discrete and continuous time processes	
	5.2	Probabilistic structure of a Random process; mean, correlation and covariance functions, stationarity of random process.	
	5.3	Ergodicity, Transmission of WSS random process through LTI system	
	5.4	Spectral analysis of random processes, power density spectrum bandwidth, cross-power density spectrum.	
	5.5	Gaussian and Poisson random process	
6		**Markov Chains And Introduction To Queuing Theory**	12
	6.1	Markov processes	
	6.2	Discrete Markov chains, The n–step transition probabilities, steady state probabilities.	
	6.3	Introduction to Continuous time Markov chains.	
	6.4	Classifications of states.	
	6.5	Markovian models	
	6.6	Birth and death queuing models	
	6.7	Steady state results	
	6.8	Single and Multiple server Queuing models	
	6.9	Finite source models	
	6.10	Little's formula	
		Total	**52**

1. Alberto Leon Garcia, “*Probability And Random Processes For Electrical Engineering*”, second edition Low price edition Pearson education.
2. Miller, “Probability And Random Processes-With Applications to Signal Processing and Communication”, first edition 2007, Elsevier.
3. Papoulis and S. Unnikrishnan Pillai, “*Probability, Random Variables and Stochastic Processes*," Fourth Edition, McGraw Hill.
4. H. Stark and J. Woods, ``*Probability and Random Processes with Applications to Signal Processing*,’’ Third Edition, Pearson Education.
5. Hwei Hsu, “*Probability Random Variable,s Random Process, Schaulm’s Outlines*, Tata McGraw Hill, 2004.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ETC504	**RF Modeling and Antennas**	**04**	**--**	**--**	**04**	**--**	**--**	**04**

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC504	**RF Modeling and Antennas**	20	20	20	80	-	-	-	100

Course Pre –requisite: : ETC 404: Wave Theory and Propagation

Course Objective: To teach students

- Design of different types of passive filters used for radio frequency application.
- Radiation phenomena and pattern of various antennas.
- The various characteristics of different types of antennas.

Course Outcome: On Completion of this course Student will be able to

- Analyze and design RF Filters
- Analyze the radiation mechanisms of antennas
- Demonstrate knowledge of antennas in communication systems. Ability to discriminate between antennas on the basis of their electrical performance.
- Discriminate various antennas on the basis of their electrical performance.

Module No.		Topics	Hrs.
1.		**Behavior of Active and Passive Components in RF range**	**04**
	1.1	Frequency Spectrum, hazards of Electromagnetic Radiations, and fundamentals of radio frequency design	
	1.2	High Frequency behavior, equivalent circuit and frequency response of resistor, capacitor, inductor, diode, BJT, and FET	
	1.3	Characteristics, structure and applications of coaxial line, stripline, microstrip line, and coplanar lines	
2		**Filter Design**	**12**
	2.1	Analysis of infinite periodic structures terminated Periodic structures, k-β diagrams and wave velocities.	
	2.2	**Image Parameter Method:** Image impedances and transfer functions for two port networks, constant-k filter sections, m-derived filter sections, and composite filters	
	2.3	**Insertion Loss Method:** Characterization by power loss ratio, maximally flat, equal ripple, and linear phase low pass filter prototype.	
	2.4	**Filter transformations:** impedances, frequency scaling, and band pass and band stop	
	2.5	Richard's transformation, Kuroda's identity, impedance, and admittance inverters	
3		**Fundamentals of Antenna**	**14**
	3.1	Conceptual understanding and radiation mechanism	
	3.2	**Fundamental Parameters of Antennas:** Radiation pattern, radiation power density, radiation intensity , beam width, directivity, antenna efficiency, gain, beam efficiency, bandwidth, input impedance, antenna radiation efficiency, antenna vector effective length and equivalent areas, maximum directivity and maximum effective areas.	
	3.3	Friss transmission equation, antenna temperature	
	3.4	Vector potential *A* for an electric current source *J*, vector potential *F* for an magnetic current source *M*, electric and magnetic fields for electric *J* and Magnetic *M* current sources, and concept of near and far field radiation.	
4		**Wire Antennas**	**10**
	4.1	**Infinitesimal dipole and small dipole:** Radiation field, near field, far field directivity, region separation	
	4.2	**Finite Length dipole**: Basic parameters of half wavelength dipole, folded dipole	
	4.3	Monopole antenna	
	4.4	Ground Effects	
	4.5	Linear elements near or on infinite perfect conductors	
	4.6	**Loop antennas**: Basic parameters	
5		**Antenna Arrays:**	**04**
	5.1	Linear arrays, planner arrays, and circular arrays	
	5.2	Array of two isotropic point sources, non-isotropic sources	
	5.3	Principle of pattern multiplication,	
	5.4	Linear arrays of n elements, broadside, radiation pattern, directivity, beam width and null directions, array factor	
	5.5	Antenna analysis using Binomial, Dolph-Tschebyscheff, Yagi Uda antenna	
6		**Special types of antennas**	**08**
	6.1	**Frequency Independent Antennas:** Log periodic and helical antennas **Microstrip Antennas: C**haracteristics, applications and limitations	
	6.2	**Reflector Antennas and Horn Antennas:** Characteristics, applications and limitations	
		Total	**52**

Recommended Books:

1. David M Pozar, "*Microwave Engineering*", John Wieley and Sons, Inc. Hobokenh, New Jersey, Fourth Edition, 2012
2. Costantine A. Balanis, "*Antenna Theory Analysis And Design*", John Wiley Publication
3. John D. Kraus, " *Antennas*", Tata McGraw Hill publication
4. Annapurna Das and Sisir K Das, "*Microwave Engineering*", Tata McGraw Hill,New Delhi, Second Edition, 2009
5. Reinhold Ludwig and Pavel Bretchko, "*RF Circuit Design*", Pearson Education Asia.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETC505	**Integrated Circuits**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ETC505	**Integrated Circuits**	20	20	20	80	--	--	--	100

Course Pre-requisite:

- FEC105: Basic Electrical & Electronics Engineering
- ETC302: Analog Electronics-I
- ETC303: Digital Electronics
- ETC402: Analog Electronics-II

Course Objectives: To teach students

- Fundamentals of analog and digital integrated circuits.
- Design methodologies using practical integrated circuits.
- The application areas of integrated circuits.

Course Outcomes: After successful completion of the course student will be able to

- Understand the fundamentals and areas of applications for the Integrated Circuits.
- Analyze important types of integrated circuits of day-to-day requirements.
- Demonstrate the ability to design practical circuits that perform the desired operations.
- Understand the differences among theoretical, practical & simulated results in integrated circuits.
- Choose the appropriate integrated circuit modules to build a given application.

Module No.		Topics	Hrs.
1.		**Review of Operational Amplifier**	**04**
	1.1	Operational amplifier overview: parameters, open loop and closed loop configurations	
2		**Applications of Operational Amplifier**	**12**
	2.1	**Amplifiers:** Current amplifier, difference amplifier, instrumentation amplifier, and programmable gain amplifier	
	2.2	**Converters:** Current to voltage converters, voltage to current converters, generalized impedance converter, voltage to frequency converter, frequency to voltage converter, logarithmic converters and antilog converters	
	2.3	**Active Filters:** Second order active finite and infinite gain low pass, high pass, band pass and band reject filters	
	2.4	**Sine Wave Oscillators:** RC phase shift oscillator, Wien bridge oscillator, Quadrature oscillator	
3		**Non-Linear Applications of Operational Amplifier**	**10**
	3.1	**Comparators:** Inverting comparator, non-inverting comparator, zero crossing detector, window detector and level detector	
	3.2	**Schmitt Triggers:** Inverting Schmitt trigger, non-inverting Schmitt trigger, and adjustable threshold levels	
	3.3	**Waveform Generators:** Square wave generator, triangular wave generator, and duty cycle modulation	
	3.4	**Precision Rectifiers:** Half wave, full wave, and applications	
	3.5	Peak detectors, sample and hold circuits	
4		**Special Purpose Integrated Circuits**	**08**
	4.1	**Functional block diagram, working, design and applications:** Timer 555	
	4.2	**Functional block diagram, working and applications:** VCO 566, PLL 565, multiplier 534, waveform generator XR 2206, power amplifier LM380	
5		**Voltage Regulators**	**08**
	5.1	Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM 337) voltage regulators.	
	5.2	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	
6		**Counters, Shift Registers and ALU (Logic Diagram and applications)**	**10**
	6.1	**MSI Counters:** Ripple counters (7490 decade, 7492 modulus-12, 7493 4-bitbinary), synchronous counters (74162 decade, 74163 4-bit binary, 74169 4-bit up/down binary)	
	6.2	**MSI Shift Registers:** 74164 serial input parallel output, 74166 parallel input serial output, 74191 serial input serial output, 74194 universal shift register	
	6.3	**Arithmetic Logic Unit:** 74181 ALU	
		Total	**52**

Recommended Books:

1. Sergio Franco, "*Design with Operational Amplifiers and Analog Integrated Circuits*", Tata McGraw Hill, 3rd Edition
2. John F. Wakerly, "*Digital Design – Principles & Practices*", Pearson Education, 3rd Edition
3. J. Millman and A. Grabel, "*Microelectronics*", Tata McGraw Hill, 2nd Edition.
4. D. Roy Choudhury and S. B. Jain, "*Linear Integrated Circuits*", New Age International Publishers, 4th Edition
5. David A. Bell, "*Operation Amplifiers and Linear Integrated Circuits*", Oxford University Press, Indian Edition
6. Ramakant A. Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Pearson Prentice Hall, 4th Edition
7. R. F. Coughlin and F. F. Driscoll, "*Operation Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6th Edition
8. J. G. Graeme, G. E. Tobey and L. P. Huelsman, "*Operational Amplifiers- Design & Applications*", New York: McGraw-Hill, Burr-Brown Research Corporation

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETS506	Business Communication and Ethics	--	2 + 2	--	--	02	--	02

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETS506	Business Communication and Ethics	--	--	--	--	50	--	--	50

Course Pre-requisite : FEC206 Communication Skills

Course Objective :

- To inculcate in students professional and ethical attitude, effective communication skills, teamwork, multidisciplinary approach and an ability to understand engineer's 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 and leadership.
- To prepare students for successful careers that meets the global Industrial and Corporate requirement' provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.

Expected Outcomes

After completion of this course students will be able to:

- Communicate effectively in both verbal and written form and demonstrate knowledge of professional and ethical responsibilities
- Participate and succeed in Campus placements and competitive examinations like GATE, CET.
- 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.

Module No.	Unit No.	Topics	Hrs
1.0	**1.0**	**Report Writing**	**08**
	1.1	Objectives of report writing	
	1.2	Language and style in a report	
	1.3	Types of reports	
	1.4	Formats of reports: Memo, letter, project and survey based	
2.0	**2.0**	**Technical Proposals**	**02**
	2.1	Objective of technical proposals	
	2.2	Parts of proposal	
3.0	**3.0**	**Introduction to Interpersonal Skills**	**08**
	3.1	Emotional Intelligence	
	3.2	Leadership	
	3.3	Team building	
	3.4	Assertiveness	
	3.5	Conflict Resolution	
	3.6	Negotiation Skills	
	3.7	Motivation	
	3.8	Time Management	
4.0	**4.0**	**Meetings and Documentation**	**02**
	4.1	Strategies for conducting effective meetings	
	4.2	Notice	
	4.3	Agenda	
	4.4	Minutes of the meeting	
5.0	**5.0**	**Introduction to Corporate Ethics and etiquettes**	**02**
	5.1	Business meeting etiquettes, interview etiquettes, professional and work etiquettes, social skills	
	5.2	Greetings and art of conversation	
	5.3	Dressing and grooming	
	5.4	Dinning etiquette	
	5.5	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions)	
6.0	**6.0**	**Employment Skills**	**06**
	6.1	Cover letter	
	6.2	Resume	
	6.3	Group Discussion	
	6.4	Presentation Skills	
	6.5	Interview Skills	
Total			**28**

Reference Books:

1. Fred Luthans, "*Organisational 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. R.C Sharma and Krishna Mohan, "*Business Correspondence and Report Writing"*
7. B N Ghosh, "*Managing Soft Skills for Personality Development*", Tata McGraw Hill.Lehman, Dufrene, Sinha, "*BCOM*", Cengage Learning, 2nd edition
8. Bell . Smith,"Management Communication" Wiley India edition, 3rd edition.

Internal Assessment (IA):
There will be no IA written examination

End Semester Examination:
There will be no ESE written examination.

List of assignments:
Term work shall consist of assignments as listed below:

1. Report writing (Synopsis or the first draft of the Report)
2. Technical Proposal (Group activity, document of the proposal
3. Interpersonal Skills (Group activity and Role play)
4. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
5. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
6. Corporate ethics and etiquettes (case study, Role play)
7. Cover Letter and Resume Printout of the Power Point presentation

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

1. Assignments - 20 marks
2. Project Report Presentation – 15 marks
3. Group Discussion – 10 marks
4. Attendance - 5 marks

At least total 08 assignments, project report presentation and group discussion covering entire syllabus must be given during the batch wise practical. The assignments and project work should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment / project / group discussion graded from time to time. The average of grades converted in to marks should be taken into account for term work assessment.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL501	Microcontrollers and Applications	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL501	Microcontrollers and Applications	--	--	--	--	25	25	-	50

Term Work:

At least ten experiments covering entire syllabus of ETC501 Microcontrollers and Applications should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and averaged. Based on above scheme grading and term work assessment should be done. Practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL502	**Communication Engineering Laboratory I**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL502	**Communication Engineering Laboratory I**	--	--	--	--	25	25	-	50

Term Work:
At least ten experiments covering entire syllabus of ETC502: Analog Communication should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and average. Based on above scheme grading and term work assessment should be done.
Practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL503	Communication Engineering Laboratory II	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL503	Communication Engineering Laboratory II	--	--	--	--	25	25	-	50

Term Work:
At least ten experiments covering entire syllabus for ETC 504: RF Modeling and antenna and ETC 505: Integrated circuits should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and average. Based on above scheme grading and term work assessment should be done.
Practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL504	Mini Project 1	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
ETL504	Mini Project 1	--	--	--	--	25	25	50

Term Work:

The main intention of Mini Project is to make student enable to apply the knowledge and skills learned out of courses studied to solve/implement predefined practical problem. The students undergo various laboratory/tutorial/simulation laboratory/work shop courses in which they do experimentation based on the curriculum requirement. The Mini Project may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be on

- Learning additional skills
- Development of ability to define and design the problem and lead to its accomplishment with proper planning
- Learn the behavioral science by working in a group

The group may be maximum **four** (04) students. Each group will be assigned one faculty as a supervisor. The college should keep proper assessment record of progress of the project and at the end of the semester it should be assessed for awarding TW marks. The TW may be examined by approved internal faculty appointed by the head of the institute. The final examination will be based on demonstration in front of internal and external examiner. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed.

The students may use this opportunity to learn different computational techniques as well as some model development. This they can achieve by making proper selection of Mini Projects.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETC601	**Digital Communication**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC601	**Digital Communication**	20	20	20	80	-	-	-	100

Pre-requisite:

- ETC405 Signal and System,
- ETC502 Analog Communication,
- ETC503 Random Signal Analysis

Course Objective:

- Aim is to identify the functions of different components
- Learn about theoretical bounds on the rates of digital communication system and represent a digital signal using several modulation methods
- Draw signal space diagrams, compute spectra of modulated signals and apply redundancy for reliable communication.

Course Outcome: At the end of course, student will be able to :

- Understand the basics of information theory and coding techniques.
- Determine the minimum number of bits per symbol required to represent the source and the maximum rate at which a reliable communication can take place over the channel.
- Describe and determine the performance of different waveform techniques for the generation of digital representation of signals.
- Determine methods to mitigate inter symbol interference in baseband transmission system.
- Describe and determine the performance of different error control coding schemes for the reliable transmission of digital representation of signals and information over the channel.
- Understand various spreading techniques and determine bit error performance of various digital communication systems.

Module No.		Topics	Hrs.
1.		**Information theory and source coding**	6
	1.1	Block diagram and sub-system description of a digital communication system, measure of information and properties, entropy and it's properties	
	1.2	Source Coding, Shannon's Source Coding Theorem, Shannon-Fano Source Coding, Huffman Source Coding	
	1.3	Differential Entropy, joint and conditional entropy, mutual information and channel capacity, channel coding theorem, channel capacity theorem	
2		**Baseband Modulation and Transmission**	6
	2.1	Discrete PAM signals and it's power spectra	
	2.2	Inter-symbol interference, Nyquist criterion for zero ISI, sinusoidal roll-off filtering, correlative coding, equalizers, and eye pattern	
3		**Base band Detection**	5
	3.1	Orthogonality, representation of signals	
	3.2	Maximum likelihood decoding	
	3.3	Correlation receiver, equivalence with matched filter	
4		**Bandpass Modulation and Demodulation**	12
	4.1	Bandpass 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)	
	4.3	Comparison between bandwidth and bit rate, applications of digital modulation schemes	
5		**Error Control Systems**	10
	5.1	Types of error control, error control codes, linear block codes, vector spaces ,vector sub spaces, generator matrix, systematic linear block codes, parity check matrix, syndrome testing ,error correction, and decoder implementation	
	5.2	**Cyclic codes:** Algebraic structure of cyclic codes, binary cyclic code properties, encoding in systematic form, circuits for dividing polynomials, systematic encoding with shift register and error detection	
	5.3	**Convolution Codes:** Time domain and transform domain approach, graphical representation, code tree, trellis, state diagram, decoding methods, maximum likelihood decoding, and free distance	7
	5.4	Viterbi decoding, hard decision Viterbi decoding , decoding window, soft decision Viterbi decoding, code spectra, recursive systematic codes, code transfer function, and application areas	
6		**Spread Spectrum**	6
	6.1	Spread Spectrum (SS) concept, PN Sequences, Direct Sequence(DS), Frequency Hopping (FH), and Time Hopping	
	6.2	Comparison of Spread Spectrum Methods, SS Communication System, DSSS with Coherent BPSK, Processing Gain, Probability of Error of FHSS Transmitter and FHSS Receiver	
Total			**52**

Recommended Books:

1. Sklar B, and Ray P. K., *"Digital Communication: Fundamentals and applications,"* Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.
2. Haykin Simon, *"Digital Communication Systems*," John Wiley and Sons, New Delhi, Forth Edition, 2014.
3. H. Taub, D. Schlling, and G. Saha, "*Principles of Communication Systems,*" Tata Mc-Graw Hill, New Delhi, Third Edition, 2012.
4. Lathi B P, and Ding Z., "*Modern Digital and Analog Communication Systems*," Oxford University Press, Forth Edition, 2009.
5. T L Singal, "*Analog and Digital Communication*," Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
6. P Ramakrishna Rao, *"Digital Communication*," Tata Mc-Graw Hill, New Delhi, First Edition, 2011.
7. M F Mesiya, *"Contempory Communication systems*", Mc-Graw Hill, Singapore, First Edition, 2013.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETC602	**Discrete Time Signal Processing**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC602	**Discrete Time Signal Processing**	20	20	20	80	-	-	-	100

Course Prerequisite: ETC 405: Signals and System

Course Objectives:

- To develop a thorough understanding of the central elements of discrete time signal processing theory and the ability to apply this theory to real-world signal processing applications.
- Use z-transforms and discrete time Fourier transforms to analyze a digital system.
- Understand the discrete Fourier transform (DFT), its applications and its implementation by FFT techniques.
- Design and understand finite & infinite impulse response filters for various applications.
- The course is a prerequisite course for further studying of other multimedia related courses, such as speech processing, image processing, audio and video data compression, pattern recognition, communication systems and so forth.

Course Outcomes: Student will able to

- Formulate engineering problems in terms of DSP tasks
- Apply engineering problem solving strategies to DSP problems
- Design and test signal processing algorithms for various applications
- Recover information from signals
- Design and simulate digital filters

Module No.		Topics	Hrs.
1		**Transform Analysis of Linear Time Invariant System**	**04**
	1.1	Review of *Z* transform and its properties, response to sinusoidal and complex exponential signals, steady-state response to periodic input signals, response to aperiodic input signals, relationships between the system function and the frequency response function, computation of the frequency response function	
	1.2	LTI systems as frequency-selective filters like; low pass, high pass, band pass, notch, comb, all-Pass filters, and digital resonators.	
	1.3	Invertibility of LTI systems, minimum-phase, maximum-phase, mixed-phase systems	
2		**The Discrete Fourier Transform and Efficient Computation.**	**12**
	2.1	Frequency domain sampling and reconstruction of discrete time signals, discrete Fourier transform (DFT), DFT as a linear transformation, properties of the DFT, relationship of the DFT to other transforms	
	2.2	Fast Fourier Transform: Radix-2 and split-radix fast Fourier transform (FFT) algorithms and their applications	
	2.3	Quantization effects in the computation of the DFT	
3		**Design of Digital filters and Implementation**	**12**
	3.1	Design of Infinite Impulse Response (IIR) filters using impulse invariant method and bilinear transformation method, Butterworth and Chebyshev filter approximation.	
	3.2	Concepts of Finite Impulse Response (FIR) filter, symmetric and anti symmetric FIR filter, FIR filter design using window method and frequency sampling method.	
	3.3	Realization structures for IIR and FIR filters using direct form structures, cascade, parallel structures, and lattice, ladder structure (only conceptual understanding)	
4		**Multi rate Signal Processing**	**08**
	4.1	Decimation by a factor *D*, interpolation by I, sampling rate conversion by a rational factor I/D	
	4.2	Polyphase filter structures, interchange of filers and down samplers/up samplers, sampling rate conversion with cascade integrator comb filters, polyphase structures for decimation and interpolation filters, structures for rational sampling rate conversion	
	4.3	Multistage implementation of sampling rate conversion.	
	4.4	Sampling rate conversion of band pass signals	
	4.5	Sampling rate conversion by an arbitrary factor – arbitrary re-sampling with polyphase interpolators, narrow band filter structures.	
	4.6	Application of Multirate Signal Processing for design of phase shifters, interfacing of digital systems with different sampling rates, implementation of narrowband low pass filters, sub band coding of speech signals	
5		**Analysis of Finite Word length effects**	**08**
	5.1	Quantization process and errors, quantization of fixed-point numbers, quantization of floating-point numbers, analysis of coefficient quantization effects	
	5.2	A/D Conversion Noise Analysis, Analysis of Arithmetic Round-Off Errors and dynamic range scaling	
6		**Applications of Digital Signal processing:**	**08**
	6.1	Dual –Tone multi frequency signal detection, spectral analysis of sinusoidal signals, spectral analysis of non stationary signals, and spectral analysis of random signals	
	6.2	Musical sound processing, digital music synthesis, discrete time analytic signal generation.	
	6.3	Trans-multiplexers, oversampling ADC and DAC and sparse antenna array design	

Total	**52**

Recommended Books:

1. Alan V. Oppenheim and Ronald Schafer, "*Discrete Time Signal Processing*", Pearson Education
2. J. Proakis, D. G. Manolakis, and D. Sharma, "*Digital Signal Processing: Principles, Algorithms and Applications*", Pearson Education.
3. P.P. Vaidyanathan, "*Multirate Systems and Filter Banks*", Pearson.
4. Robert Schilling and Sandra Harris, "*Fundamentals of Digital Signal Processing using MATLAB"*, Cengage Learning.
5. Sanjit K.Mitra, "*Digital Signal Processing*", McGrawHill education

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ETC603	**Computer Communication Networks**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC603	**Computer Communication Networks**	20	20	20	80	-	-	-	100

Course pre requisite: ETC 502 Analog Communication

Course Objective:

- To introduce analysis and design of computer and communication networks.
- To understand the network layered architecture and the protocol stack.

Course Outcomes:

Upon completion of the subject, students will be able to:

- Assemble the components of a PC and install one or more network operating systems resulting in a functioning
- 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 analyze 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.		Topics	Hrs.
1.		**Network Architectures, Protocol layers, and their Service Models:**	04
	1.1	OSI-RM model and TCP/IP protocol	
2		**Principles of Network Applications:**	10
	2.1	Application layer protocols such as HTTP, FTP, and SMTP.	
	2.2	Peer-to-Peer File Sharing Protocols and Architectures	
	2.3	ISPs and Domain name systems, Socket API and network socket programming	
3	3.1	**Reliable and Unreliable Transport-layer protocols:**	10
	3.2	TCP and UDP, Port numbers, Multiplexing and de-multiplexing	
	3.3	Flow control and congestion control. fairness delay, jitter, and loss in packet-switched networks	
	3.4	Bandwidth, throughput, and quality-of-service	
4	4.1	**Network layer Services and Protocols**	10
	4.2	Switching fabric, routing and forwarding, queues and buffering	
	4.3	Virtual-circuit and datagram networks, internet protocol. IPv4 and IPv6 tunneling	
	4.4	Link State and Distance Vector algorithms, Routing in the Internet RIP, OSPF, and BGP	
	4.5	Broadcast and multicast, handling mobility	
5		**Data link layer Services and Protocols:**	10
	5.1	Link-layer and its services, Ethernet, hubs, bridges, and switches	
	5.2	Link-layer addressing, ATM and MPLS	
	5.3	Local area networks and IEEE 802.11 wireless LANs, multiple-access protocols. Random access, efficiency of pure and slotted ALOHA, CSMA, CSMA/CD, and CSMA/CA	
6		**Introduction to Physical-layer Services and Systems**	08
	6.1	Introduction to physical media, Coax, fiber, twisted pair, DSL, HFC, WiMax, cellular, satellite, and telephone networks, bit transmission, frequency division multiplexing. time division multiplexing	
Total			**52**

Recommended Books:

1. Andrew Tanenbaum, *"Computer Networks",* PHI New Dehli,
2. Natalia Olifer and Victor Olifer, " Computer Networks", Wiley India,New Delhi
3. J. F. Kurose and K. W. Ross, "*Computer Networking: A Top-Down Approach*", Pearson Publication , 5th Edition, March 2009
4. L.Garcia et al, "*Communication Networks*", McGraw Hill Publication, 2nd Edition
5. B. Forouzan, "*Data Communication and Networking*", McGraw Hill Publication, 5th edition.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3 Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETC 604	**Television Engineering**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC 604	**Television Engineering**	20	20	20	80	-	-	-	100

Pre requisite : ETC 502 Analog Communication

Course Objective:

- To introduce the basics of picture transmission and reception.
- To become well conversant with new development in video engineering.
- To introduce most latest and revolutionary ideas in the field of digital TV, HDTV, WDTV.

Course outcome: The students will be able to

- Describe and differentiate working principles of latest digital TV, HDTV, WDTV.
- Understand, use and working principles of latest display like LCD, LED, Plasma and large plat panel monitors

Module No.		Topics	Hrs.
1		**Fundamentals of Analog T V system**	10
	1.1	Transmitter and receiver- block diagram approach, interlaced scanning, composite video signal, VSB transmission and reception (CCIR-B standards)	
	1.2	Camera tubes: basic principle ,Vidicon and Image orthicon	
2		**Color T V**	
	2.1	Compatibility considerations, Color theory, chromaticity diagram, generation of color TV signals, luminance signal, chrominance signal, frequency interleaving process, color subcarrier frequency.	10
	2.2	NTSC system- transmitter and receiver, PAL system- transmitter and receiver	
		Fundamental Concept of Digital Video	
3	3.1	Digitization, pixel array, scanning notation, viewing distance and angle, aspect ratio, frame rate and refresh rate.	12
	3.2	Raster scanning, scan line waveform, interlace, scanning standards.	
	3.3	Sync structure, data rate, linearity, bandwidth and data rate, resolution, luma, color difference coding, chroma sub sampling	
	3.4	Component digital video, composite video	
4		**Advanced TV systems**	6
	4.1	Digital video and audio signals	
	4.2	MAC signal, D2-MAC/packet signal, MAC decoding and interfacing, advantages of MAC signal	
	4.3	Direct-to-home TV(DTH)	
5		**High definition televisions**	8
	5.1	High definition TV systems, HDTV standards and compatibility, resolution and working.	
	5.2	Wide dimensions high definition TV	
	5.3	Standards of wide dimensions HDTV	
	5.4	MUSE system	
6		**Displays**	6
	6.1	Principle, working, advantages and disadvantages of Plasma, LED,LCD	
		Total	**52**

Recommended Books:

1. Gulati R.R, " *Monochrome and Color Television*," Wiley Eastern Limited publication.
2. R.G.Gupta , "*Television and Video Engineering*", Tata Mc Graw Hill publication.
3. Dhake A.M, "*Television and Video Engineering*", Tata McGraw Hill publication.
4. Keith Jack, "*Video Demystified*", 4e, , Elsevier
5. Charles Poynton, "*San Francisco, Digital video and HDTV, Algorithms And Interfaces*," Morgan Kaufmann publishers, 2003.
6. Stan Prentiss, *"High Definition TV*", second edition, , Tata McGraw Hill publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3: Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4: Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETC 605	**Operating System**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC 605	**Operating System**	20	20	20	80	-	-	-	100

Course Pre-requisite: Basic concepts of computer systems

Course Objectives:

- To introduce operating system as a resource manager, its evolutions and fundamentals.
- To help student understand concept of process and different process (linear and concurrent) Scheduling policies.
- To help student familiar with memory, file and I/O management policies.

Course Outcomes: On completing this course Student will able to:

- Understand the role of an operating system, its function and issues.
- Compare between different algorithms used for management and scheduling of processes, Memory and input-output operation.
- Appreciate the role of various productivity enhancing tools.

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Module No.		Topics	Hrs.
1		**Fundamental of Operating System(OS)**	**06**
	1.1	Definition, objectives, functions, evolution, services, types, and different views of OS	
	1.2	Operating System as a resource manager, system calls, and shell	
	1.3	Monolithic systems, layered systems, client server model, monolithic kernel and microkernel	
2		**Process Management and Memory Management**	**10**
	2.1	Process, process creation, process control block, process states, process state transition diagram	
	2.2	Scheduling queues and schedulers, preemptive and non- preemptive scheduling algorithms, types of threads, multithreading models	
	2.3	Race condition, critical section, mutual exclusion, semaphores, monitors	
	2.4	Multiprogramming with fixed and variable partitions, memory allocation strategies	
	2.5	Logical and physical address space, paging and segmentation	
	2.6	Concept, performance of demand paging, page replacement algorithms.	
	2.7	Deadlock Problem, deadlock characterization, deadlock prevention and deadlock avoidance deadlock detection and recovery	
3		**File Management and Input Output Management**	**10**
	3.1	File Naming, File Structure, File Types, File Access, File Attributes, File Operations, Memory Mapped Files, Implementing Files, contiguous allocation, linked list allocation, indexed allocations, Inode	
	3.2	Single level directory system, Two level directory system, Hierarchical Directory System	
	3.3	Principles of Input/output H/W: I/O Devices, Device Controllers, Direct Memory Access.	
	3.4	Principles of Input/output S/W: Goals Of I/O S/W, Interrupt Handler, Device Driver, Device Independent I/O Software	
	3.5	Disks : RAID levels, Disks Arm Scheduling Algorithms	
	3.6	Management of free blocks.	
4		**Unix Operating System**	06
	4.1	History of UNIX, UNIX Goals, Unix Shell, interfaces to Unix, UNIX utility programs	
	4.2	Traditional UNIX Kernel, Modern UNIX Systems	
	4.3	Unix process management: Concept, Scheduling in Unix	
	4.4	Unix Memory management: Paging, Page replacement strategies	
	4.5	Unix file management: I-node, File allocation, I/O management	
	4.6	Unix Security measures	
5		**Linux Operating System**	10
	5.1	History, Linux Processes and Thread management	
	5.2	Scheduling in Linux, Linux System calls	
	5.3	Memory management: Virtual memory, Buddy Algorithm, Page replacement policy	
	5.4	Linux File System	
	5.5	I/O management: Disk Scheduling	
	5.6	Advantages of Linux and Unix over Windows	

6		**Real Time Operating System(RTOS)**	**10**
	6.1	Introduction, Characteristics of real-time operating systems	
	6.2	Real Time task Scheduling, Modeling Timing constraints, Table-driven scheduling	
	6.3	Cyclic schedulers	
	6.4	Earliest Deadline First (EDF) scheduling	
	6.5	Rate Monotonic Algorithm(RMA)	
Total			**52**

Recommended Books:

1. Tanenbaum, "*Modern Operating Systems*", IIIrd Edition, PHI
2. Silberschatz A., Galvin P., and Gagne G, "*Operating Systems Concepts*", VIIIth Edition Wiley.
3. William Stallings, "*Operating System-Internal & Design Principles*", VIth Edition, , Pearson
4. Rajib Mall, "*Real-Time Systems: Theory and Practice*," Pearson, 2008.
5. Maurice J. Bach, "*The Design of Unix Operating System*", Prentine Hall
6. Achyut S. Godbole, "*Operating Systems*", 2nd edition, Tata McGraw Hill
7. Richard Blum and Christine Bresnahan, "*Linux Command Line & Shell Scripting*", 2nd edition, Wiley

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETC606	**VLSI Design**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ETC606	**VLSI Design**	20	20	20	80	--	--	--	100

Course Pre-requisite:

- ETC303: Digital Electronics
- ETC302: Analog Electronics-I
- ETC402: Analog Electronics-II
- ETC505: Integrated Circuits

Course Objectives:

- To teach fundamentals of VLSI circuit design and implementation using circuit simulators and layout editors.
- To highlight the circuit design issues in the context of VLSI technology.

Course Outcomes: After successful completion of the course student will be able to

- Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.
- Design MOSFET based logic circuit
- Draw layout of a given logic circuit
- Realize logic circuits with different design styles
- Demonstrate an understanding of working principle of operation of different types of memories
- Demonstrate an understanding of working principles of clocking, power reduction and distribution

Module No.		Topics	Hrs.
1		**MOSFET Fabrication and Scaling**	08
	1.1	**Fabrication:** Fabrication process flow for NMOS and CMOS, CMOS Latch-up	
	1.2	**MOSFET Scaling:** Types of scaling, short channel effects, Level 1 and Level 2 MOSFET Models	
	1.3	**Layout:** Lambda based design rules, MOSFET capacitances	
2		**MOSFET Inverters**	10
	2.1	**Circuit Analysis:** Static and dynamic analysis (Noise, propagation delay and power dissipation) of resistive load and CMOS inverter. Comparison of all types of MOS inverters. Design of CMOS inverters and its layout.	
	2.2	**Logic Circuit Design:** Analysis and design of 2-I/P NAND and NOR using equivalent CMOS inverter.	
3		**MOS Circuit Design Styles**	10
	3.1	**Design Styles:** Static CMOS, Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Domino, NORA, Zipper, C^2MOS	
	3.2	**Circuit Realization:** SR Latch, JK FF, D FF, 1 Bit Shift Register, MUX, Decoder using above design styles and their layouts	
4		**Semiconductor Memories**	08
	4.1	**SRAM:** ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits), DRAM (Operation 3T, 1T, operation modes, leakage currents, refresh operation, Input-Output circuits), Flash (mechanism, NOR flash, NAND flash), layout of SRAM and DRAM	
	4.2	**Peripheral Circuits:** Sense Amplifier, Decoder	
5		**Data Path Design**	08
	5.1	**Adder:** Bit adder circuits, Ripple carry adder, CLA adder	
	5.2	**Multipliers and shifter:** Partial-product generation, partial-product accumulation, final addition, Barrel Shifter	
6		**VLSI Clocking and System design**	08
	6.1	**Clocking:** CMOS clocking styles, Clock generation, stabilization and distribution	
	6.2	**Low Power CMOS Circuits:** Various components of power dissipation in CMOS, Limits on low power design, low power design through voltage scaling.	
	6.3	**IO pads and Power Distribution:** ESD protection, Input circuits, Output circuits, Simultaneous switching noise, power distribution scheme	
	6.4	**Interconnect:** Interconnect delay model, interconnect scaling and crosstalk	
		Total	**52**

Recommended Books:

1. Sung-Mo Kang and Yusuf Leblebici, "*CMOS Digital Integrated Circuits Analysis and Design*", Tata McGraw Hill, 3rd Edition, 2012.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "*Digital Integrated Circuits: A Design Perspective*", Pearson Education, 2nd Edition.
3. John P. Uyemura, "*Introduction to VLSI Circuits and Systems*", Wiley, Student Edition, 2013.
4. Neil H. E. Weste, David Harris and Ayan Banerjee, "*CMOS VLSI Design: A Circuits and Systems Perspective*", Pearson Education, 3rd Edition.
5. R. Jacob Baker, "*CMOS Circuit Design, Layout and Simulation*", Wiley, 2nd Edition, 2013

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions for 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL601	**Discrete Time Signal Processing**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL601	**Discrete Time Signal Processing**	--	--	--	--	25	25	-	50

Term Work:
At least ten experiments covering entire syllabus of ETC 602:Discrete Time Signal Processing on should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and average. Base on above scheme grading and term work assessment should be done.
Practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL602	**Communication Engineering Laboratory III**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL602	**Communication Engineering Laboratory III**	--	--	--	--	25	25	-	50

Term Work:
At least ten experiments covering entire syllabus for ETC 601: Digital Communication and ETC 603 Computer Communication and Networks should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and average. Base on above scheme grading and term work assessment should be done.
Practical and oral examination will be based on entire syllabus of ETC 601 and ETC 603

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL604	**Communication Engineering Laboratory IV**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL604	**Communication Engineering Laboratory -IV**	--	--	--	--	25	25	-	50

Term Work:
At least six experiments covering entire syllabus for ETC 606:VLSI Design and minimum four experiments for ETC 604: Television Engineering. should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and average. Base on above scheme grading and term work assessment should be done.
Practical and oral examination will be based on entire syllabus for ETC 606 and ETC 604.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL605	Mini Project II	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
ETL605	Mini Project II	--	--	--	--	25	25	50

Term Work:

The main intention of Mini Project is to make student enable to apply the knowledge and skills learned out of courses studied to solve/implement predefined practical problem. The students undergo various laboratory/tutorial/simulation laboratory/work shop courses in which they do experimentation based on the curriculum requirement. The mini Project may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be on

- Learning additional skills
- Development of ability to define and design the problem and lead to its accomplishment with proper planning.
- Learn the behavioral science by working in a group

The group may be maximum **four** (04) students. Each group will be assigned one faculty as a supervisor. The college should keep proper assessment record of progress of the project and at the end of the semester it should be assessed for awarding TW marks. The TW may be examined by approved internal faculty appointed by the head of the institute. The final examination will be based on demonstration in front of internal and external examiner. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed.

The topic of Mini Project I and II may be different and / or may be advancement in the same topic. The students may use this opportunity to learn different computational techniques as well as some model development. This they can achieve by making proper selection of Mini Projects.

AC 7/6/2014

Item No. 4.22

UNIVERSITY OF MUMBAI

Bachelor of Engineering
Electronics and Telecommunication Engineering

Final Year Engineering

(Sem. VII and VIII), Revised Course

(REV- 2012) effective from Academic Year 2015 -16

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

From Dean'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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble:

In the process of change in the curriculum there is a limited scope to have major changes in the fundamental subjects which are mainly part of second year of engineering. The exposure to the latest technology and tools used all over the world is given by properly selecting subjects and their hierarchy in pre-final and final year. Thus this syllabus is made to groom the undergraduate students best suited and competent in all respect with best possible efforts put in by the experts in framing detail contents of individual subjects.

The engineering education in India is expanding in manifolds and the main challenge is the quality education. All the stakeholders are very much concerned about it.

The institution or program of study is committed and open to external review to meet certain minimum specified standards. 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 graduation.

So the curriculum must be constantly refined and updated to ensure that the defined objectives and outcomes are achieved. Students must be encouraged to comment on the objectives and outcomes and the role played by the individual courses in achieving them. 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.

I, as Chairman, Board of Studies in Electronics and Telecommunication Engineering University of Mumbai, happy to state here that, heads of the department and senior faculty from various institute took timely and valuable initiative to frame Program Educational Objectives as listed below.

1. To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies.
2. To prepare students to demonstrate an ability to identify, formulate and solve electronics and telecommunication engineering problems.
3. To prepare students to demonstrate ability to design electrical and electronics systems and conduct experiments, analyze and interpret data.
4. To prepare students to demonstrate for successful career in industry to meet needs of Indian and multi-national companies.
5. To develop the ability among students to synthesize data and technical concepts from applications to product design.
6. To provide opportunity for students to work as part of teams on multidisciplinary projects.
7. To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.

These are the suggested and expected main objectives and individual affiliated institute may add further in the list. In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner’s point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

The subjects offered to undergraduate students in final year are at par to the requirement of industry. The students are also made competent to appear for various competitive examination conducted in India and abroad. The subjects offered are at enough level to prepare a base of the students to understand and learn latest state of technology. The students are trained in such a way that they become versatile in hardware and software simulation. Some subjects offered upgrades them in the field of information and technology which is a need of today's' era.

At the end I must outset extend my gratitude to all experts who contributed to make curriculum competent at par with latest technological development in the field of electronics and telecommunication engineering.

Dr. Udhav Bhosle
Chairman, Board of Studies in Electronics and Telecommunication Engineering

Semester VII

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC701	Image and Video Processing	04	--	--	04	--	--	04
ETC702	Mobile Communication	04	--	--	04	--	--	04
ETC703	Optical Communication and Networks	04	--	-	04	--	-	04
ETC704	Microwave and Radar Engineering	04	--	--	04	--	--	04
ETE70X	Elective	04	--	--	04	--	--	04
ETL701	Image and Video Processing Laboratory	--	02	--	--	01	--	01
ETL702	Advanced communication Engineering. Laboratory I	--	02	--	--	01	--	01
ETL703	Advanced communication Engineering. Laboratory II	--	02	--	--	01	--	01
ETEL70X	Elective	--	02	--	--	01	--	01
ETP701	Project (Stage I)	--	*	--	--	03	--	03
Total		**20**	**08**	**--**	**20**	**07**	**--**	**27**

Course Code (ETE70X)	Sem. VII Elective
ETE 701	Data Compression and Encryption
ETE 702	Statistical Signal Processing
ETE 703	Neural Network and Fuzzy Logic
ETE 704	Analog and Mixed Signal VLSI

- **Work load of learner in Semester VII is equivalent to 6 hours /week**

Semester VII

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. of Test 1 & Test 2				
ETC701	Image and Video Processing	20	20	20	80	--	--	100
ETC702	Mobile Communication	20	20	20	80	--	--	100
ETC703	Optical Communication and Networks	20	20	20	80	-	--	100
ETC704	Microwave and Radar Engineering	20	20	20	80	--	--	100
ETE70X	Elective	20	20	20	80	--	--	100
ETL701	Image and Video Processing Laboratory	--	--	--	--	25	25	50
ETL702	Advanced communication Engineering. Laboratory I	--	--	--	--	25	25	50
ETL703	Advanced Communication Engineering. Laboratory II	--	--	--	--	25	25	50
ETEL70X	Elective	--	--	--	--	25	25	50
ETP701	Project (Stage I)					25	25	50
Total		**100**	**100**	**100**	**400**	**125**	**125**	**750**

Semester VIII

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC801	Wireless Networks	04	--	--	04	--	--	04
ETC802	Satellite communication and Networks	04	--	--	04	--	--	04
ETC803	Internet and Voice Communication	04	--	--	04	--	--	04
ETE80X	Elective	04	--	--	04	--	--	04
ETL801	Wireless Networks Laboratory	--	02	--	--	01		01
ETL802	Satellite communication and Networks Laboratory	--	02	--	--	01		01
ETL803	Internet and Voice Communication Laboratory	--	02	--	--	01		01
ETEL80X	Elective Laboratory	--	02	--	--	01		01
ETP801	Project (Stage II)	--	**	--	--	06		06
Total		**16**	**08**	**--**	**16**	**10**		**26**

Course Code (ETE 80X)	**Sem. VIII Elective**
ETE 801	Speech Processing
ETE 802	Telecom Network Management
ETE 803	Microwave Integrated Circuits
ETE 804	Ultra Wideband Communication

**** Work load of learner in Semester VIII is equivalent to 12 hours /week.**

Semester VIII

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. of Test 1 & Test 2					
ETC801	Wireless Networks	20	20	20	80	--	--	--	100
ETC802	Satellite communication and Networks	20	20	20	80	--	--	--	100
ETC803	Internet and Voice Communication	20	20	20	80	--	--	--	100
ETE80X	Elective	20	20	20	80	--	--	--	100
ETL801	Wireless Networks Laboratory	--	--	--	--	25	--	25	50
ETL802	Satellite communication and Networks Laboratory	--	--	--	--	25	--	25	50
ETL803	Internet and Voice Communication Laboratory	--	--	--	--	25	--	25	50
ETEL80X	Elective Laboratory	--	--	--	--	25	--	25	50
ETP801	Project (Stage II)	--	--	--	--	50	--	50	100
Total		**80**	**80**	**80**	**320**	**150**		**150**	**700**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC701	Image and Video Processing	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC701	Image and Video Processing	20	20	20	80	-	-	-	100

Course pre-requisite:

- ETC 405: Signals and Systems
- ETC 602: Discrete Time Signal Processing

Course Objectives:

- To cover the fundamentals and mathematical models in digital image and video processing.
- To develop time and frequency domain techniques for image enhancement.
- To expose the students to current technologies and issues in image and video processing.
- To develop image and video processing applications in practice.

Course outcomes: Students will be able to

- Understand theory and models in Image and Video Processing.
- Interpret and analyze 2D signals in frequency domain through image transforms.
- Apply quantitative models of image and video processing for various engineering applications.
- Develop innovative design for practical applications in various fields.

Module No.		Topics	Hrs.
1		**Image Fundamentals**	04
	1.1	Image acquisition, sampling and quantization, image resolution, basic relationship between pixels, color images, RGB, HSI and other models	
2		**Two Dimensional Transforms**	06
	2.1	Discrete Fourier Transform, Discrete Cosine Transform, KL Transform, and Discrete Wavelet Transform	
3		**Image Enhancement**	
	3.1	**Spatial Domain** **Point Processing:** Digital Negative, contrast stretching, thresholding, gray level slicing, bit plane slicing, log transform and power law transform. **Neighborhood Processing**: Averaging filters, order statistics filters, high pass filters and high boost filters	08
	3.2	**Frequency Domain:** DFT for filtering, Ideal, Gaussian and Butterworth filters for smoothening and sharpening, and Homomorphic filters	
	3.3	**Histogram Modeling:** Histogram equalization and histogram specification	
4		**Image Segmentation and Morphology**	07
	4.1	Point, line and edge detection, edge linking using Hough transform and graph theoretic approach, thresholding, and region based segmentation.	
	4.2	Dilation, erosion, opening, closing, hit or miss transform, thinning and thickening, and boundary extraction on binary images	
5		**Image Restoration:**	07
	5.1	Degradation model, noise models, estimation of degradation function by modeling, restoration using Weiner filters and Inverse filters	
6		**Video Formation, Perception and Representation**	08
	6.1	Digital Video Sampling, Video Frame classifications, I, P and B frames, Notation, ITU-RBT 601Digital Video formats, Digital video quality measure.	
	6.2	**Video Capture and display:** Principle of colour video camera, video camera, digital video	
	6.3	**Sampling of video Signals:** Required sampling rates, sampling in two dimensions and three dimensions, progressive virus interlaced scans	
7		**Two Dimensional Motion Estimation**	12
	7.1	**Optical Flow:** 2-D motion Vs optical flow, optical flow equations, motion representation, motion estimation criteria, optimization method.	
	7.2	**Pixel based motion estimation:** Regularization using motion smoothing constraints, using multipoint neighborhood.	
	7.3	**Block Matching Algorithms:** Exhaustive block matching algorithms, phase correlation method, Binary feature matching.	
	7.4	**Multi resolution Motion Estimation:** General formulation, Hierarchical blocks matching Algorithms.	
Total			**52**

Recommended Books:

1. Gonzales and Woods, “*Digital Image Processing*”, Pearson Education, India, Third Edition,
2. Anil K.Jain, “*Fundamentals of Image Processing*”, Prentice Hall of India, First Edition, 1989.
3. Murat Tekalp, “*Digital Video Processing*”, Pearson, 2010.
4. John W. Woods, “*Multidimensional Signal, Image and Video Processing*”, Academic Press 2012
5. J.R.Ohm , “*Multimedia Communication Technology*", Springer Publication.
6. A.I.Bovik, “*Handbook on Image and Video Processing*", Academic Press.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered for final internal assessment.

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC702	**Mobile communication**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC702	**Mobile communication**	20	20	20	80	-	-	-	100

Prerequisites:

- ETC 601 Digital Communication
- ETC 603 Computer Communication and Networks

Course Objective:

- To study the concept of Mobile radio propagation, cellular system design.
- To understand mobile technologies like GSM and CDMA.
- To know the mobile communication evolution of 2G, 3G and 3 GPP in detail.
- To have overview of immerging technologies for 4 G standards.

Course Outcomes: Students will be able to:

- Understand GSM, CDMA concepts and architecture, frame structure, system capacity, services provided.
- Study of evolution of mobile communication generations 2G, 2.5G, 3G with their characteristics and limitations.
- Understand emerging technologies required for fourth generation mobile systems such as SDR, MIMO etc.
- Understand different indoor and outdoor propagation models related to losses and different types of fading.

Module No.		Topics	Hrs.
1. 0		**Fundamentals of Mobile Communication**	10
	1.1	Introduction to wire1ess communication	
	1.2	Frequency Division Multiple access, Time Division Multiple access, Spread Spectrum Multiple access, Space Division Multiple access, and OFDM	
	1.3	Frequency reuse, channel assignment strategies, handoff strategies, interference and system capacity, trunking and grade of service, improving the capacity of cellular systems. and related design problems	
2.0		**2G Technologies**	13
	2.1	GSM Network architecture, signaling protocol architecture, identifiers, channels, introduction frame structure, speech coder RPE-LTP, authentication and security, call procedure, handoff procedure, services and features	
	2.2	**GSM evolution in GPRS and EDGE:** Architecture and services offered	
	2.3	**IS-95 A& B(CDMA-1):** Frequency and channel specifications of forward and reverse CDMA channel, packet and frame formats, mobility and radio resource management	
3.0		**3G Technology**	09
	3.1	**IMT-2000/UMTS:** Network architecture, air Interface specification, forward and reverse channels in W-CDMA and CDMA 2000, spreading and modulation.	
	3.2	Cell search and synchronization, establishing a connection, hand off and power control in 3G system	
4.0		**3GPP LTE**	08
	4.1	Introduction and system overview	
	4.2	Frequency bands and spectrum ,network structure, and protocol structure	
	4.3	Frame slots and symbols, modulation, coding, multiple antenna techniques	
	4.4	**Logical and Physical Channels:** Mapping of data on to logical sub-channels physical layer procedures, establishing a connection, retransmission and reliability, power control.	
5.0		**Emerging Technologies for 4G**	06
	5.1	4G Introduction and vision	
	5.2	Multi antenna Technologies: MIMO; software defined radio	
	5.3	Adaptive multiple antenna techniques, radio resource management, QOS requirements	
	5.4	Overview of 4G research initiatives and developments.	
6.0		**Mobile Radio Propagation**	06
	6.1	Study of indoor and outdoor propagation models	
	6.2	Small scale fading and multi-path Small-scale multi-path propagation, parameter of multi-path channels, types of small scale fading, Raleigh and Ricean distribution,	
		Total	**52**

Recommended Books:

1. Theodore S. Rappaport , "*Wireless Communications*", Prentice Hall of India, PTR publication
2. Andreas Molisch , "*Wireless Communications*", Wiley, Student second Edition.
3. Vijay Garg , "*Wireless Network Evolution 2G-3G*", Pearson Education.
4. Young Kyun Kim and Ramjee Prasad, "*4 G Roadmap and Emerging Communication Technologies* ", Artech house.:
5. Raj Pandya , "*Mobile And Personal Communications Systems And Services*", Prentice hall.
6. Singhal , "*Wireless Communication*", TMH
7. C.Y Lee , "Mobile Communication", Wiley

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC703	Optical Communication and Networks	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC703	Optical Communication and Networks	20	20	20	80	-	-	-	100

Pre requisites:

- ETC404 Wave Theory and Propagation
- ETC502 Analog Communication
- ETC601 Digital Communication.

Course Objective: To teach students

- Optical fiber structures wave guide, fabrication and signal degradation in fiber.
- The characteristics of optical sources and detectors.
- Link budged and optical networks, design and management.
- Study the multiplexing schemes.

Course Outcome: This course enables the students to:

- Apply the fundamental principles of optics and light wave to design optical fiber communication systems.
- Identify structures, functions, materials, and working principle of optical fibers, light sources, couplers, detectors, and multiplexers.
- Design optical fiber communication links using appropriate optical fibers, light sources, couplers, detectors, and multiplexers.
- 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.		Topics	Hrs.
1.		**Optical Fiber Communication Technology**	10
	1.1	Block diagram, advantages, loss and bandwidth window, ray theory transmission, total internal reflection, acceptance angle, numerical aperture, and skew rays	
	1.2	EM waves, modes in planer guide, phase and group velocities, types of fibers according to refractive index profile and mode transmission.	
	1.3	Fiber material, fiber cables and fiber fabrication, fiber joints, fiber connectors, splices.	
2		**Transmission Characteristic of Optical Fiber**	08
	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, and non linear effects	
	2.2	Measurements of attenuation, dispersion and OTDR	
3		**Optical Communication Systems**	08
	3.1	Working principle and characteristics of sources (LED, LASER), and optical amplifiers	
	3.2	Working principle and characteristics of detectors (PIN, APD), noise analysis in detectors, coherent and non-coherent detection, receiver structure, bit error rate of optical receivers, and receiver performance.	
	3.3	Point to point links system considerations, link power budget, and rise time budget	
4		**Optical Network System Components and Optical Networks**	10
	4.1	Couplers, isolators, circulators, multiplexers, filters, fiber gratings, Fabry Perot filters, arrayed waveguide grating, switches and wavelength converters	
	4.2	SONET and SDH standards, architecture of optical transport networks (OTNs), network topologies, protection schemes in SONET/SDH, and wavelength routed architectures.	
	4.3	Operational principle of WDM, WDM network elements and Architectures, Introduction to DWDM, Solitons.	
5		**Packet Switching and Access Networks**	08
	5.1	OTDM, multiplexing and de-multiplexing, synchronization and broadcast OTDM networks.	
	5.2	Network architecture overview, OTDN networks, optical access networks, and future access networks.	
6		**Network Design and Management**	08
	6.1	Transmission system model, power penalty-transmitter, receiver optical amplifiers, crosstalk, dispersion, wavelength stabilization.	
	6.2	Network management functions, configuration management, performance management, fault management, optical safety, and service interface	
Total			**52**

Recommended Books:

1. John M. Senior, "*Optical Fiber Communication*", Prentice Hall of India Publication, Chicago, 3rd Edition, 2013
2. Gred Keiser, "*Optical Fiber Communication*", Mc-Graw Hill Publication , Singapore, 4th Edition, 2012
3. G Agrwal, "*Fiber optic communication Systems*", John Wiley and Sons, 3rd Edition, New York 2014
4. Rajiv Ramaswami and Kumar N. Sivarajan, "*Optical Networks: A Practical Perespective*", Elsevier Publication Elsevier India Pvt.ltd, 3rd Edition, 2010
5. P.E.Green, "*Optical Networks*", Prentice Hall,1994
6. Biswanath Mukherjee, "*Optical Communication Networks*", McGraw-Hill, 1997.
7. Le Nguyen Binh, "*Optical Fiber Communication System: Theory and Practice with MATLAB and Simulink*", CRC Press, 2010

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC704	**Microwave and Radar Engineering**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC704	**Microwave and Radar Engineering**	20	20	20	80	-	-	-	100

Pre requisite :

- ETC 404 Wave Theory and Propagation
- ETC 504 RF Modeling and Antenna

Course Objective: To teach the students

- Radio-frequency spectrum space, microwave communication.
- Microwave principles, working of microwave devices.
- RADAR and their applications.

Course Outcome: After Completing this course student will be able to

- Analyze the microwave passive circuit components and design the tunning and matching networks.
- Identify the state of art in microwave tubes and semiconductors and their uses in real life.
- Apply the microwave devices and RADAR for industrial and scientific purposes

Module No.		Topics	Hrs.
1.		**Waveguides and Microwave Components**	**10**
	1.1	Frequency bands and characteristics of microwaves	
	1.2	Rectangular and circular waveguides, mode analysis	
	1.3	Resonators, reentrant cavities, scattering parameters, tees, hybrid ring, directional couplers, phase shifters, terminations attenuators, ferrite devices such as isolators, gyrators, and circulators.	
2		**Impedance Matching and Tuning**	**08**
	2.1	Lumped element matching	
	2.2	Single stub tuning, double stub tuning, triple stub tuning	
	2.3	Quarter wave transformer	
3		**Generation and Amplification of Microwaves**	**10**
	3.1	Two Cavity Klystron and Reflex Klystron	
	3.2	Helix Travelling Wave Tube and Backward Wave Oscillator	
	3.3	Cross Field Amplifier, Cylindrical Magnetron, and Gyrotrons	
4		**Semiconductor Microwave Devices** (construction, working, equivalent circuit and performance characteristics)	**10**
	4.1	Varactor, PIN, Tunnel, Point Contact, Schottky Barrier, Gunn, IMPATT, TRAPATT, and BARITT.	
	4.2	BJT, Hetro junction BJT, MESFET, and HEMT	
	4.3	Parametric Amplifiers	
5		**RADAR**	**08**
	5.1	Basics of RADAR and RADAR range equation	
	5.2	**Types of RADAR:** Pulsed, Continuous wave and FMCW, Doppler, MTI, and Phased Array	
	5.3	Types of displays and Clutter	
	5.4	**Tracking RADAR**: Monopulse, Conical, Sequentiallobing	
6		**Microwave Applications**	**06**
	6.1	Microwave heating and bio-medical applications	
	6.2	Remote sensing RADAR, MSTRADAR, radiometer, instrumentation landing system, and RADAR based navigation	
Total			**52**

Recommended Books:

1. David M Pozar, “*Microwave Engineering*”, John Wieley & Sons,Inc. Hobokenh,New Jersey, Fourth Edition, 2012.
2. Samuel YLiao, “*Microwave Devices and Circuits*”, Pearson Education, Third Edition
3. Merill Skolnik, “*Introduction to RADAR Systems*”, TataMcgraw Hill , Third Edition
4. Annapurna Das and Sisir K Das, “*Microwave Engineering*”, Tata McGraw Hill,New Delhi, Second Edition, 2009
5. K. T. Matthew, “*Microwave Engineering*”, Wieleyindia, ,2011

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETE701	**Data Compression and Encryption**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETE701	**Data Compression and Encryption**	20	20	20	80	-	-	-	100

Pre requisite :
- ETC 503 Random Signal Analysis
- ETC 601 Digital Communication
- ETC 603 Computer Communication and Networks

Course Objective: To teach the students
- Lossless and Lossy compression techniques for different types of data.
- Understand data encryption techniques
- Network security and ethical hacking.

Course Outcome : Student will able to
- Implement text, audio and video compression techniques.
- Understand symmetric and asymmetric key cryptography schemes.
- Understand network security and ethical hacking.

Module No.		Topics	Hrs.
1.		**Data Compression**	**08**
	1.1	**Compression Techniques:** Loss less compression, Lossy compression, measure of performance, modeling and coding, different types of models, and coding techniques	
	1.2	**Text Compression**: Minimum variance Huffman coding, extended Huffman coding, Adaptive Huffman coding. Arithmetic coding, Dictionary coding techniques ,LZ 77, LZ 78, LZW	
2		**Audio Compression**	**04**
	2.1	High quality digital audio, frequency and temporal masking, lossy sound compression, μ-law and A-law companding, and MP3 audio standard	
3		**Image and Video Compression**	**12**
	3.1	PCM, DPCM JPEG, JPEG –LS , and JPEG 2000 standards	
	3.2	Intra frame coding, motion estimation and compensation, introduction to MPEG - 2 H-264 encoder and decoder	
4		**Data Security**	**12**
	4.1	Security goals, cryptography, stenography cryptographic attacks, services and mechanics.	
	4.2	Integer arithmetic, modular arithmetic, and linear congruence	
	4.3	Substitution cipher, transposition cipher, stream and block cipher, and arithmetic modes for block ciphers	
	4.4	Data encryption standard, double DES, triple DES, attacks on DES, AES, key distribution center.	
5		**Number Theory and Asymmetric Key Cryptography**	**12**
	5.1	Primes, factorization, Fermat's little theorem, Euler's theorem, and extended Euclidean algorithm	
	5.2	RSA, attacks on RSA, Diffie Hellman key exchange , key management, and basics of elliptical curve cryptography	
	5.3	Message integrity, message authentication, MAC, hash function, H MAC, and digital signature algorithm	
6		**System Security**	
	6.1	Malware, Intruders, Intrusion detection system, firewall design, antivirus techniques, digital Immune systems, biometric authentication, and ethical hacking.	**04**
		Total	**52**

Recommended Books:

1. Khalid Sayood, “ *Introduction to Data Compression*” ,Morgan Kaufmann, 2000
2. David Saloman, “*Data Compression: The complete reference*” , Springer publication
3. Behrous Forouzen, “*Cryptography and Network Security*”, Tata Mc Graw –Hill Education 2011
4. Berard Menezes, “*Network Security and Cryptography*”, learning publication Cengage
5. William Stallings, “*Cryptography and Network Security*”, Pearson Education Asia Publication, 5th edition

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETE702	**Statistical Signal Processing**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETE702	**Statistical Signal Processing**	20	20	20	80	-	-	-	100

Course Prerequisite:

- ETC 405 Signals and Systems,
- ETC503 Random Signal Analysis

Course Objective:

- To enable the student to understand the basic principles of random signal processing.
- To study spectral detection and estimation methods used in communication system design and their applications.

Course Outcome Students will able to:

- Design System for estimation, spectral estimation
- To perform wave formation analysis of the system
- Understand role of statistical fundamentals in real world applications.

Module No.		Topics	Hrs.
1.		**Review of Signals and Systems**	**6**
	1.1	Review of stochastic Processes	
	1.2	Gauss-Markow models, representation of stochastic process, likelihood and sufficiency	
2		**Detection Theory**	**8**
	2.1	One way, two way ANOVA table, hypothesis testing, decision criteria	
	2.2	Multiple measurements, multiple-hypothesis testing, and composite	
	2.3	Chi-square testing, asymptotic error rate of LRT for simple hypothesis testing, CFAR detection, sequential detection and Wald's test.	
3		**Detection of Signals in Noise**	**8**
	3.1	Detection of known signals in white noise	
	3.2	Correlation receiver and detection of known signals in colored noise	
	3.3	Detection of known signals in noise and maximum SNR criterion	
	3.4	Solution of integral equations and detection of signals parameters	
4		**Estimation Theory**	**10**
	4.1	Estimation of Parameters	
	4.2	Bayes Estimates and estimation of nonrandom parameters	
	4.3	Properties of estimators, linear mean-square estimation, and reproducing densities	
5		**Estimation of Waveforms**	**10**
	5.1	Linear MMSE Estimation of Waveforms	
	5.2	The Wiener Filter for estimation of stationary processes	
	5.3	Kalman Filter for estimation of non-stationary processes	
	5.4	Relation between the Kalman and Wiener Filters, nonlinear estimation, and nonparametric detection	
6		**Applications**	**10**
	6.1	Spread spectrum communications	
	6.2	RADAR target models, and target detection	
	6.3	Parameter estimation in RADAR systems	
	6.4	Dynamic Target Tracking, pattern classification and system identification	
Total			**52**

Recommended Books:

1. M.D. Srinath, P.K. Rajasekaran, and R. Viswanathan, "*Introduction to Statistical Signal Processing with Application*", Pearson Education
2. Robert M. Gray and Lee D. Davisson, "*An Introduction to Statistical Signal Processing*", Pearson Education
3. Steven Kay, "*Fundamentals of Statistical Signal Processing Volume-I: Estimation Theory*", Prentice hall publication
4. Steven Kay, "*Fundamentals of Statistical Signal Processing Volume-II: Detection Theory*", Prentice hall publication
5. Steven Kay, "*Fundamentals of Statistical Signal Processing Volume-III: Practical Algorithm Development*", Prentice hall publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETE703	**Neural Networks and Fuzzy Logic**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETE703	**Neural Networks and Fuzzy Logic**	20	20	20	80	-	-	-	100

Prerequisites: FEC 101 Applied Mathematics I

Course Objective: To teach students

- Concepts and understanding of artificial neural networks
- Fuzzy logic basic theory and algorithm formulation
- To solve real world problems.

Course Outcome: Students will get:

- Knowledge about different neural networks, their architecture and training algorithm
- Concept of Fuzzy logic, Fuzzy Sets, fuzzy rules and fuzzy reasoning
- Exposure to the applicability of neural networks and fuzzy logic

Module No.		Topics	Hrs.
1.		**Introduction to Neural Networks and its Basic Concepts:**	08
	1.1	Biological neurons and McCulloch and Pitts models of neuron	
	1.2	Types of activation functions	
	1.3	Neural networks architectures	
	1.4	Linearly separable and linearly non-separable systems and their examples	
	1.5	Features and advantages of neural networks over statistical techniques	
	1.6	Knowledge representation, learning process, error-correction learning, concepts of supervised learning, and unsupervised learning	
2		**Supervised Learning Neural Networks:**	07
	2.1	Single layer perception and multilayer perceptron neural networks, their architecture	
	2.2	Error back propagation algorithm, generalized delta rule, learning factors, step learning	
	2.3	Momentum learning	
	2.4	Concept of training, testing and cross-validation data sets for design and validation of the networks	
3		**Unsupervised Learning Neural Networks:**	09
	3.1	Competitive earning networks, kohonen self-organizing networks	
	3.2	K-means and LMS algorithms	
	3.3	RBF neural network, its structure and Hybrid training algorithm for RBF neural networks	
	3.4	Comparison of RBF and MLP networks Learning	
	3.5	Vector Quantization neural network architecture and its training algorithm	
	3.6	Hebbian learning, Hopfield networks.	
4		**Applications of Neural Networks:**	06
	4.1	Pattern classification	
	4.2	Handwritten character recognition	
	4.3	Face recognition	
	4.4	Image compression and decompression	
5		**Fuzzy logic**	14
	5.1	Basic Fuzzy logic theory, sets and their properties	
	5.2	Operations on fuzzy sets	
	5.3	Fuzzy relation and operations on fuzzy relations and extension principle	
	5.4	Fuzzy membership functions and linguistic variables	
	5.5	Fuzzy rules and fuzzy reasoning	
	5.6	Fuzzification and defuzzification and their methods	
	5.7	Fuzzy inference systems, Mamdani Fuzzy models, and Fuzzy knowledge based controllers	
6		**Applications of Fuzzy Logic and Fuzzy Systems:**	08
	6.1	Fuzzy pattern recognition	
	6.2	Fuzzy image processing	
	6.3	Simple applications of Fuzzy knowledge based controllers like washing machines, traffic regulations, and lift control	
		Total	**52**

Recommended Books:

1. S. Rajsekaran and G. A. Vijaylakshmi Pai, “*Neural Networks, Fuzzy Logic, and Genetic Algorithms*”, PHI
2. Simon Haykin, “*Neural Network- A Comprehensive Foundation*”, Pearson Education
3. Thimothy J. Ross, “*Fuzzy Logic with Engineering Applications*”, Wiley India Publications
4. Laurence Fausett, “*Fundamentals of Neural Networks*”, Pearson Education
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

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETE704	CMOS Analog and Mixed Signal VLSI Design	04	02	--	04	01	--	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ETE704	CMOS Analog and Mixed Signal VLSI Design	20	20	20	80	--	--	--	100

Course Pre-requisite:

- ETC302: Analog Electronics I
- ETC303. Digital Electronics
- ETC402: Analog Electronics II
- ETC 505: Integrated Circuits
- ETC 606 :VLSI Design

Course Objectives: To teach the students

- Importance of CMOS and Mixed Signal VLSI design in the field of Electronics and Telecommunication.
- Underlying methodologies for analysis and design of fundamental CMOS Analog and Mixed signal Circuits like Current and Voltage references, Single stage Amplifiers, Operational Amplifiers, 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

- Differentiate between Analog, Digital and Mixed Signal CMOS Integrated Circuits.
- Analyze and design current sources and voltage references for given specifications.
- Analyze and design single stage MOS Amplifiers.
- Analyze and design Operational Amplifiers.
- Analyze and design data converter circuits.

Module No.		Topics	Hrs.
1		**Fundamental Analog Building Blocks**	08
	1.1	MOS Transistor as sampling switch, active resistances, current source and sinks, current mirror and current amplifiers	
	1.2	Voltage and current references, band gap voltage reference, Beta-Multipler referenced self-biasing	
2		**Single Stage MOS Amplifiers**	14
	2.1	Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage, simulation of CMOS amplifiers using SPICE	
	2.2	Single-ended operation, differential operation, basic differential pair, large-signal and small-signal behavior, common-mode response, differential pair with MOS loads, simulation of differential amplifiers using SPICE	
	2.3	Noise characteristics in the frequency and time domains, thermal noise, shot noise, flicker noise, popcorn noise, noise models of IC components, representation of noise in circuits, noise in single-stage amplifiers (CS, CD and CG stages), noise in differential pairs, noise bandwidth, noise figure, noise temperature.	
3		**MOS Operational Amplifiers Desing**	08
	3.1	Trans-conductance operational amplifier (OTA), two stage CMOS operational amplifier	
	3.2	CMOS operational amplifiers compensation, cascade operational amplifier and folded cascade	
4		**Non-Linear & Dynamic Analog Circuits**	08
	4.1	Switched capacitor amplifiers (SC), switched capacitor integrators, first and second order switched capacitor circuits.	
	4.2	Basic CMOS comparator design, adaptive biasing, analog multipliers	
5		**Data Converter Fundamentals**	06
	5.1	Analog versus digital discrete time signals, converting analog signals to data signals, sample and hold characteristics	
	5.2	DAC specifications, ADC specifications, mixed-signal layout issues	
6		**Data Converter Architectures**	08
	6.1	DAC architectures, digital input code, resistors string, R-2R ladder networks, current steering, charge scaling DACs, Cyclic DAC, pipeline DAC,	
	6.2	ADC architectures, flash, 2-step flash ADC, pipeline ADC, integrating ADC, and successive approximation ADC	
Total			**52**

Recommended Books:

1. B. Razavi, "*Design of Analog CMOS Integrated Circuits*", first edition, McGraw Hill,2001.
2. Harry W. Li and David E Boyce, "*CMOS Circuit Design, Layout, Stimulation*", PHI Edn, 2005
3. P.E.Allen and D R Holberg, "*CMOS Analog Circuit Design*", second edition, Oxford University Press, 2002.
4. Gray, Meyer, Lewis and Hurst "*Analysis and design of Analog Integrated Circuits*", 4th Edition Willey International, 2002

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL701	**Image and Video Processing**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
ETL701	**Image and Video Processing**	--	--	--	--	25	25	50

Term Work:
At least ten experiments covering entire syllabus for ETC 701: Image and Video Processing be set to have predefined inference and conclusion. Simulation based experiments are also encouraged. An attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment graded. The average of grades converted in to marks should be taken into account for term work assessment.
Practical and Oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL702	**Advanced Communication Engineering Laboratory I**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
ETL702	**Advanced Communication Engineering Laboratory I**	--	--	--	--	25	25	50

Term Work:
At least ten experiments covering entire syllabus for ETC 702: Mobile Communication be set to have predefined inference and conclusion. Simulation based experiments are also encouraged. An attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment graded. The average of grades converted in to marks should be taken into account for term work assessment.
Practical and Oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL703	**Advanced Communication Engineering Laboratory II**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
ETL703	**Advanced Communication Engineering Laboratory II**	--	--	--	--	25	25	50

Term Work:
At least ten experiments covering entire syllabus for ETC 703: Optical Communication and Network and ETC 704: Microwave and Radar Engineering be set to have predefined inference and conclusion. Simulation based experiments are also encouraged. An attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The average of grades converted in to marks should be taken into account for term work assessment.
Practical and Oral examination will be based on entire syllabus of ETC 703 and ETC 704

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL70X	**Elective**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
ETL70X	**Elective**	**--**	**--**	**--**	**--**	**25**	**25**	**50**

Term Work:
At least ten experiments covering entire syllabus for respective elective subject be set to have predefined inference and conclusion. Simulation based experiments are also encouraged. An attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment graded. The average of grades converted in to marks should be taken into account for term work assessment.
Practical and Oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETP701	Project (Stage I)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETP701	Project (Stage I)	--	--	--	--	25	-	25	50

Term Work:

The final year students have already under gone project assignment in their pre-final year in Mini Project I and II. In final year group of maximum **four** students will be completing a comprehensive project work based on the courses studied. The project work may be internally assigned or may be externally assigned by the research institutes, industry etc. Each group will be assigned one faculty as a supervisor. This project work in final year may be extension of the Mini Project work done in pre-final year.

The main intention of Project work is to enable students to apply the knowledge and skills learned out of courses studied to solve/implement predefined practical problem. The Project work may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be

- Learning additional skills
- Development of ability to define, design, analysis and implementation of the problem and lead to its accomplishment with proper planning
- Learn the behavioral science by working in a group
- The project area may be selected in which the student intend to do further education and/or may be either intend to have employment or self employment
- The topic of project should be different and / or may be advancement in the same topic of Mini Project
- The students may use this opportunity to learn different computational techniques as well as some model development. This they can achieve by making proper selection of Project work.

The college should keep proper assessment record of the progress of project and at the end of the semester it should be assessed for awarding TW marks. The TW should be examined by approved internal faculty appointed by the head of the institute on the basis of following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Report in prescribed University format.

An approved external examiner and internal examiner appointed by the head of the institute together will assess during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained.

Subject Code	Course Name	Teaching Scheme	Credits Assigned					
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ETC801	**Wireless Networks**	04	--	--	04		--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ETC801	**Wireless Networks**	20	20	20	80	--	--	--	100

Course Pre requisites :

- ETC 603 Computer Communication and Networks
- ETC 702 Mobile Communication

Course Objectives:

- Introduction to planning and design of wireless networks
- Introduction to HSPA systems
- To study emerging technologies like Bluetooth, zigbee, Wimax
- Understanding the wireless sensor network architecture and the protocol stack and WSN applications.

Course Outcomes: The students will be able to:

- Describe the phases of planning and design of mobile wireless networks
- List and compare personal area network (PAN) technologies such as Zigbee, Bluetooth etc
- Students will details of sensor network architecture, traffic related protocols , transmission technology etc
- Understand middleware protocol and network management issues of sensor networks

Module No.		Topics	Hrs.
1		**Overview of Cellular Systems**	**08**
	1.1	Mobile telephony, introduction to GSM.	
	1.2	Universal mobile telecommunication system	
	1.3	Introduction to HSPA, Advanced Antenna Systems for HSPA + and LTE	
2		**Planning and Design of Wide-Area Wireless Networks**	**12**
	2.1	Basics of indoor RF planning	
	2.2	Three phases of wireless network design	
	2.3	Indoor coverage from the macro layer	
	2.4	Link budgets for GSM, CDMA, CDMA2000, HSDPA systems, indoor UMTS/HSPA challenge, common UMTS rollout mistake	
3		**Emerging Wireless Technologies**	**10**
	3.1	**Bluetooth:** concepts of Pico net , scatter net etc., protocol stack, link types, security, network connection establishments, usage models, etc.	
	3.2	**ZigBee**: components, architecture, network topologies, protocol stack etc.	
	3.3	**UWB and RFID:** technical requirements, components and characteristics, applications	
	3.4	**WiMAX:** 802.16 based protocol architecture, physical layer, fixed and mobile WiMAX	
4		**Overview of Wireless Sensor Network**	**12**
	4.1	Background of sensor network technology, sensor network architectural elements, historical survey of sensor networks	
	4.2	Applications of wireless sensor network, range of applications, examples of category 1 and 2 WSN Applications	
	4.3	Technologies for wireless sensor network, sensor node technology, hardware and software, sensor taxonomy	
	4.4	Wireless network, operating environment, wireless network trends, transmission technology	
	4.5	Medium access control protocols, routing protocols, transport control protocols	
6		**Middleware for Sensor Networks & Network Management**	**10**
	6.1	Middleware principles	
	6.2	Middleware architecture, existing middleware	
	6.3	Network management, requirements	
	6.4	Network management models, design issues	
Total			**52**

Recommended Books:

1. Indoor Radio Planning: A Practical Guide for GSM, DCS, UMTS, HSPA and LTE, 2nd Edition Morten Tolstrup ISBN: 978-0-470-71070-8 480 - July 2011 -Wiley
2. Vijay K. Garg, "*Wireless Communication and Networking*", Morgan -Kaufmann Series in Networking—Elsevi**er**
3. Kazem Sohraby, Daniel Minoli, and Taieb Znati, "*Wireless Sensor Networks: Technology, Protocols, and Applications*", Wiley Student Edition
4. Feng Zhao and Leonidas Guibas, "*Wireless Sensor Networks, An Information Processin Approach*",--Morgan Kaufmann
5. Holger and Andreas Willig, "*Protocols and Architectures for WSN*", Wiley student edition

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC 802	Satellite Communication and Network	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC 802	Satellite Communication and Network	20	20	20	80	-	-	-	100

Pre-requisites:

- ETC 502: Analog communication
- ETC 601: Digital Communication

Course Objective:

- To provide an in-depth understanding of different concepts used in a satellite communication system.
- To explain the tools necessary for the calculation of basic parameters in a satellite communication system.
- To get knowledge of every aspects of satellite communication like orbital mechanics, launching techniques, satellite link design, earth station technology and different access system towards a satellite.

Course Outcome: The Students will be able to

- Explain the basics of satellite communication
- Explain and analyzes link budget of satellite signal for proper communication
- Use the system for the benefit of society
- Use the different application of satellite communication

Module No.		Topics	Hrs.
1.		**Overview of Satellite Systems, Orbits and Launching**	10
	1.1	Frequency allocation for satellite services, system design consideration, satellite services-VSAT, global positioning satellite system, maritime satellite services, gateways	
	1.2	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	
	1.3	Sub-satellite Point, predicting satellite position, antenna look angels, 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		**Space Segment**	8
	2.1	Attitude control, spinning satellite stabilization, momentum wheel stabilization, station keeping, thermal control, TT and C subsystem, transponders, wideband receiver, input de-multiplexer, power amplifier, antenna subsystem	
	2.2	Equipment reliability and space qualification	
3		**Satellite Links**	12
	3.1	Isotropic radiated power, transmission losses, free-space transmission, feeder losses, antenna misalignment losses, fixed atmospheric and ionospheric losses, link power budget	
	3.2	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	
	3.3	**Uplink:** Saturation flux density, input back off, earth station HPA, **Downlink:** Output back off, satellite TWTA output	
	3.4	Effects of rain, uplink rain-fade margin, downlink rain-fade margin, combined uplink and downlink C/N ratio, inter-modulation noise	
4		**Earth Station.**	04
	4.1	Design considerations, receive-only home TV systems, outdoor–indoor unit for analog (FM) TV, master antenna TV system, transmit-receive earth stations	
	4.2	Community antenna TV systems	
5		**The Space Segment Access and Utilization**.	8
		Space segment access methods, pre-assigned FDMA, demand assigned FDMA, SPADE system, bandwidth-limited and power-limited TWT amplifier operation	
		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	
		Code Division Multiple Access: Direct-sequence spread spectrum–acquisition and trackling, spectrum spreading and dispreading – CDMA throughput	
6		**Satellite Networking**	10
	6.1	**Satellite Network:** net work reference models and protocols, layering principle, open system interconnection (OSI), reference model, IP reference model, reference architecture for satellite networks, basic characteristics of satellite networks, onboard connectivity with transparent processing, analogue transparent switching, Frame organization, Window organization, On board connectivity with beam scanning	
	6.1	**Laser Satellite Communication:** Link analysis, optical satellite link transmitter, optical satellite link receiver, satellite beam acquisition, tracking & positioning, deep space optical communication link	
		Total	**52**

Recommended Books:

1. Dennis Roddy, *"Satellite Communications"*, 3rd Ed., Mc. Graw-Hill International Ed. 2001.
2. Wilbur L. Pritchard, Henri G. Suyderehoud, and Robert A. Nelson, *"Satellite Communication systems Engineering",* Pearson Publication
3. Gerard Maral and Michel Bousquet, *"Satellite Communication Systems",* 4th Edition Wiley Publication
4. Timothy Pratt, Charles Bostian, and Jeremy Allmuti, *"Satellite Communications"*, John Willy & Sons (Asia) Pvt. Ltd. 2004
5. M. Richharia, "*Satellite Communication Systems Design Principles*", Macmillan Press Ltd. Second Edition 2003.
6. Gerard Maral, "*VSAT Networks*", John Willy & Sons

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be selected from all the module

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC803	**Internet and Voice Communication**	20	20	20	80	-	-	-	100

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC803	**Internet and Voice Communication**	20	20	20	80	-	-	-	100

Course Pre requisite :

- ETC 502: Analog communication
- ETC 601: Digital Communication
- ETC 604: Computer Communication and Networks

Course Objectives:

- To focus on Internet protocol, standards, services and administration.
- To discuss voice over IP as a real-time interactive audio/video service.

Course Outcomes: The students will be able to:

- Implement local area networks using both static and dynamic addressing techniques including sub netting.
- Install, configure, and troubleshoot server and client operating systems.
- Disassemble, troubleshoot/debug, upgrade, replace basic components, and reassemble servers and client systems.
- Explain the concept of encapsulation and its relationship to layering in the network models.
- Explain how TCP's byte-stream sliding window is related to a traditional packet-based sliding window algorithm.
- 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.

Module No.		Topics	Hrs.
1.		**Review of TCP /IP:**	**06**
	1.1	TCP /IP networking model, layer functions.	
	1.2	TCP/IP protocols, services, sockets and ports, encapsulations, difference between ISO and Internet layering.	
2		**Application Layer:**	**08**
	2.1	Host configuration, DHCP	
	2.2	Domain Name System (DNS), remote Login, TELNET and SSH	
	2.3	FTP and TFTP, World Wide Web, HTTP, electronic mail, SMTP, POP, IMAP, and MIME	
3		**Transport Layer:**	**12**
	3.1	User datagram protocol(UDP) header fields and their functions, pseudo header	
	3.2	Transmission control protocol (TCP), need for stream delivery, properties of reliable stream delivery, TCP header fields, ports, connections, end points, passive and active open, segment, stream and sequence numbers, variable window size and flow control.	
	3.3	Out of band data, checksum, acknowledgement and retransmission, round trip samples	
	3.4	Karn's algorithm, timer back off, response to delay variation and congestion, TCP state machine, connection establishment	
4		**Internetworking layer:**	**08**
	4.1	Internet protocol (IP) datagram, header fields and their functions	
	4.2	Internet control message protocol, IP address classes, broadcast, multicast and special addresses, network space and host space, subnets and supernets	
	4.3	Private IP addresses, classless inter domain routing (CIDR), CIDR subnet addressing, variable length in CIDR subnet addressing	
5.		**Voice Communication**	**04**
	5.1	Digitizing audio and video, audio compression, video compression	
6.		**Real-Time Interactive Audio and Video**	**16**
	6.1	Characteristics, RTP, RTP packet format	
	6.2	UDP port, RTCP, sender report, receiver report, source description message, bye message, application-specific message, UDP port	
	6.3	SIP,H.323	
	6.4	Flow characteristics, flow classes, techniques to improve QOS, resource reservation, admission control	
Total			**52**

Recommended Books:

1. B. Forouzan, "*TCP/IP Protocol Suite*", 4th Edition, McGraw-Hill Publication
2. Leon Garcia, "*Communication Networks*", 2nd Edition McGraw-Hill Publication
3. Kurose and Ross, "*Computer Networking*", 5th Edition Pearson Publication
4. Ted Wallingford, "*Switching to VoIP*", Oreilly Publication

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETE801	Speech Processing	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETE801	Speech Processing	20	20	20	80	-	-	-	100

Course Pre-Requisites:

- ETC405 Signals and Systems
- ETC602 Discrete Time Signal Processing

Course Objective:

- To introduce the models of speech production and acoustic phonetics
- To teach time and frequency domain techniques for estimating speech parameters
- To teach predictive techniques for speech coding
- To introduce speech recognition and speech synthesis applications

Course Outcomes: Students will be able to:

- Demonstrate basic knowledge in speech production mechanism, phoneme classification, digital models for speech production, Homomorphic speech processing and LPC analysis
- Demonstrate applications of signal processing theory for estimation of speech parameters in time and frequency domain including pitch and formants
- Analyze application of speech processing in speech compression, speech recognition, and speech synthesis
- Enhance their written and oral technical communication skills related to speech processing subject and will be better prepared for higher study and lifelong learning

Module No.		Topics	Hrs.
1.		**Speech Production, Acoustic Phonetics and Auditory Perception**	**10**
	1.1	Anatomy and physiology of speech organs, articulatory phonetics, acoustic phonetics, acoustic theory of speech production, discrete time model for speech production	
	1.2	Ear physiology and psychoacoustics	
2		**Speech Analysis in Time Domain**	**06**
	2.1	Time energy, average magnitude, and zero-crossing rate, speech vs silence discrimination	
	2.1	Short-time autocorrelation, pitch period estimation using short-time autocorrelation, median smoothing	
3		**Speech Analysis in Frequency Domain:**	**06**
	3.1	Time dependent Fourier representation for voiced and unvoiced speech signals, linear filtering interpretation, spectrographic displays	
	3.2	Pitch period estimation based on FFT and harmonic peak detection method, estimation of formants using log spectrum	
4		**Homomorphic Speech Processing**	**08**
	4.1	Cepstral analysis of speech, mel frequency cepstral coefficients (MFCC), perceptual linear prediction (PLP)	
	4.2	Pitch period estimation in cepstral domain, evaluation of formants using cepstrum	
5		**LPC and Parametric Speech Coding**	**12**
	5.1	Review of lattice structure realization, forward and backward error filters, normal equations & its solutions, levinson-durbin algorithm, covariance method, Berg's algorithm	
	5.2	Channel Vocoders, linear prediction (LP) based vocoders, residual excited LP (RELP) based Vocoders, voice Excited LP (VELP) based vocoders, multi-pulse LP (MPLP) based vocoders, code excited LP (CELP) based vocoders	
6		**Speech Processing Applications**	**10**
	6.1	Speech recognition systems, deterministic sequence recognition for ASR, statistical sequence recognition for ASR (Hidden Markov Model (HMM))	
	6.2	Text to speech system (TTS), concatenative synthesis, synthesis using formants, LPC synthesizer	
		Total	**52**

Recommended Books:

1. Rabiner and Schafer, "*Digital Processing of Speech Signals*", Pearson Education, Delhi, 2004.
2. Shaila D. Apte, "*Speech and Audio Processing*", Wiley India, New Delhi, 2012.
3. Douglas O'Shaughnessy, "*Speech Communications: Human & Machine*", Universities Press, Hyderabad, Second Edition, 2001.
4. Ben Gold and Nelson Morgan, "*Speech and Audio Signal Processing*", Wiley India (P) Ltd, New Delhi, 2006.
5. Thomas F. Quatieri, "*Discrete-Time Speech Signal Processing: Principles and Practice*", Prentice Hall, 2001.
6. J. L. Flanagan, "*Speech Analysis Synthesis and Perception*", Second edition, Springer-Verlag (1972).

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETE802	**Telecom Network Management**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETE802	**Telecom Network Management**	20	20	20	80	-	-	-	100

Prerequisite: ETC 603: Computer Communication and Networks

Course Objective:

- To familiarize the student with the design, analysis operation and management of modern data communications networks.
- To provide the student with a working knowledge of the types of communications network management systems and their strengths and limitations in solving various information network management problems.

Course Outcomes: The students will be able to:

- Demonstrate broad knowledge of fundamental principles and technical standards underlying
- Understand basic of telecommunication, networking and information technologies.
- Architect and implement networked informative systems.
- Continuously improve their technology knowledge and communication skills.
- Anticipate the way technological change and emerging technologies might alter the assumptions underlying architectures and systems.

Module No.		Topics	Hrs
1.		**Overview of Network Management**	06
	1.1	Case histories on network, system and service management, challenges of IT managers	
	1.2	Network Management: Goals, organization and functions	
	1.3	Network management architecture and organization network management perspectives	
2		**OSI Network Management**	08
	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		**Internet Management (SNMP)**	13
	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	Remote monitoring. RMON	
4		**Broadband Network Management**	10
	4.1	Broadband networks and services, ATM Technology – VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN	
	4.2	ATM Network Management – ATM network reference model, integrated local management interface. ATM management information base, role of SNMP and ILMI in ATM management.	
	4.3	M1, M2, M3, M4 interface. ATM digital exchange interface management	
5		**Network Management Applications**	08
	5.1	Configuration management.	
	5.2	Fault management	
	5.3	Performance management	
	5.4	Event correlation techniques	
	5.5	Security management	
	5.6	Accounting management, report management, policy based management services	
	5.7	Level management	
6		**Telecommunication Management Networks(TMN)**	07
	6.1	Need for TMN	
	6.2	Conceptual model	
	6.3	TMN standards	
	6.4	TMN management services architecture and TMN implementation	
		Total	**52**

Recommended Books:

1. Mani Subramaniam, "*Network Management Principles and Practise*", Addison Wisely, New York, 2000.
2. Lakshmi G. Raman, " *Fundamental of Telecommunications Network Management*" Eastern Economy Edition, IEEE Press New Delhi.
3. Salh Aiidarons, Thomas Plevoyak "*Telecommunications Network Technologies and implementations*" Eastern Economy Edition, IEEE press New Delhi-1998.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETE803	Microwave Integrated Circuit	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETE803	Microwave Integrated Circuit	20	20	20	80	-	-	-	100

Course pre requisite:

- ETC 403: Wave Theory and Propagation
- ETC 504: RF Modeling and Antennas
- ETC 704: Microwave and Radar Engineering
-

Course Objective:

- To understand the integration of microwave devices in the form of IC.
- To understand the basic principles and advanced applications of Microwave Engineering,
- To design different amplifier, oscillator and mixers for various applications.

Course outcome: The students will be able to

- Design and implement the microwave layouts.
- Design and implement the microwave amplifier, oscillator, and mixer circuits.

Module No.		Topics	Hrs.
1.		**Hybrid MICs And Monolithic MICs**	**08**
	1.1	Definition, characteristics, comparison with conventional circuits, field of application and limitations and criteria for the choice of substrate material in HMICS and MMICS.	
	1.2	Thin film hybrid circuits, thick film hybrid circuits, art work, masking, photolithography, resistor stabilization, sawing, brazing process, wire bonding.	
	1.3	Monolithic MICs: Doping by ion implantation, Ohmic contacts, metal resistive layers, gate metal, dielectric and air-bridge vias, wafer process steps.	
2		**Micro Strip Lines**	**08**
	2.1	Planar wave guides, non-tem propagation, line impedance definitions, quasi-static approximations, quasi-static line parameters.	
	2.2	Micro strip open circuits and gaps, micro strip corners, step change in width.	
	2.3	Dispersion analysis, micro strip characteristic impedance, symmetric t junction, green's functions, millimeter wave modeling of micro strip lines.	
3		**Coupled Line Propagation**	**10**
	3.1	Coupled line propagation: wave equations for coupled lines, propagation models, coupled line parameters, coupled line parameter variations with frequency, directional couplings, lange coupler, coupled line pair operated as a four port.	
	3.2	Coplanar wave guides: design considerations and coplanar line circuits.	
4		**Microwave Amplifier Design**	**12**
	4.1	Introduction, derivation of transducer power gain, stability, power gains, voltage gains, and current gains, single-stage transistor amplifier design.	
	4.2	Power amplifier design: device modeling and characteristics, optimum loading.	
	4.3	Single-stage power amplifier design and multi-stage design.	
	4.4	Power distributed amplifiers. class of operation, power amplifier stability, amplifier linearization methods.	
5		**Microwave Oscillator Design**	**08**
	5.1	Introduction, compressed smith chart, series of parallel resonance, resonators, two-port oscillator design, negative resistance from transistor model, oscillator q and output power.	
	5.2	Noise in oscillators: linear approach, analytical approach to optimum oscillator design using s parameters, nonlinear active models for oscillators.	
	5.3	Microwave oscillator performance, design of an oscillator using large single y parameters, example for large single design based on bessel functions, design examples for best phase noise and good output power.	
6		**Microwave Mixer Design**	**06**
	6.1	Introduction, diode mixer theory, single-diode, single-balanced and double-balanced mixers.	
	6.2	FET mixer theory, balanced FET mixers, special mixer circuits, mixer noise.	
		Total	**52**

Recommended Books:

1. D. H. Schrader, "*Microstrip Circuit Analysis*", Prentice Hall PTR, New Jersey.
2. D. M. Pozar, "*Microwave Engineering*", John Wiley & Sons Publication, 2013.
3. K. C. Gupta, R. Garg, and I. J. Bahl, "*Microstrip Lines and Slot Lines*", Artech House.
4. M. M. Radmanesh, "*Radio Frequency and Microwave Electronics*", Pearson Education, 2006.
5. D. Vendelin, A. M. Pavio, and U. L. Rohde, "*Microwave Circuit Design*", John Wiley & Sons Publication.
6. Sweet, "*MIC and MMIC Amplifier and Oscillator Design*", 1990 Edition, Artech House.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2to 5 marks will be asked.
4. Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETE804	**Ultra Wide Band Communication**	**04**	**--**	**--**	**04**		**--**	**04**

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETE804	**Ultra Wide Band Communication**	**20**	**20**	**20**	**80**	**-**	**-**	**-**	**100**

Prerequisite: ETC 504: RF Modeling and Antennas.

Course Objective:
- To focuses on the basic techniques that concerns present and future dynamic UWB communication systems.
- To encompass all areas of design and implementation of UWB systems.
- To develop a comprehensive overview of UWB system design that spans propagation, transmit and receive antenna implementations, standards and advanced topics, modulation and multiple access, network issues, and applications.

Course Outcomes: Students will be able to;
- Understand nuances of planning and design of RF network
- Work professionally in the area of Antenna design and Radio Propagation.
- Apply the knowledge of mathematics and engineering to solve practical EM engineering problems.

Module No.		Topics	Hrs.
1.		**Introduction**	**10**
	1.1	UWB BASICS.	
	1.2	Regulatory bodies	
	1.3	UWB signals and systems with UWB waveforms	
	1.4	Power spectral density, Pulse shape, Pulse trains, Spectral masks	
	1.5	Multipath, penetration characteristics, spatial and spectral capacities – speed of data transmission	
	1.6	Gaussian waveforms, Designing waveforms for specific spectral masks.	
	1.7	Practical constraints and effects of imperfections.	
2		**Signal Processing Techniques For UWB Systems And UWB Channel Modeling**	**10**
	2.1	Effects of lossy medium on UWB transmitted signal	
	2.2	Time domain analysis, frequency domain analysis	
	2.3	Detection and Amplification,	
	2.4	Two ray UWB propagation model,	
	2.5	Frequency domain auto regressive model, IEEE proposals for UWB channel models	
3		**UWB Communications**	**05**
	3.1	UWB modulation methods, pulse trains	
	3.2	UWB transmitter/receiver	
	3.3	Multiple access techniques in UWB, capacity of UWB systems	
4		**Advanced UWB Pulse Generation**	**05**
	4.1	Comparison of UWB with other wideband communication systems	
	4.2	Interference and coexistence of UWB with other systems	
	4.3	Hermite pulses: orthogonal prolate spheroidal wave functions	
	4.4	Wavelet packets in UWB PSM	
	4.5	Applications of UWB communication systems	
5		**UWB Antennas and Arrays, Position and Location with UWB Signals**	**10**
	5.1	Antenna fundamentals: Antenna radiation for UWB signals	
	5.2	Conventional antennas and Impulse antennas for UWB systems	
	5.3	Beam forming for UWB signals: radar UWB array systems	
	5.4	Wireless positioning and location: GPS techniques, Positioning techniques time resolution issues, UWB positioning and communications	
6		**UWB Communication Standards and Systems**	**12**
	6.1	UWB standardization in wireless personal area networks	
	6.2	DS-UWB proposal, MB-OFDM UWB proposal: IEEE proposals for UWB channel models	
	6.3	UWB ad-hoc and sensor networks	
	6.4	MIMO and Space-time coding for UWB systems	
	6.5	Self-interference in high data-rate UWB communications, coexistence of DS-UWB with WIMAX	
		Total	**52**

Recommended Books:

1. M. Ghavami, L. B. Michael and R. Kohno, "*Ultra Wideband Signals and Systems In Communication Engineering*", 2nd Edition, John Wiley & Sons, NY, USA, 2007.
2. Jeffrey H. Reed, "*An Introduction To Ultra Wideband Communication Systems*", Prentice Hall Inc., NJ, USA, 2005.
3. Ian Oppermann, Matti Hamalainen and Jari Iinatti "*UWB Theory and Applications*", John Wiley & Sons Ltd, 2004

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL 801	Wireless Networks Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL801	Wireless Networks Laboratory	--	--	--	--	25	--	25	50

Term Work:
At least ten experiments covering entire syllabus of ETC 801: Wireless Network be set to have predefined inference and conclusion. Simulation based experiments are also encouraged. An attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment graded. The average of grades converted in to marks should be taken into account for term work assessment
Oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL 802	**Satellite Communication and Networks Laboratory**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL802	**Satellite Communication and Networks Laboratory**	--	--	--	--	25	--	25	50

Term Work:
At least ten experiments covering entire syllabus of ETC 802: Satellite Communication and Network be set to have predefined inference and conclusion. Simulation based experiments are also encouraged. An attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment graded. The average of grades converted in to marks should be taken into account for term work assessment.
Oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETL 803	**Internet and Voice Communication Laboratory**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL803	**Internet and Voice Communication Laboratory**	--	--	--	--	25	--	25	50

Term Work:
At least ten experiments covering entire syllabus of ETC 803: Internet and Voice Communication Laboratory be set to have predefined inference and conclusion. Simulation based experiments are also encouraged. An attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment graded. The average of grades converted in to marks should be taken into account for term work assessment
Oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETEL 80X	**Elective**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETEL 80X	**Elective**	--	--	--	--	25	--	25	50

Term Work:
At least ten experiments covering entire syllabus of respective Elective subject be set to have predefined inference and conclusion. Simulation based experiments are also encouraged. An attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment graded. The average of grades converted in to marks should be taken into account for term work assessment
Oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETP801	**Project (Stage II)**	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETP801	**Project (Stage II)**	--	--	--	--	50	-	50	100

Term Work:

The final year students have already under gone project assignment in their seventh semester and in this semester the students are expected to continue the project work of stage I.

The college should keep proper assessment record of the progress of project and at the end of the semester it should be assessed for awarding TW marks. The TW should be examined by approved internal faculty appointed by the head of the institute on the basis of following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Design, implementation, and analysis of the project work.
- Results, conclusions and future scope.
- Report in prescribed University format.

An approved external examiner and internal examiner appointed by the head of the institute together will assess during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained.

Chemical Engineering

Sr. No.	Subject Code	Subject Name	Count
1	CHL307	Chem. Engg. Lab (FF)	1
2	CHL308	Engineering Chemistry Lab I	1
3	CHL309	Computer Programming & Numerical Methods Lab	1
4	CHL407	Engineering Chemistry Lab II	1
5	CHL408	Chemical Engg Lab (SFMO)	1
6	CHL409	MED Lab	1
7	CHC506	Business Communication & Ethics	1
8	CHL507	Chemical Engg Lab (MTO-I)	1
9	CHL508	Chemical Engg Lab (CRE-I)	1
10	CHL509	Chemical Engg Lab (HTO-I)	1
11	CHL510	Chemical Engg Lab (Synthesis)	1
12	CHL607	Chemical Engg Lab (MTO-II)	1
13	CHL608	Chemical Engg Lab (CRE-II)	1
14	CHL609	Chemical Engg Lab (HTO-II)	1
15	CHL707	Chemical Engg Lab (PED)	1
16	CHL708	Chemical Engg Lab (PDC)	1
17	CHL807	Chemical Engineering Lab (EE)	1
18	CHL808	Chemical Engg Lab (MSO)	1
		Total	18

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Chemical Engineering (Second Year – Sem.III& IV), Revised course

(REV- 2012)from Academic Year 2012 -13,

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

From Dean'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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble to the Revision of Syllabus in Chemical Engineering

The Chemical Process Industry has undergone dramatic changes in the last few years both nationally and internationally. In fact these very boundaries are merging into one global market with international competence. Today Chemical Engineering is considered as Molecular Engineering which operates at various scales to bring about transformations in a wide variety of materials. Chemical Engineering is becoming inclusive of Bio-technology, Nanotechnology and Material Science like never before. The professional arena of a Chemical Engineer has expanded greatly to cater to sectors as wide as Pharmaceutical and Electronics in addition to the more traditional Oil & Gas and Petrochemical Industries.

Parallel to these developments, the growth and expansion of the World Wide Web offers new opportunities as well as new challenges. Today the latest research trends have become accessible from drawing rooms across the globe. This acts as a positive feedback mechanism in increasing the pace of research in all fields including Chemical Engineering and Bio-technology. There is also an incredible amount of content, in a variety of formats, available on the net. The availability of free software such as Scilab and COCO vastly expands our boundaries of learning.

Hence, an Under-graduate 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 sciences with problem solving abilities and communication skills. It must cultivate a willingness to face open-ended problems with inadequate data. 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 graduates to carry out research and develop products to meet rapidly changing needs and demands.

With this scenario as the backdrop, a full day conference was organized at D. J. Sanghvi College of Engineering on the 30th of January 2013. It was attended by the various heads of departments of chemical engineering as well as experts from industry. The program objectives and outcomes were thoroughly discussed in this meeting and the core structure of the syllabus was formulated. A second meeting was held in TSEC on 5th of March 2013 to decide the subject experts for the subjects of III and IV semesters.

Finally, a meeting of the Board of Studies in Chemical Engineering (Ad Hoc.) was conducted at the Fort Campus of the University of Mumbai, on the 20th of April 2013, where the final draft of the Core Structure and the detailed syllabus for semesters III and IV were approved.

Dr. Ramesh Vulavala

Chairman, Board of Studies in Chemical Engineering (Ad Hoc.)

University of Mumbai.

University of Mumbai
Scheme for SE: Semester-III

Teaching Scheme

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tutorial	Theory	Pract	Tut	Total
CHC301	Applied Mathematics-III	03	-	01	3.0	-	1.0	4.0
CHC302	Engineering Chemistry-I	04	-	-	4.0	-	-	4.0
CHC303	Fluid Flow (FF)	03	-	01	3.0	-	1.0	4.0
CHC304	Computer Programming & Numerical Methods	03	-	01	3.0	-	1.0	4.0
CHC305	Process Calculations	03	-	01	3.0	-	1.0	4.0
CHC306	Chemical Engineering Economics	03	-	01	3.0	-	1.0	4.0
CHL307	Chem. Engg. Lab (FF)	-	03	-	-	1.5	-	1.5
CHL308	Engineering Chemistry Lab I	-	03	-	-	1.5	-	1.5
CHL309	Computer Programming & Numerical Methods Lab	-	02	-	-	1.0	-	1.0
Total		19	08	05	19	4.0	5.0	28

Examination Scheme

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Average of Test 1 and Test 2					
CHC301	Applied Mathematics-III	20	20	20	80	25	-	-	125
CHC302	Engineering Chemistry-I	20	20	20	80	-	-	-	100
CHC303	Fluid Flow (FF)	20	20	20	80	25	-	-	125
CHC304	Computer Programming & Numerical Methods	20	20	20	80	25	-	-	125
CHC305	Process Calculations	20	20	20	80	25	-		125
CHC306	Chemical Engineering Economics	20	20	20	80	25	-	-	125
CHL307	Chem. Engg. Lab (FF)	-	-	-	-	-	25	-	25
CHL308	Engineering Chemistry Lab I	-	-	-	-	-	25	-	25
CHL309	Computer Programming & Numerical Methods Lab	-	-	-	-	-	25	-	25
Total				120	480	125	75	-	800

University of Mumbai

Scheme for SE: Semester-IV

Teaching Scheme

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tutorial	Theory	Pract	Tut	Total
CHC401	Applied Mathematics-IV	03	-	1.0	3.0	-	1.0	4.0
CHC402	Engineering Chemistry-II	04	-	-	4.0	-		4.0
CHC403	Chemical Engg. Thermodynamics - I	03	-	1.0	3.0	-	1.0	4.0
CHC404	Material Science &Engineering	03	-	1.0	3.0	-	1.0	4.0
CHC405	Mechanical Equipment Design (MED)	03	-	1.0	3.0	-	1.0	4.0
CHC406	Solid Fluid Mechanical Operations (SFMO)	03	-	1.0	3.0	-	1.0	4.0
CHL407	Engineering Chemistry Lab II	-	03	-	-	1.5	-	1.5
CHL408	Chemical Engg Lab (SFMO)	-	03	-	-	1.5	-	1.5
CHL409	MED Lab	-	02	-	-	1.0		1.0
Total		19	08	05	19	4.0	5.0	28

Examination Scheme

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Average of Test 1 and Test 2					
CHC401	Applied Mathematics-IV	20	20	20	80	25	-	-	125
CHC402	Engineering Chemistry-II	20	20	20	80	-	-	-	100
CHC403	Chemical Engg. Thermodynamics – I	20	20	20	80	25	-	-	125
CHC404	Material Science Engineering	20	20	20	80	25	-	-	125
CHC405	Mechanical Equipment Design (MED)	20	20	20	80	25	-	-	125
CHC406	Solid Fluid Mechanical Operations (SFMO)	20	20	20	80	25		-	125
CHL407	Engineering Chemistry Lab II	-	-	-	-	-	25	-	25
CHL408	Chemical Engg Lab (SFMO)	-	-	-	-	-	25	-	25
CHL409	M ED Lab	-	-	-	-	-	-	25	25
Total				120	480	125	50	25	800

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 work done over the entire semester.**
- It is suggested that each tutorial be graded immediately and an average be taken at the end.
- A minimum of ten tutorials will form the basis for final evaluation.

Theory Examination:

- In general all theory examinations will be of 3 hours duration.
- Theory examination for MED in semester IV will be of 4 hour 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& 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.
- 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.

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ANNEXURE -I
Program Structure for S.E. Chemical Engineering
Mumbai University

Semester III

Teaching Scheme

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tutorial	Theory	Pract	Tut	Total
CHC301	Applied Mathematics-III	03	-	01	3.0	-	1.0	4.0
CHC302	Engineering Chemistry-I	04	-	-	4.0	-	-	4.0
CHC303	Fluid Flow (FF)	03	-	01	3.0	-	1.0	4.0
CHC304	Computer Programming & Numerical Methods	03	-	01	3.0	-	1.0	4.0
CHC305	Process Calculations	03	-	01	3.0	-	1.0	4.0
CHC306	Chemical Engineering Economics	03	-	01	3.0	-	1.0	4.0
CHL307	Chem. Engg. Lab (FF)	-	03	-	-	1.5	-	1.5
CHL308	Engineering Chemistry Lab I	-	03	-	-	1.5	-	1.5
CHL309	Computer Programming & Numerical Methods Lab	-	02	-	-	1.0	-	1.0
Total		19	08	05	19	4.0	5.0	28

Examination Scheme

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Average of Test 1 and Test 2					
CHC301	Applied Mathematics-III	20	20	20	80	25	-	-	125
CHC302	Engineering Chemistry-I	20	20	20	80	-	-	-	100
CHC303	Fluid Flow (FF)	20	20	20	80	25	-	-	125
CHC304	Computer Programming & Numerical Methods	20	20	20	80	25	-	-	125
CHC305	Process Calculations	20	20	20	80	25	-		125
CHC306	Chemical Engineering Economics	20	20	20	80	25	-	-	125
CHL307	Chem. Engg. Lab (FF)	-	-	-	-	-	25	-	25
CHL308	Engineering Chemistry Lab I	-	-	-	-	-	25	-	25
CHL309	Computer Programming & Numerical Methods Lab	-	-	-	-	-	25	-	25
Total				120	480	125	75	-	800

Course Code	Course/Subject Name	Credits
CHC301	**Applied Mathematics III**	**4**

Prerequisites:

- 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.
- Complex integration and applications of the residue theorem.
- 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	No. of Hrs.
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 eigen spaces of 2x2 and 3x3 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 - v are given; Milne-Thomson method; cross-ratio (no proofs); conformal mappings; images of straight lines and	07

	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

References:

- Mathematical Methods in Chemical Engineering, V.G. Jenson and G.V. Jeffrey's, Academic Press, 1970.
- Laplace transforms, Murray Spiegel, Schaum's Outline Series, 1974
- Complex variables, Murray Spiegel, Schaum's Outline Series, 1964
- Linear Algebra, Murray Spiegel, Schaum's Outline Series, 1964
- Advanced Engineering Mathematics by *Erwin Kreyszig*, 9TH Edition, Wiley India.

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.
- Knowledge of Inductive effect, Mesomeric effect, Resonance, Tautomerism, Hyperconjugation and bond cleavage to form reactive species. Knowledge of substitution reaction.

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 learn the basic areas in chemistry like different theories of chemical bonding, organometallic chemistry, mechanism and application of aromatic substitution, elimination reactions and the orientation of functional groups.
- Students will also be capable of defining the different basic terms related to electrochemistry, spectroscopic methods, different analytical techniques and the application of surfactants.
- Students will be aware of the significance of active methylene group during organic synthesis and the importance of catalyst. Moreover, on the basis of Huckel's rule, students will be able to differentiate between aromatic and non-aromatic compounds.
- Students will be able to carry out organic estimations, gravimetric analysis and handle different instruments in the laboratory.

Module No.	Contents	No. of Hours
1	**Basic Concepts of Chemistry and Molecular Structures** • Hydrogen bonding, Valence bond-Theory, Molecular orbital theory, Non-bonding and anti-bonding orbitals, LCAO method, VSEPR theory .Structure of BF_3, PCl_3, PCl_5 and SF_4. Molecular orbital structures of homonuclear and heteronuclear molecules H_2, BF_2, B_2, C_2, N_2, O_2, F_2, CO, HF, NO_2, metallic bond.	8
2	**Co-ordination chemistry** • Co-ordination number or ligancy, Complex ion, Co-ordination dative bond complex ions. Theories of coordination compounds such as Werner's Co-ordination theory, Valence bond-Theory, Crystal field theory (CFT), Ligand field theory. Effective Atomic Number (EAN). Nomenclature and isomerism (Only Geometrical and Structural) in co-ordination compounds with respect to co-ordination number 4 and 6. Application of CFT to tetrahedral and octahedral complexes, drawbacks of CFT, MOT as applied to octahedral complexes of Fe, Measurement of CFSE (10Dq), Numericals based on EAN and 10Dq measurement, Applications of coordination compounds.	10
3	**Organometallic compounds and Bio-inorganic chemistry** • Chemistry of Fe-carbonyls with respect to preparation, properties, structure and bonding. Biochemistry of proteins containing Cu, Fe and Zn chemistry of cytochromes and their application, O_2 atom transfer reactions of biomolecules containing Fe.	07
4	**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.	07
5	**Reactive intermediates** • Reactive intermediates • Carbocation, carbanion, carbon free radicals and carbenes – their formation, structure & stability. • Name reactions with mechanism w.r.t. each reactive intermediate. Carbocation – Pinacol - Pinacolone reaction. Carbanion – Michael reaction. Free radical - Wohl-Ziegler bromaination reaction. Carbene - Reimer-Tiemann reaction for aldehyde.	11
6	**Substitution reactions** A. Electrophilic substitution reactions. - In monocyclic aromatic compounds - Mechanism - Orientation influence - Friedel Craft alkylation B. Nucleohilic substitution reactions. - SN1 reaction with mechanism - SN2 reaction with mechanism C. Elimination reactions. - E1 reaction with mechanism - E2 reaction with mechanism	9

References:

- Advanced Inorganic Chemistry – J. D. Lee
- Vogels Textbook of Practical organic chemistry.
- Spectroscopy - Kalsi
- A textbook of Physical Chemistry - Glasston Samuel, Macmillan India Ltd. (1991)
- Organic Chemistry - I L Finar volume I and II.

Course Code	Course/Subject Name	Credits
CHC303	Fluid Flow	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 understand basic principles and equations of fluid flow.
- 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. for incompressible and compressible fluids.
- They can select pumps and valves and would be able to calculate power requirement for pumping as well as agitation operations.

Module .No.	Contents	No. of Hours
1	**Introduction and Basic Concepts:** • Scope and Applications of fluid flow • Properties of fluids such as Density, viscosity, surface tension, capillarity effect, vapor pressure, compressibility factor, Enthalpy, Entropy.	**2**
2	**Pressure and Fluid Statics:** • Fluid Pressure at a Point, • Pascal's Law, • Pressure Variation in a fluid at rest. • Measurement of Pressure • Manometer. • Peizometer U-Table Manometer • Single Column manometer • U – Tube differential manometer • Inverted Differential U – tube manometer • Inclined manometer. • Hydrostatic Equilibrium	**4**
3	**Fluid Kinematics:** • Types of fluid flow namely steady and unsteady, Uniform and non-uniform, laminar and turbulent, compressible and incompressible,	**2**

	internal and external, one, two and three dimensional flow. • Concepts of Stream lines, stream tubes. Newton Law of Viscosity, Rheological behavior of fluid	
4	**Basic Equations of Fluid Flow** • Equation of Continuity, • Equation of motion: Euler's equation of motion, Bernoulli's equation from Euler's Equation. • Modified Bernoulli's equation.	**5**
5	**Practical Application of Bernoulli's Equation:** • Venturimeter: Horizontal and inclined. • Orificemeter, Pitot tube • Notches and Weirs: Introduction, classification, Derivation for V – notch.	**5**
6	**Flow through Circular Pipes:** • Shear – Stress, Distribution and velocity distribution for incompressible fluids in cylindrical tube • Relationship between Skin friction and wall shear, friction factor, Darcy's Weisbach equation • Reynolds experiment and Reynolds no., Formation of Boundary layer. **Laminar Flow through Pipes:** • Shear stress, velocity distribution, • Derivation of local velocity, maximum velocity, average velocity • Kinetic Energy Correction factor, Hagen – Poiseullie equation. **Turbulent Flow:** • Velocity distribution equations, Average velocity, local velocity, maximum velocity, kinetic energy correction factor.**Von Carman** equation and friction factors (No Numericals on universal velocity) • Equivalent diameter for circular and non circular ducts. • Pipes in series and Parallel. • Losses due to different fittings, sudden expansion etc.	**9**
7	**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. **Flow past immersed bodies:** • Drag forces, Coefficient of drag, Terminal settling velocity, Stoke's Law. Capillary viscometer. **Power Consumption in Agitation:** • Power curves, Power No., types of impellers.	**6**
8	**Pumps and Valves:** • Classification and types, Centrifugal pumps, Introduction, main parts, Work done, Power required, Definitions of heads and efficiency, NPSH, Priming, Cavitations characteristic curves. • Specific speed, minimum speed. **Reciprocating Pump :** • Classifications and working **General idea about Compressors, Fans and Blowers**. **Types of Valves** • Globe valves, Check valves, Gate valves, butterfly valves and non – return valves.	**6**

References:

- Warren L. Mccabe, Julian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, McGraw Hill International Edition.
- Coulson J. M., Richardson J. F., Backhurst J. R. and J. H. Harker, Chemical Engineering, Vol. 1
- Fluid Mechanics and Hydraulics by Suresh Ukarande , Ane Books, 2012.
- Introduction to Fluid Mechanics, 7th edition, Robbert W. Fox, Philip J. Pritchard, Alan T. McDonald, WILEY, India Edition.
- Fluid Mechanics Fundamentals and Applications, Yunus A. Cengel, John M. Cimbala, Adapted by S. Bhattacharya, The McGraw Hill Companies.
- Fluid Mechanics and Hydraulic Machines, Dr. R. K. Bansal, Laxmi Publications Pvt. Ltd.

Course Code	Course/Subject Name	Credits
CHC304	**Computer Programming and 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.
- The students will be able make plots of their results.

Module	Contents	No. of hrs
1	• Introduction to Scilab. • Handling vectors and matrices in Scilab. • Program control using For , While and Do loops. • Decision making with If and Case structures.	05
2	• Solution of algebraic and transcendental equations. • RegulaFalsi Method. • Successive substitution. • Secant Method. • Newtons Method one and two simultaneous equations.	9
3	• Systems of linear equations. • Gauss-Seidel Method. • Gauss-Jordan Method.	05
4	• Ordinary differential equations. • Eulers explicit and implicit methods. • Runge-Kutta second and fourth order methods. • Adams-Bashforth formulas.	9
5	• Partial differential equations. • Method of lines. • Crank-Nicholson method. • Laplace equation. • Iterative methods. • Parabolic equations. Bender-Schmidt method.	9
6	• Difference Equations	02

References:

- Programming in ScilabByVinu V Das, New Age International Publishers
- Numerical Methods, M. K. Jain, S. R. K. Iyengar, and R. K. Jain
  Sixth Edition.New Age International Publishers, New Delhi, 2012.
- Numerical Methods for Engineers. By Santosh K. GuptaNew Age Publishers, Second Edition, 2010
- Introduction to Chemical Engineering Computing by Bruce A. FinlaysonWiley-International, 2005.

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	No. of hrs
1	• Introduction • Units And Dimensions Various systems of units, conversion of units from one system to other • Basic Chemical Calculations, Density, specific volume, specific gravity, Concentration & composition of mixtures and solutions. Density of gases & vapors using Ideal Gas law & Van der waals equation of state, Dalton’s law, Amagat,s law, concept of VLE, Raoult’s law, Henry’s law.	6
2	• Material Balance (For Unit Operations) • 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.	8
3	• Material Balance (for process involving Chemical Reaction)	9
4	• Recycle , Bypass and Purge Calculations (For Module 2 & 3)	3
5	• Calculations using Psychrometric chart; Humidity and saturation	3
6	• Energy Balance • Heat capacity, sensible heat, latent heat, calculation of enthalpy	10

	changes. • General energy balance equation; Energy balances for process involving chemical reaction including adiabatic reactions & combustion processes (Orsat Analysis & Net, Gross Calorific Value determination). Material and Energy Balance (Binary Distillation &Combustion)	

References:

- Stoichiometry- Bhatt , B. I. U., Vora S. M.: Tata McGraw Hill.
- Basic Principles & Calculations in Chemical Engineering- D. M. Himmelblau, Prentice Hall of India Pvt. Ltd.
- R. M. Felder, R. W. Rousseau, Elementary Principles of Chemical Processes; Jonn Wiley Sons, Inc, New York, 1978.

Course Code	Course/Subject Name	Credits
CHC306	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 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.

Module	Contents	No. of hrs
1	**Introduction to Basic Principles of Economics:** • 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**: • 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	**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 • Growth strategy- steady state and big – push growth strategy; balanced and unbalanced growth	**02**
4	**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 • Accumulation, inventory and cost-of-sales account • Material cost – Different Methods: current average, fifo, lifo	**03**
5	**Interests and Investment Costs:** • Importance of time value of money- Interest and Interest rate; • 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 Projects	**06**

6	**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	**03**
7	**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 (six tenth rule); Components of costs in FCI; • Methods of Cost Estimation • Estimation of Total Product Cost; • Break even Analysis	**10**
8	**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**

References:

- Peters, M. S. and Timmerhaus, K. D. , “Plant design and economics for chemical engineers”, latest edition, Mcgraw Hill, New York
- Pravin Kumar “Fundamentals of Engineering Economics” Wiley India.
- Kharbanda, O. P. and Stallworthy, E. A. “Capital cost estimating for process industries”, Butterworths, Londen
- K. K Dewett and Adarshchand, “ Modern Economic Theory”, latest edition, S Chand and Company
- O. P Khanna, “Industrial Engineering and Management” DhanpatRai Publications (P) Ltd.
- AtulSathe, ShubhadaKanchan, “Chemical Engineering Economics”, VipulPrakashan, Mumbai

Course Code	Course/Subject Name	Credits
CHL307	Chemical Engineering Lab (FF)	1.5

List of Experiments Suggested:

- Viscosity by Efflux time.
- Reynolds Apparatus.
- Bernoulli's apparatus
- Venturimeter
- Orificemeter
- Pitot tube
- V – Notch
- Friction through Circular pipe
- Flow through Annulus.
- Flow through Helical coil
- Pipe Fitting (Minor Losses)
- Centrifugal Pumps
- Power Consumption in agitated vessel
- Viscosity by Stoke's Law

Course Code	Course/Subject Name	Credits
CHL308	Engineering Chemistry-I Lab	1.5

List of Experiments Suggested:

Volumetric analysis:

Preparation of standard solutions and to find normality and deviation factor. [Any 3]

Titrimetric analysis:
- Analysis of talcum powder for Mg content by EDTA method
- Analysis of Aspirin as per I.P. or USP
- Determination of fluoride content in the toothpaste spectrophotometrically
- Estimation of CaO in cement
- Estiimation of Vitamin C using Ceric ammonium sulphate
- Estimation of Glycine by non aqueous titration using perchloricacid

Organic estimations
- Estimation of aniline
- Estimation of phenol
- Estimation of Acetamide

Gravimetric estimation of
- Barium as $BaCl_2$
- Tin as $SnCl_2$
- Nickel as Ni D.M.G.
- Zinc as $ZnSO_4$

Course Code	Course/Subject Name	Credits
CHL309	**Computer Programming and Numerical Methods Lab**	**1**

List of Experiments Suggested:

- Solving a single NLE by Successive Substitution.
- Solving a single NLE by Regula-Falsi method.
- Solving a single NLE by Newton's method.
- Solving a system of linear equations by Gauss Jordan method.
- Solving a system of linear equations by Gauss Seidel method.
- Solving an ODE by Euler's methods.
- Solving an ODE by RK methods.
- Solving an ODE by Adam-Bashforth method.
- Solving a PDE by Crank-Nicholson method.
- Solving a PDE by Bender-Schmidt method.

Semester IV

Teaching Scheme

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tutorial	Theory	Pract	Tut	Total
CHC401	Applied Mathematics-IV	03	-	1.0	3.0		1.0	4.0
CHC402	Engineering Chemistry-II	04		-	4.0			4.0
CHC403	Chemical Engg. Thermodynamics - I	03		1.0	3.0		1.0	4.0
CHC404	Material Science &Engineering	03		1.0	3.0		1.0	4.0
CHC405	Mechanical Equipment Design (MED)	03		1.0	3.0		1.0	4.0
CHC406	Solid Fluid Mechanical Operations (SFMO)	03		1.0	3.0		1.0	4.0
CHL407	Engineering Chemistry Lab II		03			1.5		1.5
CHL408	Chemical Engg Lab (SFMO)		03			1.5		1.5
CHL409	MED Lab		02			1.0		1.0
Total		19	08	05	19	4.0	5.0	28

Examination Scheme

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Average of Test 1 and Test 2					
CHC401	Applied Mathematics-IV	20	20	20	80	25	-	-	125
CHC402	Engineering Chemistry-II	20	20	20	80			-	100
CHC403	Chemical Engg. Thermodynamics - I	20	20	20	80	25			125
CHC404	Material Science Engineering	20	20	20	80	25			125
CHC405	Mechanical Equipment Design (MED)	20	20	20	80	25	-	-	125
CHC406	Solid Fluid Mechanical Operations (SFMO)	20	20	20	80	25		-	125
CHL407	Engineering Chemistry Lab II						25		25
CHL408	Chemical Engg Lab (SFMO)						25		25
CHL409	M ED Lab							25	25
Total				120	480	125	50	25	800

Course Code	Course/Subject Name	Credits
CHC401	Applied Mathematics-IV	04

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 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 problems coming across while studying higher level of Chemical Engineering .(Example: Flow of Liquid through Pipes/Gases etc.)

Module	Contents	No. of 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.	9
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. Gauss Divergence Theorem, Stokes' Theorem. (ONLY NUMERICAL PROBLEMS. NO PROOFS REQUIRED).	10

References:

- Advanced Engineering Mathematics by *Erwin Kreyszig*, 9^{TH} Edition, Wiley India.
- Schuam's outline series in Fourier series.
- Schuam's outline series in partial differential equations.
- Partial differential equations Vol 1 by Rutherford Aris.

Course Code	Course/Subject Name	Credits
CHC402	Engineering Chemistry – II	04

Prerequisites:

- Basic Concepts of Physical Chemistry and Titration Analysis.

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.
- To understand the effect of various parameters on catalytic reactions.

Course Outcomes:

- Students will understand the concepts of electrochemistry, chromatographic methods, different analytical techniques and the application of surfactants.
- Students will be aware of the significance of active methylene group during organic synthesis and the importance of catalyst. Moreover, on the basis of Huckel's rule, students will be able to differentiate between aromatic and non-aromatic compounds.
- Students will be able to carry out solvent extractions, optical methods and handle different instruments in the laboratory.

Module	Contents	No. of Hours
01	**Electrochemistry** • Conductance, specific conductance, equivalent conductance, molar conductance. Effect of dilution and temperature on conductance. Transport number.DebyeHuckel theory of strong electrolytes. Concentration cells with and without transference w.r.t. cations. Standard cells. Use of EMF measurement and other technique for determination of solubility product, hydrogen ion concentration.	8
02	**Instrumental methods of Analysis** • **Conductometry** Principle and types of titrations - Acid-base, precipitation and complexometric. • **Potentiometr**y: Principle and types of titrations - Acid-base, precipitation and complexometric. • **AmperometryPolarography:** Methods and applications. • **Chromatography** Adsorption and partition. Study of Paper Chromatography, Thin	10

	Layer Chromatography, High Performance Liquid Chromatography, Gas (Liquid and solid) Chromatography –Principle and their applications. • **Optical Methods** (Principle, Instrumentation and applications) UV, IR, NMR, GC-MS spectroscopy, flame photometry.	
03	• **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.	9
04	• **Colloids and surfactants** • Origin of charge on colloidal particles. Concept of electrical double layer. • Helmholtzand system models. Electro-kinetic Phenomenon-Electrophoresis, electro-osmosis, streaming potential and Dorn effect (Sedimentation potential). • Colloidal electrolytes, Donnam Membrane equilibrium Colloidal electrolytes. • Emulsions O/Wand W/O types, emulsifying agents, surfactants. • Applications of surfactants in detergents, pesticide formulations and food industry.	9
05	• **Industrially important esters and Aromaticity** • Synthesis and properties of malonic ester and aceto acetic ester • Aromaticity and aromatic character, Huckel's rule of aromaticity, Aromatic character of Benzene, Naphthalene, Anthracene,Pyrrole, Furan, Thiophene, Pyridine.	7
06	• **Catalysis** • Definition. Criteria of catalysis. Types (Homogeneous and Heterogeneous). • Catalytic promoters, poisons. Negative catalysis and inhibition. Autocatalysis and Induced catalysis. Activation energy and catalysis. Intermediate compound formation theory. Adsorption theory. Acid-Base catalysis and mechanism. Enzyme catalysis. Characteristics and mechanism of enzyme catalysis.	9

References:

- Organic Chemistry - I L Finar volume I and II
- Instrumental methods of Analysis - Willard, Merritt, CBS publishers and Distributors
- Instrumental Methods of Chemical Analysis -S.M.Khopkar
- A textbook of Physical Chemistry - Glasston Samuel, Macmillan India Ltd. (1991)
- Physical chemistry - Castellan G.W.Addison Hesly-Haroda Student Edition(1994)
- Inorganic chemistry - Huheey

Course Code	Course/Subject Name	Credits
CHC403	**Chemical Engineering Thermodynamics-I**	**04**

Prerequisites:
- Basic thermodynamic properties, laws and equations.
- Differential Equations, Linear Algebraic Equations.

Course Objectives:
- To make students familiar with the basics of Chemical Engineering Thermodynamics.
- To learn to apply 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	No. of hours
01	• Concept of System, Surrounding, Processes, Cycle, State and • Path function, heat and work interactions, reversible and irreversible processes • Concept of Internal Energy and Enthalpy • First Law of Thermodynamics • Application of First Law of Thermodynamics to various types of processes, reactive processes and cycles • Thermodynamic Analysis of Flow Processes	7
02	• 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 of reversible and irreversible processes and cycles. • Concept of Exergy and Exergy of Chemical Processes	8
03	• Ideal Gas and real gas behavior • Equation of States- Van der Waals, Berthelot, Redlich-Kwong, Soave Redlich Kwong, Virial and Peng Robinson. • Applications of above mentioned equations of states to pure fluids as well as to mixtures of gases	8
04	• Helmholtz Energy and Gibbs Energy. • Maxwell relations and various thermodynamic relations • Joule Thompson effects and estimation of Joule Thompson coefficient for gases.	8
05	• Residual Properties- Residual Enthalpy and Entropy • Thermodynamic Charts, Diagrams and their applications • Fugacity and fugacity coefficient	8

References:

- Stanley I Sandler, “Chemical and Engineering Thermodynamics”, John Wiley and Sons.
- Richard M Feldar, Ronald W Rousseau, “Elementary Principles of Chemical Processes”, Third Edition, Wiley publishers.
- Yunus A Cengel, Michael A Boles, “Thermodynamics- An Engineering Approach”, McGraw Hill.
- K.V Narayanan, “A textbook of Chemical Engineering Thermodynamics”, PHI learning.
- Rao Y.V.C, “Chemical Engineering Thermodynamics”, University Press.

Course Code	Course/Subject Name	Credits
CHC404	**Material Science & Engineering**	**4**

Prerequisites:

- Crystal Structures, X Ray Diffraction, Imperfections in Solids.
- Primary & Secondary Bonding, Types of Alloys, Corrosion & its types.

Course Objectives:

- To understand the basic fundamentals of Science behind Materials on atomic scale and in bulk materials.
- To find various types of Materials and analyze how properties change due to various effects.
- To apply the above knowledge for the selection of materials for process equipments.

Course Outcomes:

- Students would have knowledge about the existence of new materials and their properties.
- The students will be able to choose appropriate material for process equipments.

Module	Contents	No. of Hours
01	• Scope of Material Science & Engineering and its importance in Chemical Engineering Course • Introduction of Standard Model of an atom; Young's Double Slit Experiment for dual nature, Wave nature of electron, Heisenberg's Uncertainity Principle, De Broglie's Wavelength, Schrodinger's Wave Equation for 1-D Time Dependent.	7
02	• Introduction to Magnetic Materials, Influence of Temperature on Magnetic Behavior, Magnetic Storage, Superconductivity • Energy Band Structures in Solids, Electrical Conduction in Ionic Ceramics & in Polymers • Light Interaction with solids, Atomic & Electronic Interactions, Optical Properties of Metals, Optical Properties of Non Metals , Opacity & Translucency in Insulators like Glass	9
03	• Iron-Carbon System, Phase diagram for Iron-Carbon System, Cooling curve of Fe, Solid Phase Fe-Fe carbide phase diagram, Development of Microstructures in Iron-Carbon alloys • Deformation of Materials & Strengthening Mechanisms • Elastic Deformation, Plastic Deformation, Mechanisms of strengthening in Metals, Recovery, Recrystallization & Grain growth • Crystal Imperfections • Theories of Failure – Fatigue (cyclic stresses, S-N Curve, Crack Theory), Fracture (Types, Principles & Mechanisms) &	10

	Creep (Types)	
04	• Polymer alloys(Difference in properties with their parent polymers) & their applications (ABS- PS, PC-PET, SAN-EPDM, PET-PS), Plastics for Packaging for food, beverages, oil & Detergents • Composites (FRP in detail) • Graphite, Ceramics, Refractories, Clay	03
05	• Mechanism & Factors influencing Corrosion • Corrosion of Ceramic Materials • Degradation of Polymers	03
06	• Factors determining choice of Materials • MOC for Process Equipments • MOC for handling chemicals (in reactor, storage vessel and transportation) like Ammonium Chloride, Sulfuric Acid, Chlorine (Dry & Wet)	07

References:

- W. D. Callister, Fundamentls of Materials Science and Engineering, Wiley
- S.D.Dawande, Process Equipment Design, Denett& Co
- Beiser-Mahajan-Choudhary, Concepts of Modern Physics, McGrawHill
- Michael Ashby-Hugh Shercliff-David Cebon, Materials- Engineering, Science, Processing and Design, BH
- M.G.Fontana, Corrosion Engineering, Tata 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 a 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 No.	Contents	No. of Hrs.
1	Introduction to Chemical process Equipment Design: 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 stress due to compression, tension, bending, torsion& thermal stresses, Principal stress and theories of failure. Concept of hook's law, material behaviour and poison'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	4
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 <u>PART A: Pressure Vessel Subjected to Internal Pressure.</u> Complete design of cylindrical pressure vessel as per IS: 2825: 1969 Study, selection & design of various heads such as Flat, hemispherical, tori-spherical, elliptical & conical.	10

	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 Appendix F by use of charts. Analytical approach by elastic bucking & plastic deformation.	
3	Storage Vessels: 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	6
4	Agitators: Study of various types of agitators & their application, Baffling, Power requirement of agitators & their applications, system which includes design of shaft based on equivalent twisting moment, equivalent bending moment and critical speed. Design of blades & Blade assembly, key & key ways. Design of rigid flange coupling, Study of seals and design of stuffing box and gland	6
5	Reaction Vessels: Introduction, Classification of reaction vessels, Material of Construction, Heating system, Design of vessel, Study & design of various types of jackets like plain and half coil.	4
6	Vessel Supports: 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	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

References:

- Machine Drawing by N.D.Bhatt and V.M.Panchal, Charotar publication
- Process Equipment Design by M.V.Joshi and V.V.Mahajani, Macmilan India
- Process Equipment Design and Drawing by Kiran Ghadyalji,Nandu publication.
- Process Equipment Design- Vessel design by L.E.Brownell and E.H.Young,John Wiley
- Chemical Engineering Volume 6-Design by J.M.Coulson, J.F.Richardson and R.H.Sinnott,Pergamon Press.
- Pressure Vessel Handbook by Eugene F.Megyesy,Pressure vessel company

Course Code	Course/Subject Name	Credits
CHC406	**Solid Fluid Mechanical Operations**	**04**

Prerequisites

- Fluid Flow Operations
- Engineering Mechanics
- Differential Equations

Course Objectives

- Understanding basic principles of particle size measurement and distribution.
- Basic knowledge in particle technology (particle size, shape, specific surface).
- Ability to understand phenomena related to specific surface of particles.
- Understanding concepts of sedimentation, flow through packed bed, filtration.
- Ability to understand solid mixing and solid conveying.

Course Outcomes

- The student would understand the concept of particle size measurement and distribution.
- The student would understand the concept of hindered settling, sedimentation and particle mechanics.
- The student would understand the concept of solid mixing, solid storage and solid conveying.
- The student would understand the concept of filtration.

Module	Contents	No. of hours
01	• Introduction:-Scope & Application of Solid Fluid Operation. • Particle Size Analysis:-Particle Size Measurement & distribution. • Sieve Analysis Screening Equipments, Capacity & Effectiveness.	5
02	• Introduction to Size Reduction Equipments, • Their Selection & Power Requirement in Milling Operations.	5
03	• Storage & Conveying of Solids: - Introduction to Storage Solids, Bins, Hoppers & Silos. • Jensen's Equation. • Conveying of Solids: - Introduction to Conveying of Solids, Belt Conveyor, Bucket Conveyor, Pneumatic Conveyor &Elevators.	7
04	• Flow through Packed Beds:-Characteristics of Packing, Ergen's Equation, Flow of a single fluid through a packed bed, Problems of Channeling & Wetting. • Fluidization.: - Fluidization Characteristics, aggregative & particulate fluidization, Minimum Fluidization, Voidage& Minimum Fluidization Velocity, Voidage Correlation, Gas-Solid fluidization characteristics • Filtration:-Flow through Filter Cakes & Medium	9

	• Washing (Numerical), Const Rate & Pressure Filtration, Filter aids, Selection of filtration Equipment.	
05	• Particle Mechanics:-Motion of Particles in fluids, Effect of particle shape, Stokes Law, Hindered Settling. • Sedimentation: - Gravity Settling, Batch Sedimentation, Kynch Theory of Sedimentation. • Area & Depth of Thickener. • Particle Separation Based on motion of Particles through fluids:-Froth floatation & Elutriation.	9
06	• Mixing of Solids & Paste. • Gas-Solid Separation Equipment:-Fabric Filter, Cyclone Separator, Electrostatic precipitator	4

References:

- Unit Operations of Chemical Engineering, W C McCabe & J C Smith, McGraw Hill.
- Chemical Engineering, Vol. II, J M Coulson and J F Richardson, Pergamon press.
- Perry's Handbook for Chemical Engineers, Robert H. Perry & Don W. Green,8th edition, McGraw Hill.
- Unit Operations by Foust

Course Code	Course/Subject Name	Credits
CHL407	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].

- Spectro-photometry.
- Estimation of Fe^{3+} ions by Spectrophotometry.

- Organic Estimations.
- Estimation of Glucose Iodometrically.
- Estimation of Ester by Hydrolytis.
- Volume strength and amount of H_2O_2.

Course Code	Course/Subject Name	Credits
CHL408	Chemical Engineering Lab (SFMO)	1.5

List of Experiments Suggested:

- Sieve Analysis
- Effectiveness of Screen
- Size Reduction by Jaw Crusher
- Size Reduction by Hammer Mill
- Size Reduction by Ball Mill
- Batch Sedimentation
- Flow through Packed Bed
- Flow through Fluidized Bed
- Filtration
- Sigma Mixer

Course Code	Course/Subject Name	Credits
CHL409	MED Lab	1

List of Suggested Drawing Sheets

- Assembly and Detailed drawings of Machine elements like shafts, key and keyways, Fasteners, Types of welding technique and symbols.
- Assembly and Detailed drawings of Pressure vessel parts such as types of heads, Nozzle joints and flanged joints, mountings (Sight glass, Light glass, man hole etc)
- Assembly and Detailed fabrication drawings of complete pressure vessel and its parts to a recommended scale.
- Assembly and Detailed fabrication drawings of complete storage vessel and its parts to a recommended scale.
- Assembly and Detailed fabrication drawings of Agitator vessel and its parts like coupling and stuffing box to a recommended scale
- Assembly and Detailed fabrication drawings various types of reaction vessel to a recommended scale
- Assembly and Detailed fabrication drawings of various types supports to a recommended scale

AC 07/06/2014 Item no. 4.38

UNIVERSITY OF MUMBAI

Revised Syllabus
Program - **Bachelor of Engineering**
Course - **Chemical Engineering**
(Third year - Sem V and VI)

under
Faculty of Technology
(As per Credit Based Semester and Grading System from 2014-15)

From Deans 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 (PEOs) and give freedom to affiliated Institutes to add few (PEOs) 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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 3 – 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014- 2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble to the Revision of Syllabus in Chemical Engineering

The Chemical Process Industry has undergone dramatic changes in the last few years both nationally and internationally. In fact these very boundaries are merging into one global market with international competence. Today Chemical Engineering is considered as Molecular Engineering which operates at various scales to bring about transformations in a wide variety of materials. Chemical Engineering is becoming inclusive of Biotechnology, Nanotechnology and Material Science like never before. The professional arena of a Chemical Engineer has expanded greatly to cater to sectors as wide as Pharmaceutical and Electronics in addition to the more traditional Oil & Gas and Petrochemical Industries.

Parallel to these developments, the growth and expansion of the World Wide Web offers new opportunities as well as new challenges.Today the latest research trends have become accessible from drawing rooms across the globe. This acts as a positive feedback mechanism in increasing the pace of research in all fields including Chemical Engineering and Biotechnology. There is also an incredible amount of content, in a variety of formats, available on the net. The availability of free software such as Scilab and COCO vastly expands our boundaries of learning.

Hence, an Under-graduate 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 sciences with problem solving abilities and communication skills. It must cultivate a willingness to face open-ended problems with inadequate data. 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 graduates to carry out research and develop products to meet rapidly changing needs and demands.

With this scenario as the backdrop, a full day conference was organized at D. J. Sanghvi College of Engineering on the 30th of January 2013. It was attended by the various heads of departments of chemical engineering as well as experts from industry. The program objectives and outcomes were thoroughly discussed in this meeting and the core structure of the syllabus was formulated. A second meeting was held in TSEC on 5th of March 2013 to decide the subject experts for the subjects of III and IV semesters.

Finally, a meeting of the Board of Studies in Chemical Engineering (Ad Hoc.) was conducted at the Fort Campus of the University of Mumbai, on the 30th of April 2014, where the final draft of the Core Structure and the detailed syllabus for semesters V and VI were approved.

Dr. Ramesh Vulavala
Chairman, Board of Studies in Chemical Engineering (Ad Hoc.)
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 work done over the entire semester.
- It is suggested that each tutorial be graded immediately and an average be taken at the end.
- A minimum of ten (unless specified in course syllabus) tutorials will form the basis for final evaluation.

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(unless specified minimum requirement in syllabus).

University of Mumbai

Scheme for TE: Semester-V

Course Code	Course Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHC501	Chemical Engineering Thermodynamics - II	03	–	01	3.0	–	1.0	4.0
CHC502	Mass Transfer Operations - I (MTO-I)	03	–	01	3.0	–	1.0	4.0
CHC503	Heat Transfer Operations – I (HTO-I)	03	–	01	3.0	–	1.0	4.0
CHC504	Chemical Reaction Engineering - I (CRE-I)	03	–	01	3.0	–	1.0	4.0
CHC505	Chemical Technology	03	–	–	3.0	–	–	3.0
CHC506	Business Communication & Ethics	–	02* + 02	–	–	–	–	2.0
CHL507	Chemical Engg Lab (MTO-I)	–	03	–	–	1.5	–	1.5
CHL508	Chemical Engg Lab (CRE-I)	–	03	–	–	1.5	–	1.5
CHL509	Chemical Engg Lab (HTO-I)	–	03	–	–	1.5	–	1.5
CHL510	Chemical Engg Lab (Synthesis)	–	03	–	–	1.5	–	1.5
	Total	15	16	04	15.0	6.0	6.0	27.0

*Theory for entire class.

Examination Scheme

Course Code	Course Name	Examination Scheme							
		Theory marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
CHC501	Chemical Engineering Thermodynamics - II	20	20	20	80	25	–	–	125
CHC502	Mass Transfer Operations - I (MTO-I)	20	20	20	80	25	–	–	125
CHC503	Heat Transfer Operations – I (HTO-I)	20	20	20	80	25	–	–	125
CHC504	Chemical Reaction Engineering - I (CRE-I)	20	20	20	80	25	–	–	125
CHC505	Chemical Technology	20	20	20	80	–	–	–	100
CHC506	Business Communication & Ethics	–	–	–	–	50	–	–	50
CHL507	Chemical Engg Lab (MTO-I)	–	–	–	–	–	25	–	25
CHL508	Chemical Engg Lab (CRE-I)	–	–	–	–	–	25	–	25
CHL509	Chemical Engg Lab (HTO-I)	–	–	–	–	–	25	–	25
CHL510	Chemical Engg Lab (Synthesis)	–	–	–	–	–	–	25	25
			Total	100	400	100	75	75	750

Course Code	Course Name	Credits
CHC501	Chemical Engineering Thermodynamics - II	4.0

Prerequisites

Chemical Engineering Thermodynamics – I, Engineering Mathematics.

Course Objectives

The course objectives are

- The student should be able to relate thermodynamics to the Chemical Engineering Problems.
- The students should be able to use thermodynamics rules to find the equilibrium in phases.
- The students should be able to calculate and trace the equilibrium concentration and conversions of a reversible reaction.
- The students should be able to calculate the actual power required for given duty of refrigeration.

Course Outcomes

The student learn the application of First law and second law to the problem of phase equilibrium and reaction equilibrium . The students also learn to calculate the refrigerant flow rate for a given duty of refrigeration. This helps in estimating 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 equipment.

Detail syllabus

Module	Contents	No. of hrs
1	**Reaction Thermodynamics:** Calculation of heat of reaction for batch reactors, Calculation of heat of reaction for continuous reactors.	05
2	**Fundamentals of Phase Equilibria:** Concept of equilibrium in phases, The theory of ideal and non ideal solutions, Thermodynamic equations of Vapor Liquid Equilibrium for ideal and non ideal solutions, Liquid Liquid and Solid Liquid equilibria.	12
3	**Reaction Equilibria:** Representation of reaction stoichiometry, Concept of reaction equilibria, single and multiple reactions, Degrees of freedom for single and multiple reactions.	10
4	**Refrigeration:** Theory of refrigeration, Vapor Absorption Refrigeration, Vapor Absorption Refrigeration, Estimation of refrigerant flow rate and power of compression.	07
5	**Methods for estimation of Thermodynamics properties:** Estimation methods for critical parameters, Estimation method for Mixture Enthalpy and Entropy.	05

References

1. Stanley I. Sandler, Chemical, Biochemical, and Engineering Thermodynamics, 4 ed., Wiley Student Edition

2. M.J. Moran, H.N. Shapiro, Fundamentals of Engineering Thermodynamics, 6 ed., Wiley Student Edition

3. Peter Atkins, Physical Chemistry, 9 ed., Oxford University Press.

Note for the teacher/instructors: The teachers should encourage the student to use computer for solving problems. It would be worth mentioning that Microsoft Excel suffices for solving most of the problems in the syllabus. A total of twelve assignments and tutorials together should be given to the students at regular intervals. Students should be encouraged to submit assignment using word processor and as far as possible they should be allowed to submit it online in some form. As far as possible it should be multiple choice questions for problem based in mid term tests.

Course Code	Course Name	Credits
CHC502	Mass Transfer Operations - I (MTO-I)	4.0

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.

Detail syllabus

Module	Contents	No. of hrs
1	**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, Equimolal counter diffusion of two components. Molecular Diffusion in binary liquid solutions – Steady state diffusion of one component in non-diffusing second component, Steady State Equimolal 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	08
2	**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.	08

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Module	Contents	No. of hrs
3	**Equipments for Gas-Liquid Contacting:** Classification of equipments for gas-liquid contacting • 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.	06
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	06
6	**Humidification and Dehumidification:** Introduction, Vapour Pressure Curve, Properties of Vapour-Gas mixtures [Understanding various terms], Theory of wet bulb temperature, Adiabatic Saturation Curves,Humidity Charts, Adiabatic operation : (Air water systems) water coolers, cooling towers	06

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 New York 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.Sinnot (Ed) Coulson and Richardson chemical engineering, vol 6, Butterworth Heinman, New Delhi, 2000.

Course Code	Course Name	Credits
CHC503	Heat Transfer Operations – I (HTO-I)	4.0

Prerequisites

Laws of thermodynamics, Units and dimensions, Fluid flow principles, Solution techniques of ordinary and partial differential equations.

Course Objectives

- Students should be able to calculate rate of heat transfer by all three modes of heat transfer.
- Understand the basic principles involved in mechanism and calculation of heat transfer rates.
- Able to deal with most common types of unsteady state operations of heat transfer.
- Should become familiar with equipments, used for heat transfer in industry.

Course Outcomes

Upon completion of this course the learners will be acquainted to process design concept of heat transfer equipments and prepared for heat transfer equipment design study.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction:** 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	02
2	**Steady state conduction:** Fourier's Law, thermal conductivity, conduction through a flat slab, composite slab, conduction through a cylinder, composite cylinder, conduction through sphere, composite sphere. Critical radius of insulation. Concept of thermal resistance, fouling factors, Wilson plot, calculation of overall heat transfer coefficients.	05
3	**Unsteady state conduction:** Lumped Parameter Analysis -systems with negligible internal resistance. Biot number, Fourier number, Heating a body under conditions of negligible surface resistance,, heating a body with finite surface and internal resistance, heat transfer to a semi-infinite wall.	04
4	**Heat transfer by 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 correlations for internal and external flows, equivalent diameter for heat transfer, estimation of wall temperature, correlations for heat transfer by natural convection from hot surfaces of different geometries and inclination.	07

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Module	Contents	No. of hrs
5	**Heat transfer in condensation and boiling:** 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.	05
6	**Steam:** Properties of steam. Steam generation by utilizing process waste heat, efficient use of steam in plant.	04
7	**Heat transfer through extended surfaces:** longitudinal, transverse and radial fins, calculations with different boundary conditions, efficiency and effectiveness of fin, calculation of rate of heat transfer.	03
8	**Heat Exchangers:** Classification and types of heat exchangers, Double pipe heat exchanger, calculation of LMTD, effectiveness NTU method. Introduction to Shell and Tube Heat Exchanger. heat transfer in agitated vessel	05
9	**Radiation heat transfer:** Emissivity, absorptivity, black body, grey body, opaque body, Stephan Boltzmann law, Kirchoff's law. Equations for rate of heat transfer by radiation for various cases. Basic unsteady state radiation heat transfer.	04

References

1. D. Q. Kern, Process Heat Transfer, McGraw Hill, 1997.
2. Incropera Frank P., Dewitt David P., Bergman T. L., Lavine A. S., Seetharamu K. N., Seetharam T. R., Fundamentals of Heat and Mass Transfer, Wiley, 2014.
3. Holman, J. P., Heat Transfer, 9 ed., McGraw Hill, 2008.
4. R. K. Sinnott, Coulson & Richordsons Chemical Engineering Design, Vol. 6, Elsevier Butterworth-Heinemann.
5. J. M. Coulson and J. F. Richardson with J. R. Backhurst and J. H. Harker, Coulson & Richordsons Chemical Engineering Design, Vol. 1 & 2, Elsevier Butterworth-Heinemann, 1996.
6. W. D. Seider, J. D. Seader, D. R. Lewin, Product & Process Design Principles Synthesis, Analysis and Evaluation, John Wiley and Sons, Inc.
7. Robert W. Serth, Process Heat Transfer: Principles and Applications, Elsevier Science & Technology Books.
8. John H. Lienhard IV, John H. Lienhard V, A Heat Transfer Textbook, Phlogiston Press.
9. McCabe W.L., Smith J.C., Harriot P., Unit Oerations of Chemical Engineering, 5th ed., McGraw Hill, 1993

Course Code	Course Name	Credits
CHC504	Chemical Reaction Engineering - I (CRE-I)	4.0

Prerequisites

Students should know basic Chemistry pertaining to Chemical Reactions, Chemical formula etc. They are required to be aware of Chemical processes 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

- Development of Kinetic model for homogeneous reactions giving emphasis on various types of reactions like reversible, irreversible, 1st order, 2nd order reactions, series parallel reactions, homogeneous catalytic reactions, autocatalytic reactions, reactions in adiabatic or non isothermal conditions.
- Development of design strategy for homogeneous reactions considering different types of reactors for example batch reactors, flow reactors, semi batch reactors, recycle reactors etc.Reactor design for reactions operating under adiabatic or non-isothermal conditions.

Course Outcomes

Students will be able to apply the knowledge they have gained to find the model equation and use this model to design the reactors used for homogeneous reactions taking place in isothermal or non isothermal conditions.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction and reaction kinetics of homogeneous systems:** Various types of reactions: Reversible Vs irreversible reactions. Homogeneous Vs heterogeneous reactions. Catalytic Vs non-catalytic reactions. Single vs multiple reactions. Auto catalytic reactions, Rate of reaction, Rate constants, Order/ molecularity. Formulation and solution of rate equations for batch reactors for simple and complex reactions. Effect of thermodynamic equilibrium. Temperature dependency-Various Theories. Reaction mechanism and it influence on kinetics, search for plausible mechanism via reaction kinetics	09
2	**Methods of analysis of experimental data:** For Constant volume & variable volume batch reactor – Integral method of analysis of experimental data, Differential method of analysis. Concept of half-life /fractional life. Over all order of irreversible reactions (initial rate method). Empirical rate equation for nth order reactions. Analysis of complete rate of reactions. Partial analysis of rate of reaction. Reversible and irreversible reactions in parallel Reversible and irreversible reaction in series. Homogeneous catalysed reactions. Auto Catalytic reactions. Shifting order reactions	09

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Module	Contents	No. of hrs
3	**Design of reactor:** 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. Recycle reactor and auto catalytic reactor. 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:** Heat of reaction and its variation with temperature. Variation of equilibrium constant and equilibrium conversion with temperature. Effect of temperature on reactor performance for adiabatic and non adiabatic operations. Case of exothermic reactions in mixed reactor. Optimum temperature progression. Multiple reactions- effect on product distribution. Temperature and scale effect on productivity of reactor. Various problems based on design of non-isothermal reactor are to be solved by using various numerical methods.	09

References

1. Levenspiel, O.,Chemical Reaction Engineering, 3 ed., John Wiley & Co.
2. Smith J.M., Chemical Engineering Kinetics, McGraw Hill.
3. Laidler, K.J., Chemical Kinetics, Tata McGraw Hill, 1997.
4. Hill C.G., Chemical Reaction Engineering.
5. Walas, Reaction Kinetics for Chemical Engineers, McGraw Hill.
6. Sharma M.M & L.K Doraiswamy, Heterogeneous Reactions, Vol 1
7. Fogler, H.S., Elements of Chemical Reaction Engineering, 4 ed.,PHI, 2008.

Course Code	Course Name	Credits
CHC505	Chemical Technology	3.0

Prerequisites

Knowledge of chemistry, physics, physical chemistry and mathematics. Knowledge of Unit Operations and Unit Processes. Knowledge of material balance and energy balance

Course Objectives

- To give students insight of different chemical processes.
- To understand development of process from its chemistry.
- To understand different engineering problems in process industry.

Course Outcomes

At the end of the course student will be able to :

- demonstrate various manufacturing processes,
- explain industrial processing and overall performance of any chemical process,
- find out the overall process aspects including yield, waste etc.,
- draw and illustrate the process flow diagram.

Detail syllabus

Module	Contents	No. of hrs
1	Introduction: Unit Operations and Processes Concept Used in Chemical Industries. General principles applied in studying an industry, phases of development of chemical industries in India. An overview on industries such as: vegetable oils & animal fats, natural waxes / resins, essential oils & Flavour ingredients Industry, Food & Agro-Products An overview of other industrially important products: Paints, Varnishes & lacquers, Soaps & Detergents, Dyes & Intermediates, Agrochemicals, Pharmaceuticals: Penicillin.	07
2	Manufacturing of Acids: Sulphuric Acid (DCDA Process), Nitric Acid, Acetic Acid & Phosphoric Acid (WET Process), Manufacturing of Fertilizers: Ammonia, Urea, Superphosphate (SSP, TSP) & Ammonium Sulphate	08
3	Sugar, starch & alcohol industries. Introduction to biodiesel processing. Chloro-Alkali Industries: Manufacturing of Caustic Soda, Hydrochloric Acid and Hydrogen, Soda Ash (Solvay and Dual Process).	07
4	Synthesis of Important Heavy Organic Chemicals and Intermediates : Styrene , Phenol, Purified Terephthalic acid.	07
5	Synthesis of Polymers: Polyethylene: LDPE, LLDPE and HDPE; Polyster Fibre, Nylon and PVC.	06

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Module	Contents	No. of hrs
6	Basic Building Blocks of Petrochemical Industry: Treatment of Crude oils and the products there from; refining vs. cracking; manufacture of Acetylene, Ethylene, Benzene Toluene, Xylene.	05

References

1. Austin, G. T., Shreve's Chemical Process Industries, 5 Ed., McGraw Hill International Edition.
2. Pandey, G. N., A text book of Chemical Technology, Vol. I and II., Vikas Publications, 1984
3. Rao, G. N. and Sittig, M. Drydens outlines of Chemical Technology for 21st Century, East West Press, 3rd edition
4. Heaton, C. A., An introduction to industrial chemistry, Leonard Hill, 1984
5. Thomson, R., Moden inorganic chemicals industries, Royal Society of chemistry, 2nd ed., 1994
6. Kirk-Other's, Encyclopedia of chemical technology, John Wiley and sons Inc., 4th ed. 1990
7. Ullmanns Encyclopedia of Industrial Chemistry, VCH, 1985
8. McKettas Encyclopedia of chemical processing and design, Marcel Dekker, 1999
9. Pletcher, D. and Walsh, F. C., Industrial Electro-chemistry, Chapman & Hall, 1990
10. Alok Adholeya and Pradeepkumar Dadhich, Production and Technology of Biodiesel: seeding a change, TERI Publication, New Delhi, 2008
11. 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 Name	Credits
CHC506	Business Communication & Ethics	2.0

Course Objectives

- To inculcate in students professional and ethical attitude, effective communication skills, teamwork, skills, 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 provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.

Course Outcomes

A learner will be able to

- Communicate effectively in both verbal and written form and demonstrate knowledge of professional and ethical responsibilities,
- participate and succeed in Campus placements and competitive examinations like GATE, CET,
- 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.

Detail syllabus

Module	Contents	No. of hrs
1	Report Writing: Objectives of report writing Language and Style in a report Types of reports Formats of reports: Memo, letter, project and survey based	7
2	Technical Proposals Objective of technical proposals Parts of proposal	2
3	Introduction to Interpersonal Skills Emotional Intelligence Leadership Team Buliding Assertiveness Conflict Resolution Negotiation Skills Motivation Time Management	7
4	Meetings and Documentation Strategies for conducting effective meetings Notice Agenda Minutes of the meeting	2
5	Introduction to Corporate Ethics and etiquettes Business Meeting etiquettes, Interview etiquettes, Professional and work etiquettes, Social skills Greetings and Art of Conversation Dressing and Grooming Dinning etiquette Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions)	2
6	Employment Skills Cover letter Resume Group Discussion Presentation Skills Interview Skills	6

References

1. Fred Luthans, Organizational Behavior , Mc Graw Hill, edition
2. Lesiker and Petit, Report Writing for Business , Mc Graw 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. R.C Sharma and Krishna Mohan, Business Correspondence and Report Writing,
7. B N Ghosh, 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. K. Alex ,Soft Skills, S Chand and Company
11. Dr.KAlex,SoftSkills,S Chand and Company
12. R.Subramaniam, Professional Ethics Oxford University Press 2013.

Course Code	Course Name	Credits
CHL507	Chemical Engg Lab (MTO-I)	1.5

Concept for experiments

The laboratory work shall consist of a record of minimum eight experiments performed during the term. The design of experiments should cover all concepts (such as Mass transfer coefficient, Gas liquid contacts, Absorption, Drying, Humidification etc.) mentioned in the syllabus. Each and every experiment should conclusively demonstrate / verify the theory. The students should be able to explain variations (if any) between observed and expected results based on technical knowledge. Each experimental report should contain a discussion of the results obtained.

Course Code	Course Name	Credits
CHL508	Chemical Engg Lab (CRE-I)	1.5

Concept for experiments

Minimum 8 experiments need to be performed by the students on following concepts.

- Effect of concentration and temperature on reaction rate.
- Batch reactor.
- Arrhenius constants.
- Differential and integral analysis.
- Acidic hydrolysis.
- Condensation polymerisation kinetics.
- Constant flow stirred tank reactor (CSTR).
- Plug flow reactor (PFR).
- CSTRs connected in series.
- PFR-CSTR combination in series.

Course Code	Course Name	Credits
CHL509	Chemical Engg Lab (HTO-I)	1.5

Concept for experiments

Minimum seven practical including experiments on conduction, unsteady state conduction, forced and natural convection, condensation, heat exchangers should be done. These can include any additional experiment based on the syllabus.

Course Code	Course Name	Credits
CHL510	Chemical Engg Lab (Synthesis)	1.5

Concept for experiments

Concept for experiments to be designed by instructor is students should developed an approach towards engineering a chemical process. Some of the suggested processes are Preparation of a soap, detergent, paper, polymer products, pharmaceutical products, membrane, nano-particles, dye, rubber, biochemical, biodiesel, food product, oil.

examples of few lab prepared chemicals along with raw materials can be

Sr. No.	PREPARETION	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 Büchner funnel; filter paper ;graduated cylinder
2	ALUM FROM ALUMINUM	Aluminum can or aluminum metal, Crushed ice, 9M H_2SO_4, 1.5M KOH solution, Methanol, $NaHCO_3$ (sodium bicarbonate)	Glass filter funnel, Büchner 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, five drops of 85% phosphoric acid, distilled water	burette clamp, burner, stand with iron ring, wire gauze, ice bath,50 ml flask beaker, Büchner 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 flask, filter,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 water	Two paper cups (5 ounce), stirring rod (popsicle stick or equivalent), small bucket or large beaker (1000 ml or larger)

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Sr. No.	PREPARETION	Chemicals required	Apparatus/ glassware required
7	p-BROMO-NITROBENEZENE FROM BROMOBENEZENE	Conc. H_2SO_4, conc. HNO_3, bromobenzene, ethyl alcohol, conical flask, funnel, filter 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 flask, 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

University of Mumbai

Scheme for TE: Semester-VI

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHC601	Instrumentation	03	–	01	3.0	–	1.0	4.0
CHC602	Mass Transfer Operations – II (MTO-II)	03	–	01	3.0	–	1.0	4.0
CHC603	Heat Transfer Operations – II (HTO-II)	03	–	01	3.0	–	1.0	4.0
CHC604	Chemical Reaction Engineering – II (CRE-II)	03	–	01	3.0	–	1.0	4.0
CHC605	Plant Engineering	04	–	–	4.0	–	–	4.0
CHE606	Elective – I	04	–	–	4.0	–	–	4.0
CHL607	Chemical Engg Lab (MTO-II)	–	03	–	–	1.5	–	1.5
CHL608	Chemical Engg Lab (CRE-II)	–	03	–	–	1.5	–	1.5
CHL609	Chemical Engg Lab (HTO-II)	–	02	–	–	1.0	–	1.0
	Total	20	08	04	20.0	4.0	4.0	28.0

Examination Scheme

Subject Code	Subject Name	Examination Scheme							
		Theory marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
CHC601	Instrumentation	20	20	20	80	25	–	–	125
CHC602	Mass Transfer Operations – II (MTO-II)	20	20	20	80	25	–	–	125
CHC603	Heat Transfer Operations – II (HTO-II)	20	20	20	80	25	–	–	125
CHC604	Chemical Reaction Engineering – II (CRE-II)	20	20	20	80	25	–	–	125
CHC605	Plant Engineering	20	20	20	80	–	–	–	100
CHE606	Elective – I	20	20	20	80	–	–	–	100
CHL607	Chemical Engg Lab (MTO-II)	–	–	–	–	–	25	25	50
CHL608	Chemical Engg Lab (CRE-II)	–	–	–	–	–	25	–	25
CHL609	Chemical Engg Lab (HTO-II)	–	–	–	–	–	25	–	25
			Total	120	480	100	75	25	800

Elective Streams(CHE606)

Sem.	Management Stream	Technology Stream	Process System Engineering Stream
VI	Operations Research	Advanced Material	Computational Fluid Dynamics

Course Code	Course Name	Credits
CHC601	Instrumentation	4.0

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

Detail syllabus

Module	Contents	No. of hrs
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, Differential 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

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Module	Contents	No. of hrs
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 De-pressurization, Introduction to SIL Classification, LOPA Methods, Basic Process Control Schemes.	10

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 Name	Credits
CHC602	Mass Transfer Operations – II (MTO-II)	4.0

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.

Course Outcomes

At the end of the course student will be able to :

- understand equilibrium in all separation process
- describe the mass transfer equipments
- design distillation column
- choose choose the separation operation which will be economical for the process
- optimize the process parameters
- understand membrane separation processes principle and working

Detail syllabus

Module	Contents	No. of hrs
1	**Distillation:** Introduction to Distillation, Vapor-liquid Equilibria – 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 and without reflux], Equipments for liquid-liquid extraction.	06

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Module	Contents	No. of hrs
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, Ion Exchange Equilibria, Ion Exchange Equipments	06
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 Ls law of crystal growth, Material and energy balance for crystallizers, Crystallization equipment-description.	04
6	**Membrane separation Technique:** Need of membrane separation and its advantages, classification of membrane separation process, Various membrane configurations. Various membrane and their applications, Ultra filtration, Nano filtration. Reverse osmosis, Pervaporation. Membrane distillation.	06

Note:

Minimum one assignment on each module should be given at regular intervals. The term work assessment will be based on quality of assignments, attendance in the theory class / tutorials, performance, punctuality and orals at the time of submission.

References

1. Treybal R.E., Mass transfer operation, 3rd ed., McGraw Hill New York, 1980.
2. McCabe W.L. and Smith J.C., Unit operation in chemical engineering, 5th ed., McGraw Hill New York 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, Butterworth Heinman, New Delhi, 2000.
5. Coulson J.M. Richardson J.F. Backhurst J.R.and Harker J.H. Coulson and Richardosn chemical engineering, vol 2, Asian book pvt ltd, New Delhi, 2000.
6. R.K.Sinnot (Ed) Coulson and Richardson chemical engineering, vol 6, Butterworth Heinman, New Delhi, 2000.

Course Code	Course Name	Credits
CHC603	Heat Transfer Operations – II (HTO-II)	4.0

Prerequisites

Mathematics, Heat Transfer Operations – I.

Course Objectives

Student should able to design shell and tube heat exchangers - condenser, reboilers, evaporators, etc. Student should able to design furnace. Students should know how heat exchanger design software work.

Course Outcomes

Detail syllabus

Module	Contents	No. of hrs
1	**Shell and Tube Heat Exchanger Design for Liquids:** TEMA standards, Stream Analysis Method, Bell-Delaware method. Effect of fouling, and over-design.	12
2	**Plate type heat exchangers(PHE):** Design methods, gasket selection, limitations and advantages PHE	06
3	**Condensers:** Shell and tube condensers – horizontal, vertical. Barometric condensers. Effect of non-condensible. Engineering problems and troubleshooting.	06
4	**Reboiler:** Design – Kettle type reboiler, horizontal thermosyphon reboiler, vertical thermosyphon reboiler. Engineering problems and trouble shooting.	06
5	**Furnace Design:** Radiant section, convection section. Box type furnace. Methods of Lobo and Evans. Method of Wilson, Lobo and Hottel.	08
6	Introduction to Heat exchanger design using softwares e.g. HETRAN, HTRI, TEAMS, etc	02

Note:

It is suggested to arrange tutorials along with practicals of subject code CHL609 to facilitate design and simulations of different exchangers. Students need to take one mini project which should include full scale design of Shell and tube heat exchanger for different process conditions. Minimum six tutorials should be considered for term work.

References

1. Serth, Robert W., Process Heat Transfer Principles and Applications, Elsevier Science & Technology Books, 2007.

2. Kern, D. Q., Process Heat Transfer, McGraw Hill, 1965.

3. Holman, J.P., Heat Transfer, McGraw Hill, 6th Ed., 1986.
4. Standards of Tubular Exchanger Manufacturers Association (TEMA), 8th Ed., New York, 1999.
5. R.K.Sinnot (Ed) Coulson and Richardson chemical engineering, vol 6, Butterworth Heinman, New Delhi, 2000.
6. Bell, K. J., Muller, A.C., Wolverine Engineering Data Book -II, Wolverine Tube Inc., 2001.
7. Rajiv Mukherjee, Effectively Design Shell-and-Tube Heat Exchangers, Chemical Engineering Progress, February 1998.
8. James O. Maloney (Ed), Perry's Chemical Engineers Handbook, Section 11, 8th Ed., McGraw Hill, 2008.
9. Gas Processors Suppliers Association, Engineering Data Book, Section 8 & 9, 12th Ed.,Oklahoma,s 2004.

Course Code	Course Name	Credits
CHC604	Chemical Reaction Engineering – II (CRE-II)	4.0

Prerequisites

Students should know basic Chemistry pertaining to Chemical Reactions, Chemical formula etc. They are required to be aware of Chemical processes 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

- Development of Kinetic model for Heterogeneous reactions giving emphasis on various types of reactions like non catalytic, catalytic, liquid liquid reaction, liquid gas reactions in isothermal, adiabatic or non isothermal conditions.
- Development of design strategy for Heterogeneous reactions considering different types of reactors for example fixed bed tubular reactor, fluidized bed reactor, packed bed reactors etc.Reactor design for reactions operating under isothermal, adiabatic or non-isothermal conditions.
- Studying the real reactors considering residence time distribution in various reactors and obtaining actual design parameters.

Course Outcomes

Students will be able to apply the knowledge they have gained to find the model equation and use this model to design the reactors used for heterogeneous reactions taking place in isothermal or non isothermal conditions.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction:** Kinetics and mechanism of various Heterogeneous reactions and design consideration of reactors used during different operating conditions. **Catalytic heterogeneous reactions:** Properties of solid catalysts, Physical adsorption and Chemisorption, Surface area and pore size distribution, Langmuir-Hinshelwood model, General mechanism of solid catalysed fluid phase reactions. Special cases when (a) Film resistance controls. (b) Surface phenomenon controls. (c) Surface reaction controls (d) Pore diffusion controls. Intrinsic kinetics and various cases of adsorption and reaction stage controls. Concept of effectiveness factor of catalyst and its dependence on catalyst properties and kinetic parameters.	09

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Module	Contents	No. of hrs
2	**Design of solid catalysed fluid phase reactors:** Phenomenon observed in operation of packed, fluid bed, slurry and such reactors. Product distribution in multiple and complex reaction. Thermal Effects, phenomena of stability, instability and run away and its analysis. Strategies for stable operation of reactors. Design consideration of fluid-solid catalytic reactors, including Fluid bed reactors.	03
3	**Non-Catalytic heterogeneous reactions:** General mechanism of reaction.,Various models. Specific cases with respect:(a) Film diffusion controlling. (b) Ash diffusion controlling. (c) Chemical reaction controlling. **Design of reactors for non-catalytic reactors:** Experimental reactors for heterogeneous Reactions, Non-Catalytic Fluid Solid Reactions in Flow Reactors, Application to design of continues solid flow reactors; various design considerations, Application of fluid bed reactors and their design consideration, heat transfer effects.	12
4	**Kinetics of fluid-fluid reactions:** Reaction with mass transfer, The rate equation pertaining to fast to very slow reactions. **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.	09
5	**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 – Tank in series model and Dispersion Model, Recycle Model. Multi parameter models, 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.	06

References

1. Smith J. M., Chemical Reaction Engineering, 3 ed., Tata McGraw Hill, 1980.
2. Levenspiel O., Chemical Reaction Engineering, John Wiley & Sons, 3 ed., 1999.
3. Laidler, K.J., Chemical Kinetics, Tata McGraw Hill, 1997.
4. Hill C.G., Chemical Reaction Engineering.
5. Walas, Reaction Kinetics for Chemical Engineers, Mcgraw Hill, 1959.
6. Fogler, H.S. Elements of Chemical Reaction Engineering, 4 ed.,PHI, 2008.

7. Doraiswamy & Sharma, Heterogeneous Reaction, Vol. 1 & 2, John Wiley, 1984.
8. Walas, Chemical Reaction Engineering – Hand Book of Solved problems, Gordon & Breach, 1995

Course Code	Course Name	Credits
CHC605	Plant Engineering	4.0

Prerequisites

Knowledge of Process Calculations, Thermodynamics and Fluid flow.

Course Objectives

- At the end of the course the students should understand the knowledge of industrial safety, plant utilities and statistical analysis of results.
- They should able to understand industrial accidents and hygiene, hazards and risk analysis.
- They should 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 humidification and dehumidification operations.
- They should be able to understand the Principles of refrigeration, study different refrigeration systems and refrigerants and their importance.
- They should understand how to select vacuum system and to carry out various operations under vacuum, and knowledge of various types of vents and flares.
- They should learn about statistical analysis of experimental results.

Course Outcomes

- Students will demonstrate the knowledge of industrial safety, utilities and statistical analysis.
- Students will know different types industrial accident, industrial hygiene and risk analysis.
- Students will know how to make efficient use of steam and boilers in chemical industries.
- Students will have deep knowledge of working various compressors and humidification and dehumidification operations.
- Students will be able to find refrigeration effect for different refrigeration systems.
- Students will have knowledge of vacuum systems and vacuum operations, venting and flaring.
- Students will be able carry out statistical analysis of experimental results.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction to safety:** Introduction, safety programs. **Accidents:** Nature of accidents, process of accidents. **Industrial hygiene:** Phases of industrial hygiene projects.Material safety data sheet. **Fire:** Fire triangle, Flammability characteristics of liquids and gases,Minimum oxygen concentration, Ignition energy, Autoignition, Autoxidation, Adiabatic compression, Ignition sources, Sprays and mists, Prevention methods. **Explosion:** Detoriation, Deflagration, Confined explosion, VCE, BLEVE, Blast damage, Missile damage, Prevention methods.	06

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Module	Contents	No. of hrs
2	**Relief systems, Hazards and risk assessment:** **Relief:** Concept, Location of relief, Types, Relief systems. Deflagration venting for dust and vapour explosion. Venting for fires. **Hazards identification:** Hazards Check-list, Hazards Surveys, HAZOP, HAZON. **Risk assessment:** Event trees, Fault trees. Accident investigation: Accident investigation process, AIDS for diagnosis, recommendations.	06
3	**Steam generators:** Steam generators,classification of boilers, boiler mountings and accessories. Performance of steam generators. Distribution of steam in plant. Efficient use of steam.	09
4	**Air:** Compressed air from blower, compressor. Air drying system for instrument air and plant air. Humidification and dehumidification of air.	08
5	**Refrigeration:** Principles of refrigeration. Refrigeration system like compression refrigeration, absorption refrigeration, chilled water system, air conditioning. Types of refrigerants and their importance.	08
6	**Vacuum systems, Venting and flaring:** Different types of vacuum systems. Types of vents and flares.	08
7	**Statistical analysis of results:** Data tabulation and graphical representation. Standard deviation and standard error. Degree of freedom. Analysis of variance (ANOVA).Linear regression analysis.	07

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. Ashoutosh Panday; Plant Utilities; Vipul Prakashan, Mumbai
5. Kothari, C. R. and Garg, Gaurav (2014). Research Methodology: Methods and Techniques, Third edition, New age international publishers, New Dehli.

Course Code	Course Name	Credits
CHE606	Elective – I : Operations Research	4.0

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.

Detail syllabus

Module	Contents	No. of hrs
1	**Linear Programming:** Introduction, Graphical Method of Solution, Simplex, Two-Phase Method, Duality, Dual Simplex, Revised Simplex, Sensitivity Analysis	10
2	**Transportation Models:** Examples of Transportation Models, The Transportation Algorithm, The Assignment Model, The Transshipment Model	06
3	**Network Models:** Scope and Definition of Network Models, Minimal Spanning Tree Algorithm, Shortest Route Problem, Maximal Flow Model, CPM and PERT, Minimum-Cost Capacitated Flow Problem	10
4	**Integer and Dynamic Programming:** Branch and Bound Method, Travelling Salesman Problem, Introduction to Dynamic Programming, Forward and Backward Recursion, Selected Applications,	06
5	**Deterministic Inventory Models:** Classic EOQ Model, EOQ with Price Breaks, Multi-item EOQ with Storage Limitation, Dynamic EOQ Models, No-Setup Model, Setup Model	06

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Module	Contents	No. of hrs
6	**Decision Analysis and Game Theory:** Decision Making under Certainty, Decision Making under Risk Decision Under Uncertainty, Game Theory	06
7	**Queuing Systems:** Elements of a Queuing Model, Role of Exponential Distribution, Pure Birth and Death Models, Generalized Poisson Queuing Model, Measures of Performance	06

References

1. Hamdy A. Taha, Operations Research, 8 Ed., Prentice Hall India.
2. Thomas Edgar, Optimization of Chemical Processes, David M.Himmelbleau,2 Ed., John Wiley.

Course Code	Course/Subject Name	Credits
CHE606	Elective – I: Advanced Material	4.0

Prerequisites

Mechanical, Electrical, Magnetic and Optical behaviour of material Iron- Carbon system and alloy, deformation and failure in metals Polymer alloys, ceramics, FRP composites polymer and their Properties Corrosion and choice of materials

Course Objectives

To understand various advanced material such as conducting polymer, high temperature polymer, stainless steel material, composites, ceramics etc. To understand properties and engineering applications of above material. To understand fabrication methods of above materials.

Course Outcomes

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. Student will have knowledge of different types of composite material, their properties and application Understand the fabrication of various composite material. Student will have knowledge of types of nanotube and nanosensor their application. Understand the thin film coating methods and their application in various fields.

Detail syllabus

Module	Contents	No. of hrs
1	**Advanced Metallic Material**: Stainless steels: Types, properties of stainless steel, corrosion resistance and selection of stainless steel, failure of stainless steel. High Temperature Alloys: Properties and types. Titanium Alloys and Cobalt - Chromium Alloys: composition, properties and applications, Nitinol as Shape memory alloy and its application	07
2	**Advanced Polymeric Material:** Structure, preparation and application of various conducting polymers, high temperature polymers and liquid crystal polymers, Biomedical application of polymers such as hydrogels, polyethylene, polyurethanes, polyamides and silicone rubber.	05
3	**Ceramic Material:** Properties of ceramic material, classification of ceramic material, ceramic crystal structures. Behaviour of ceramic material: dielectric, semiconductor, ferroelectric, magnetic, mechanical behaviour, Preparation and application of ceramic material: Alumina, partially stabilized zirconia, Sialon, Silicon Nitride, Silica Carbide Processing of ceramics.	06

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Module	Contents	No. of hrs
4	**Composite Materials:** Necessity of composite material, classification of composite material, types of matrix and reinforcement, Reinforcement mechanism, choosing material for matrix and reinforcement **Fiber Reinforcement Plastic Processing:** Open moulding and closed moulding, Carbon Composites: fabrication and properties	07
5	**Metal Composites:** Advantages of metal composite over metal, types of reinforcement and matrix fabrication types, various fabrication process, mechanical behavior and properties **Ceramic Composites:** matrices and reinforcement, mechanical properties, fabrication methods.	08
6	**Carbon Nanotube**: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, hardfacing, thermal spraying, diffusion process, useful material for appearance, corrosion and wear.	06

References

1. B. K. Agrawal, Introduction to Engineering Material, Tata McGraw Hill Education Pvt. Ltd, 2012.
2. A. K Bhargava, Engineering Material: Polymer, Ceramic and Composites, PHI learning Pvt. Ltd, 2010.
3. Dr. H K Shivanand, B.V. Babu Kiran, Composite Material, Asian Books Private Limited, 2010.
4. T. Pradeep, Nano: The Essential, Tata McGraw Hill Education Pvt. Ltd, 2010.
5. William Smith, Structure and Properties of Engineering Alloy, 2nd Edition, McGraw Hill International Book.
6. William Smith, Javad Hasemi, 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 & Tumber S.R., Polymer of high Technology, Electronic and Photonics, ACS symposium series, ACS , 1987
9. Dyson R.W., Engineering. Polymers, Chapman and Hall, First Edition, 1990
10. Chawala K.K., Composites materials, science and Engineering, 3rd Edition
11. Sujata V. Bhat, Biomaterial, Narosa Publication Pvt. Ltd.

Course Code	Course/Subject Name	Credits
CHE606	Elective – I: Computational Fluid Dynamics	4.0

Prerequisites

Linear Algerbra, Partial Differential Equations, Scilab

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.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction:** Advantages of Computational Fluid Dynamics, Typical Practical Applications,Equation Structure, Overview of CFD	02
2	**Preliminary Computational Techniques:** Discretisation, Approximation to Derivatives, Accuracy of the Discretisation Process, Wave Representation, Finite Difference Method	04
3	**Theoretical Background:** Convergence, Consistency, Stability, Solution Accuracy, Computational Efficiency	06
4	**Weighted Residual Methods:** General Formulation, Finite Volume Method, Finite Element Method and Interpolation, Finite Element Method and the Sturm-Liouville Equation	08
5	**Steady Problems:** Nonlinear Steady Problems, Newtons Method, Direct Linear Method, Thomas Algorithm	06
6	**One-dimensional Diffusion Equation:** Explicit Methods, Implicit Methods, Boundary and Initial Conditions, Method of Lines	08
7	**Multidimensional Diffusion Equation:** Two-Dimensional Diffusion Equation, Multidimensional Splitting Schemes, Splitting Schemes and the Finite Element Method, Neumann Boundary Conditions	08

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Module	Contents	No. of hrs
8	**Linear Convection-Dominated Problems:** One-Dimensional Linear Convection Equation, Numerical Dissipation and Dispersion, Steady Convection-Diffusion Equation, One-Dimensional Transport Equation, Two-Dimensional Transport Equation	10

References

1. C.A.J. Fletcher, Computational Techniques for Fluid Dynamics 1, Springer-Verlag Berlin Heidelberg GmbH.

2. John D. Anderson, Computational Fluid Dynamics, McGraw Hill Education Private Limited.

Course Code	Course Name	Credits
CHL607	Chemical Engg Lab (MTO-II)	1.5

Concept for experiments

The laboratory work shall consist of a record of minimum eight experiments performed during the term.The design of experiments should cover all concepts (such as Distillation, liquid-liquid extraction, Adsorption, leaching, Crysatllisation & Membarne separation etc) mentioned in the syllabus. Each and every experiment should conclusively demostrate / verify the theory.

The students should be able to explain variations (if any) between observed and expected results based on technical knowledge. Each experimental report should contain a discussion of the results obtained.

Course Code	Course Name	Credits
CHL608	Chemical Engg Lab (CRE-II)	1.5

Concept for experiments

Minimum 8 experiments need to be performed by the students on following concepts.

- Void Volume, Porosity & Solid density of catalyst particle.
- Solid fluid Heterogeneous non-catalytic reaction.
- RTD study in CSTR.
- RTD study in packed column.
- RTD study in PFR.
- Semi-batch reactor
- Adiabatic batch reactor.
- Heterogeneous catalytic esterification reaction between alcohol and acetic acid using acid catalyst.

Course Code	Course Name	Credits
CHL609	Chemical Engg Lab (HTO-II)	1.0

Concept for experiments

Experiments should be based on Design and simulation of Shell and Tube heat exchangers like liquid-liquid and gas-liquid heat exchange without phase change, condensers, reboilers, etc. Minimum six simulations need to be performed using simulators like HETRAN/HTRI/TEAMS, etc.

AC 26/02/2015 Item no. 4.62

UNIVERSITY OF MUMBAI

Revised Syllabus
Program – **Bachelor of Engineering**
Course – **Chemical Engineering**
(Final Year – Sem VII and VIII)

under
Faculty of Technology
(As per Credit Based Semester and Grading System from 2015-16)

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 work done over the entire semester.
- It is suggested that each tutorial be graded immediately and an average be taken at the end.
- A minimum of ten, or as specified in syllabus, tutorials will form the basis for final evaluation.
- The total marks for term work(except project and seminar) will be awarded as follows:

Assignments etc.	20
Attendance	05

Further, while calculating marks for attendance, the following guidelines shall be adhered to:

75 % – 80%.	03
81% – 90%	04
91% onwards	05

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 as much of the syllabus as possible.

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 & Seminar Guidelines

- Project Groups: Students can form groups with not more than 3(Three) per group.
- The load for projects may be calculated as below,

  Sem VII: $\frac{1}{2}$hr for teacher per group.

  Sem VIII: 1 hr for teacher per group.

- Maximum of four groups can be allotted to a 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

Scheme for BE: Semester-VII

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHC701	Process Equipment Design (PED)	03	–	01	3.0	–	1.0	4.0
CHC702	Process Engineering	03	–	01	3.0	–	1.0	4.0
CHC703	Process Dynamics & Control (PDC)	03	–	01	3.0	–	1.0	4.0
CHE704	Elective – II	04	–	–	4.0	–	–	4.0
CHP705	Project – A	–	–	08	–	–	3.0	3.0
CHS706	Seminar	–	–	03	–	–	3.0	3.0
CHL707	Chemical Engg Lab (PED)	–	03	–	–	1.5	–	1.5
CHL708	Chemical Engg Lab (PDC)	–	03	–	–	1.5	–	1.5
	Total	13	06	14	13.0	3.0	9.0	25.0

Examination Scheme

Subject Code	Subject Name	Examination Scheme							
		Theory marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1 (A)	Test 2 (B)	Avg.of (A) & (B)					
CHC701	Process Equipment Design (PED)	20	20	20	80	25	–	–	125
CHC702	Process Engineering	20	20	20	80	25	–	–	125
CHC703	Process Dynamics & Control (PDC)	20	20	20	80	25	–	–	125
CHE704	Elective – II	20	20	20	80	–	–	–	100
CHP705	Project – A	–	–	–	–	100	–	50	150
CHS706	Seminar	–	–	–	–	50	–	–	50
CHL707	Chemical Engg Lab (PED)	–	–	–	–	–	–	25	25
CHL708	Chemical Engg Lab (PDC)	–	–	–	–	–	25	25	50
			Total	80	320	225	25	100	750

Elective Streams(CHE704)

Sem.	**Management Stream**	**Technology Stream**	**Process System Engineering Stream**
VII	High Performance Leadership	• Polymer Technology • Petroleum Refining Technology	• Advanced Process Simulation

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHC701	Process Equipment Design	3.0	1.0	4.0

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 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

- Student will demonstrate ability to carry out complete chemical engineering project.
- Students will demonstrate ability to design process equipments as heat exchanger, distillation column, high pressure vessels etc.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction:** The organisation of a chemical engineering project. Flow sheet presentation i) Block diagram ii) Pictorial representation iii) Presentation of stream flowrates. iv) Information to be included. v) Plant layout. The P & I diagram i) Symbols and layout. ii) Basic symbols. Computer Aided Design Softwares. Material safety data sheet.	03
2	**Heat Exchangers:** Introduction. Codes and Standards for heat exchangers. Material of construction. 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. Complete fabrication drawing for designed heat exchanger to a recommended scale. Design of standard vertical evaporator with design of calendria and tube, flange, evaporator drum & heads.	12
3	**Design of Tall Columns:** Stresses in column shell. Shell thickness determination at various heights. Elastic stability under compression stresses. Complete fabrication drawing for designed column to a recommended scale.	08

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Module	Contents	No. of hrs
4	**High Pressure Vessels:** Stress analysis for thick walled cylinders. Theories of elastic failure. Prestressing of thick walled vessels. Design of monoblock high pressure vessels. Multilayer high pressure vessel design and construction. Materials of construction for high pressure vessels.	12
5	**Introduction to Design of Crystallizers, Filters and Dryers:** Design considerations for Crystallizers, filters, absorption column, extractor and dryers (No numerical problems).	03
6	**Piping Design and Layout:** Pipe sizing for gases and liquids. Piping for high temperature. Piping layout and its factors under consideration. Design of buried and overhead pipeline.	02

TUTORIALS:

- Design procedure or example based on heat exchanger.
- Design procedure or example based on short tube vertical evaporator.
- Design procedure or example based on distillation column.
- Design procedure or example based on monoblock high pressure vessel.
- Design procedure or example based on multilayer high pressure vessel.

References

1. Process Equipment Design- Vessel Design by E. Brownell and Edwin, H. Young, John Wiley, New York 1963.
2. Chemical Engineering Vol 6-Design by J.M. Coulson, J.F.Richardson and P.K Sinnot, Pregamon 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		
		Theory	Tut.	Total
CHC702	Process Engineering	3.0	1.0	4.0

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 students experience in conducting and in planning experiments in the modern engineering laboratory including interfacing experiments with computers as well as interpreting the significance of resulting data and properly reporting results in well written technical reports.
- 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 posses ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Detail syllabus

Module	Contents	No. of hrs
1	**An Overview of Process Engineering:** Process engineering and Chemical Engineering, Basic functions of Process Engineering: understanding and transferring licensor's know-how, development of P&ID, equipment selection and specifications, input to other engineering disciplines. Activities of Process engineering: Material and Energy balance, gathering data, establishing design basis, P&I diagram, control strategy, equipment specifications, deciding requirements of interlock shut down arrangement, piping requirement, civil and electrical requirements, acquiring knowledge of codes and standards, statutory requirements, safety study, preparing operating manuals, commissioning, interaction with other engineering disciplines, interaction with external agencies	01
2	**Preliminary Process Selection:** Economic evaluation of process: fixed and variable costs. Analysis of environmental concerns of process: rules & regulations of pollution control board, handling hazardous materials, etc. Safety analysis of process, Analysis of control structure of process, Flexibility analysis of process	01
3	**Selection of Process Steps:** Various types of diagrams to represent the process: block diagram, process flow diagram(PFD) , process and instrumentation diagram (P&ID), utilities line diagram. Basic steps in PFD synthesis: gathering information, representing alternatives, criteria for assessing preliminary design. PFD: objective, way of presentation, essential constituents (equipment symbols, numbers, names, process stream flow lines, utility designation, operating conditions, etc), optional constituents (energy exchange rates, physical properties of streams, etc) Way of presenting major equipments in PFD: vessels, heat exchangers, pumps, compressors, distillation columns, process lines, instruments, Common characteristics of PFD	02

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Module	Contents	No. of hrs
4	**Flowsheet Synthesis Based on Design Heuristics:** Input information to the process for flow sheet synthesis: reactions, side reactions, maximum yield, catalyst deactivation rate, production rate, product purity, raw material, process constraints, plant & site data, cost data, physical properties. Level 1 decision in flow sheet synthesis: batch v/s continuous process (production rates, market forces, operational problems, single unit for multiple operations). Level 2 decision in flow sheet synthesis: input output structure of flow sheet (feed purification, recover or recycle reversible by-products, gas recycle & purge stream, reactants not to recover or recycle, number of output streams). Level 3 decision in flow sheet synthesis: Recycle structure of flow sheet (number of reactor systems, recycle streams, excess reactants, heat effects & equilibrium limitations, reversible by-products, reactor heat effects). Level 4 decision in flow sheet synthesis: separation system for process (phase of reactor effluent and separation system, vapor recovery system (VRS), liquid recovery system (LRS), types of VRS and LRS. Level 5 decision in flow sheet synthesis: heat integration in flow sheet. Reactor trains: options & selection criteria, CSTR, PFR, reactors similar to CSTR, application of different reactor geometries and associated heuristics.	06
5	**Mass & Energy Balances around Major Equipments in Flow Sheet:** Physico-chemical specification of each process stream in flow sheet. Detailed mass and energy balance around major equipments in flow sheet using thumb rules: reactors, mixers, splitters, flash columns, distillation columns, absorption column, stripping column, evaporator, dryer	07

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Module	Contents	No. of hrs
6	**Sizing and Costing of Major Equipments in Flow Sheet:** Sizing of equipments using short cut designing methods and design heuristics: reactors, heat exchangers, distillation columns, pumps, compressors, evaporators. Costing of equipments: evaluation of updated bare module cost of above process equipments using Guthries costing modules	08
7	**Utility Selection for Process:** Plant utilities: concept, Major types of plant utilities: heating utilities, cooling utilities, compressed air, nitrogen, vacuum, water, electricity. Heating utilities and their operating T & P ranges: steam, pressurized hot water, thermal fluids dowtherm A, E, inorganic salt mixtures, mineral oils, silicon compounds. Cooling utilities and their operating T & P ranges: cooling tower water, chilled water, chilled brine system. Utility Hook-ups. Evaluating minimum utility requirement for process using pinch analysis	05
8	**Control Strategy for Process**: To suggest control strategies for various process parameters to be controlled. Degree of Freedom analysis for suggested controlled strategy. Alternate control strategies for various process parameters	03
9	**Safety and Hazard Analysis for Process:** Major types of accidents in chemical industries: fire, explosion, toxic release. Fire: probability of occurrence, potential for fatalities and economic losses, fuel-oxidants-ignition source for fire to occur, fire triangle, types of fire. Explosion: probability of occurrence, potential for fatalities and economic losses, types of explosion Toxic release: probability of occurrence, potential for fatalities and economic losses, entry route-entry organ-method of control, various models to analyse toxic release. Multiple Redundancy System: Risk assessment and its different methods – event tree analysis, fault tree analysis, quantitative risk analysis, layer of protection analysis, HAZOP	03

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Module	Contents	No. of hrs
10	**Basic Chemical Processes:** Common Features and Preliminary Process System (PPS) for Basic Chemical Processes: Nitration, Chlorination, Oxidation, Sulfonation, Liquid Phase Catalytic Reduction	04

References

1. Systematic Methods Of Chemical Process Design, Loren T Biegler, Grossman E.I., Westberg, A.W. Prentice Hall Intl ed., 1997

2. Conceptual Design of Chemical Processes, J.M.Douglas, McGraw Hill International Editions, 1988

3. Chemical Process Equipment: selection & design, Walas, S.M., Butterworth, London, 1980

4. Strategy of Process Engineering, John D.F.Rudd & C.C. Watson, Wiley & Sons International, 1968

5. Process Design Principles: synthesis analysis & evaluation, Sieder, W.D., Seader J.D. & Lewin D.R., John Wiley & Sons, 1998.

6. 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

7. Introduction to Process Engineering and Design, S B Thakore, B I Bhatt, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2011

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHC703	Process Dynamics & Control	3.0	1.0	4.0

Prerequisites

Linear Algebra, Differential Equations, Laplace Transforms.

Course Objectives

- To understand dynamic behaviour of process systems and equipments.
- To understand frequency response of dynamic systems.
- To understand and analyse stability charecteristics of dynamic systems.
- To design controllers.

Course Outcomes

- The student will be able to model dynamical systems and study their responses in Time ,Laplace and Frequency domains.
- The student will be able to design stable controllers, for important chemical processes

Detail syllabus

Module	Contents	No. of hrs
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	**Dynamic Models of Processes:** The Rationale for Dynamic Process Models, General Modelling Principles, Degrees of Freedom Analysis, Typical Dynamic Models.	06
3	**Transfer Function Models:** Transfer Functions of Typical Systems, First and Second Order Systems, Properties of Transfer Functions, Transfer Functions of Systems in Series, Time Delay Processes, Linearisation of Non-linear Systems, State Space and Transfer Function Matrix Models.	03
4	**Dynamic Behaviour of Processes:** Standard Process inputs, Response of First Order Processes, Response of Second Order Processes, REsponse of Integrating Processes.	06

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Module	Contents	No. of hrs
5	**Development of Empirical Models From Process Data:** Fitting First and Second Order Models Using Step Tests, Development of Discrete Time Dynamic Models, Identifying Discrete Time Models From Experimental Data.	04
6	**Feedback and Feedforward Control:** Basic Control Modes, Features of PID and On-off Control, Conntrol Valve Characteristics, Response of Feedback Control Systems, Digital Verions of PID Controllers.	02
7	**Closed-Loop Response and Stability:** Closed-Loop Transfer Functions, Closed-Loop Response, Stability, Root Locus.	04
8	**Controller Design and Tuning:** Performance Criteria, Model-Based Design Methods, Controller Tuning, Controllers with Two Degrees of Freedom, On-Line Tuning.	04
9	**Control Strategies:** Degrees of Freedom Analysis, Selection of Variables, Typical Applications.	02
10	**Frequency Response:** Frequency Response of Typical Systems, Bode Stability Criterion, Nyquist Stability Criterion, Gain and Phase Margins.	05

References

1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, 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 Chemical Engineers,2nd Ed., Mc-Graw Hill Publishing Co.

3. Stephanopoulos, Chemical Process Control, PHI Learning Pvt. Ltd.

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHE704	Elective – II : High Performance Leadership	4.0	–	4.0

Prerequisites

This course is designed to enhance your leadership to improve your ability to lead with purpose, to communicate effectively, and to work well with others. The course will be a combination of learning about leadership through the review of literature. Students will further develop and apply various skills and techniques deemed to be essential for successful leadership in organizations. The course also explores leadership challenges and opportunities in relation to individual and team performance.

Course Objectives

- To become aware of strengths and weaknesses in one's leadership behaviour.
- Analyse the numerous approaches of leadership development and critically evaluate how they may be applied in practice.
- To understand how the most successful leaders are able to influence followers through effective communication of well-reasoned ideas, proposals and values.
- To systematically train and improve one's leadership effectiveness.

Course Outcomes

- Improve one's self leadership skills through effective emotion regulation and emotional intelligence.
- Apply concepts of leadership and effective communication to individuals, groups, and organizations

Detail syllabus

Module	Contents	No. of hrs
1	**Leadership:** Theories of Leadership, Leadership Styles and Leadership, Leadership Skills, Objectives for personal development.	05
2	**Leadership Skills:** Leadership Skills and Leadership, Developing competencies, The Business Related Inventory of Personality (strengths and weaknesses), Changing behaviour in critical situations.	07
3	**Team work & Positive thinking:** Team work & Team building, Positive thinking Martin Seligmans theory of Learned, Helplessness, Learned Optimism Lessons through Literature Positive thinking, Attitudes, Beliefs, Lateral Thinking.	07

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Module	Contents	No. of hrs
4	**Interpersonal skills:** Interpersonal skills Conversation, Feedback, Feed forward, Transformational Leadership: analysis and consequences from the 360° feedback Interpersonal skills, Delegation, Humour, Trust, Expectations, Values, Status, Compatibility.	06
5	**Effective Leadership Communication:** Principles of effective communication: authenticity, clarity, credibility, and empathy. Persuasion including body language, posture, facial expressions, gestures, creating a personal relationship (message-audience-speaker), Impact speech: effective and convincing lines of argument.	08
6	**Conflict Management:** Types of conflicts, Coping strategies and Conflict Management Styles. Creative problem Solving Techniques.	06

References

1. Jeff Grimshaw & Gregg Baron, Leadership Without Excuses : How to Create Accountability and High-Performance, Tata McGraw - Hill Education, 1st Ed., 2010.
2. Harrison Owen, Wave Rider: Leadership for High Performance in a Self-organizing World, Berrett-koehler Publishers, 2008.
3. Daniel Goleman, Richard E. Boyatzis, Annie McKee, Primal Leadership: Realizing the Power of Emotional Intelligence, Harvard Business Review Press, 2002.
4. John Baldoni, Great Communication Secrets of Great Leaders, Primento Digital Publication, 2012.
5. Paul Glen, Leading Geeks: How To Manage And Lead The People Who Deliver Technology, Wiley Publication, 2002.
6. Shel Holtz, Corporate Conversations : A Guide To Crafting Effective And Appropriate Internal Communications, Phi Learning Pvt Ltd, 1st Ed., 2007.
7. Garber, J. and Seligman, M.E.P., Human Helplessness: Theory and Applications, New York Academic Press.,1980.
8. Bass, Bernard. M., The Bass Handbook of Leadership, Theory, Research & Managerial Applications, 4th edition, New York, 2008

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHE704	Elective – II: Polymer Technology	4.0	–	4.0

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.
- Select polymerization reactor for a polymer product.
- Characterize polymers and state polymer additives, blends and composites.

Detail syllabus

Module	Contents	No. of hrs
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.	06
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

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Module	Contents	No. of hrs
3	**Molecular Weight and Molecular Weight Distribution:** Molecular Weights, Polydispersity Index, Different Methods of 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.	08
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 plastisizers 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. Manufacturing of thermoset polymers such as Phenolic resins.	12

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. McCrum N.G et.al. ,Principles of Polymer Engineering , 2nd ed., Oxford Sciences, 1997.
9. Bhatnagar M.S., a Textbook of Polymers Vol.I & Vol.II, S.Chand & Co. Ltd.,New Delhi, 2004.

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHE704	Elective – II: Petroleum Refining Technology	4.0	–	4.0

Prerequisites

Knowledge about Formation and origin of petroleum, composition and testing methods,Basic treatment Techniques.

Course Objectives

- To understand petroleum refinery products, its evaluation techniques, and treatment techniques.
- To understand various cracking processes, and its applications in chemical industries.

Course Outcomes

Students will be able to understand petroleum refinery products, its evaluation techniques, and treatment techniques,various cracking processes, and its applications in chemical industries.

Detail syllabus

Module	Contents	No. of hrs
1	**Origin formation and composition of petroleum:** Origin theory, Reserves and deposits of world. Types of crude and Indian crude types. Exploration Reserves.	06
2	**Refinery products and feedstock:** Overall refinery flow.Low boiling products. Gasoline Specifications. **Fuels:** Jet fuels, automotive diesel fuels. Oils:-Heating Oils, Residual fuel Oils, Crude Oil properties, Composition of petroleum, Crude suitable for asphalt manufacture. Crude distillation curves. Distillation characteristics. Petrochemical Feedstock.	10
3	**Fractionation of Petroleum:** Dehydration and desalting of crude, Heating of Crude Pipe still Heaters. Multi-component Fractionation of Petroleum including pump-around and side-stripping.Blending of gasoline. Over lead corrosion in distillation unit.	12
4	**Treatment Techniques and product specifications:** Fraction impurities treatment of gasoline, Treatment of kerosene, Treatment of Lubes. Wax and purification.	08

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Module	Contents	No. of hrs
5	**Catalytic Cracking and thermal process:** Fluidised bed catalytic cracking, Catalytic reforming, Coking, Hydrogen Process Hydro cracking, Hydrodesulphurization, Hydro-Treatment. Alkalyation process, Isomerisation Proccess, Polymer gasoline.	10
6	**Asphalt Technology:** Source of Asphalt. Air Blowing of Bitumen up-gradation of heavy crude.Brief review about bio-refinery	06

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 Francies .
4. Chemical Process Industries, Austin, G.T Shreves.
5. Encyclopedia of chemical processing and design by john J. McKhetta; Marcel Deckker, Inc.
6. Chemial Weakly for supply and demand figures and current prices and price trends.

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHE704	Elective – II: Advanced Process Simulation	4.0	–	4.0

Prerequisites

Process Calculations, Computer Programming.

Course Objectives

To understand the tools of process integration.

Course Outcomes

The student will be able to design integrated processes.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction:** Introduction to Process Integration, Alternative Processes, Process Synthesis, Process Analysis, Process Integration.	02
2	**Overall Mass Targeting:** Targeting for Minimum Discharge of Waste, Targeting for Minimum Fresh Material Utilities, Mass-Integration Strategies for Attaining Targets.	04
3	**Graphical Techniques for Direct-Recycle Strategies:** Introduction, Source-Sink Mapping Diagram and Lever-Arm Rule, Selection of Sources, Sinks, and Recycle Routes, Direct REcycle Targets Through Material Recycle Pinch Diagram, Multi-component Source-Sink Mapping Diagram.	08
4	**Synthesis of Mass Exchange Networks (A Graphical Approach):** Design of Individual Mass Exchangers, Cost Optimization of Mass Exchangers, Synthesis of Mass Exchange Networks, Mass Exchange Pinch Diagram, Screening of Multiple External MSAs.	08
5	**Mass Integration Strategies:** Low/No Cost Strategies, Most Changes in Operating Conditions and Process Variables, medium-Cost Strategies and Main Technology Changes.	06
6	**Algebraic Approach to Targeting Direct Recycle:** Algebraic Targeting Approach, Algebraic Targeting Procedure, The Composition Interval Diagram, Table of Exchangeable Loads, Mass Exchange Cascade Diagram, Example of Cleaning of Aqueous Waste.	06

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Module	Contents	No. of hrs
7	Recycle Strategies Using Property Integration Contents: Property Based Material Recycle Pinch Diagram, Process Modification, Clustering Techniques for Multiple Properties, Cluster Based Source Sink Mapping, Design Rules, Multiplicity, Clusters and Mass Fractions, Examples.	10
8	**Mathematical Approach:** Problem Statement and Representation, Formulation of Optimization Models, Interaction between Direct Recycle and the Process, Synthesis of MENs.	08

References

1. Mahmoud M. El-Halwagi, Process Integration, Academic Press

Course Code	Course/ Subject Name	Credits
CHP705	Project – A	3.0

Details

- 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 were allotted in Project A,B to the students.
- Students are advised to take up industrial/ experimental oriented/ simulation and/or optimization based topics for their projects.

Course Code	Course/ Subject Name	Credits
CHS706	Seminar	3.0

Details

- 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.

Course Code	Course/ Subject Name	Credits
CHL707	Chemical Engg Lab (PED)	1.5

Concepts for experiments:

Includes drawing sheets based on

- Process flow diagram and piping and instrument diagram.
- Fabrication drawing of problem based on heat exchanger.
- Fabrication drawing of problem based on short tube vertical evaporator.
- Fabrication drawing of problem based on distillation column.
- Fabrication drawing of problem based on monoblock high pressure vessel.
- Fabrication drawing of problem based on multilayer high pressure vessel.

Course Code	Course/ Subject Name	Credits
CHL708	Chemical Engg Lab (PDC)	1.5

Concepts for experiments:

Objective for experiments

- To correlate the theoretical understanding of the dynamics of systems with actual observations.
- To calculate system parameters from observed data.
- To validate system models.
- To study closed-loop behaviour of control systems

At least eight experiments should be carried out in this lab course based on the following concepts:

- Dynamic behaviour of typical first and second-order systems.
- Dynamic behaviour of systems in series.
- Response of closed loop systems with different control configurations.
- Tuning of Controllers.

University of Mumbai

Scheme for BE: Semester-VIII

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHC801	Modelling, Simulation & Optimization (MSO)	03	–	01	3.0	–	1.0	4.0
CHC802	Project Engineering & Entrepreneurship Management	03	–	01	3.0	–	1.0	4.0
CHC803	Environmental Engineering (EE)	04	–	–	4.0	–	–	4.0
CHC804	Energy System Design	03	–	01	3.0	–	1.0	4.0
CHE805	Elective – III	04	–	–	4.0	–	–	4.0
CHP806	Project – B	–	–	08	–	–	6.0	6.0
CHL807	Chemical Engineering Lab (EE)	–	02	–	–	1.0	–	1.0
CHL808	Chemical Engg Lab (MSO)	–	02	–	–	1.0	–	1.0
	Total	17	04	11	17.0	2.0	9.0	28.0

Examination Scheme

Subject Code	Subject Name	Examination Scheme							
		Theory marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1 (A)	Test 2 (B)	Avg.of (A) & (B)					
CHC801	Modelling, Simulation & Optimization (MSO)	20	20	20	80	25	–	–	125
CHC802	Project Engineering & Entrepreneurship Management	20	20	20	80	25	–	–	125
CHC803	Environmental Engineering (EE)	20	20	20	80	–	–	–	100
CHC804	Energy System Design	20	20	20	80	25	–	–	125
CHE805	Elective – III	20	20	20	80	–	–	–	100
CHP806	Project – B	–	–	–	–	100	–	50	150
CHL807	Chemical Engineering Lab (EE)	–	–	–	–	–	25	25	50
CHL808	Chemical Engg Lab (MSO)	–	–	–	–	–	25	–	25
				Total 100	400	175	50	75	800

Elective Streams(CHE805)

Sem.	**Management Stream**	**Technology Stream**	**Process System Engineering Stream**
VIII	Total Quality Management	• Advanced Separation Technology • Biotechnology • Nanotechnology	• Advanced Process Control • Advanced Transport Phenomenon

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHC801	Modelling, Simulation & Optimization (MSO)	3.0	1.0	4.0

Prerequisites

Linear Algebra, Process Calculations, Computer Programming.

Course Objectives

- To understand writing and solving linear balance equations for single units as well as complete flowsheets.
- To understand writing and solving systems of non-linear equations for single and multiple units.
- To understand simulation of complete flowsheets.
- To understand optimization of single and multiple units.

Course Outcomes

- The student will be able to write and solve linear and non-linear mass and energy balance equations for individual as well as multiple units.
- The student will be able to carry out sequential and equation oriented simulation of complete flowsheets.
- The student will be able to optimize typical chemical processes.

Detail syllabus

Module	Contents	No. of hrs
1	**Mass and Energy Balances:** Introduction, Developing Unit Models for Linear Mass Balances, Linear Mass Balances, Setting Temperature or Pressure Levels from Mass Balances, Energy Balances.	10
2	**Unit Equation Models:** Introduction, Thermodynamic Options for Process Simulation, Flash Calculation, Distillation Calculations, Other Unit Operations.	10
3	**Simulation:** Introduction, Process Simulation Modes, Methods for Solving Systems of NLE, Recycle Partitioning and Tearing, Simulation Examples.	10
4	**Process Flowsheet Optimization:** Introduction, Constrained Non-Linear Programming, SQP, EO based Process Optimization.	10

References

1. Lorenz T. Beigler, Ignacio E.Grossman, Arthur W. Westburg, Systematic Methods of Chemical Process Design, Prentice Hall

2. Thomas Edgar, David M. Himmelbleau, Optimization of Chemical Processes, 2nd Ed., John Wiley.

3. A. W. Westerberg, H. P. Hutchison, R. L. Motard, P. Winter, Process Flowsheeting, Cambridge University Press; 1 edition (June 9, 2011).

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHC802	Project Engineering & Entrepreneurship Management	3.0	1.0	4.0

Prerequisites

- Employment and Corporate Skills.

Course Objectives

- Project management demands the judicious mix of science, arts and technology, so the objective is to project the scientific aspects of project management.
- To amidst real life constraints for the benefit of the individual, project and society.
- To learn entrepreneurship for the improvement of technology, product and the society for the economical growth.

Course Outcomes

- To prepare students for an exciting, challenging and rewarding managerial career.
- To insight students in identifying opportunities, creating and starting a venture, financing and managing the venture.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction:** Definition of project, project management, project life cycle, project types, Project over runs, Role, responsibilities demands on project manager.	04
2	**Project initiation:** Feasibility reports of various types project selection criteria, project licensing, Basic and detailed engineering, Guarantees, Liabilities, Risk insurance, types of estimates.	06
3	**Project clearances:** Various laws & regulations, List of various clearances, Intellectual property rights, Patents, need for clearances and influences on project, management, LOI. **Project organization:** Various forms of pure project, matrix and mixed type. Project team, responsibilities of various members.	08
. . . cont.	**Project planning:** WBS, responsibility charts, contracts, types, role of contractor, sub-contractor consultant, selection criteria and appointment procedure	

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Module	Contents	No. of hrs
4	**Project Scheduling and execution:** CPM and PERT, GANTT charts, LOB , Resource allocation, ABC and VED Analysis , Economic Order Quantity (EOQ), CAT vs RAT. (Numericals included)	08
5	**Project monitoring and control:** Time and cost control tools and techniques, fund flow control, Project quality control, Importance of environmental and safety aspects. **Project termination:** Commissioning, start up, stabilization, close out.	06
6	**Entrepreneurship:** Definition of entrepreneurship, Concept of entrepreneur and entrepreneurship, Characteristics, aspects of entrepreneurship, factors affecting entrepreneurship. Classification and types of entrepreneurship based on business, technology, motivation, growth and stages of development.	06

References

1. Choudhary, S., Project Management.
2. Joy, P. K., Total Project Management.
3. Jack Meredith and Samuel, Project management a Managerial approach.
4. Vasant Desai, Dynamics of entrepreneurial development and management.

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHC803	Environmental Engineering (EE)	4.0	–	4.0

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 and management of various types of pollutants.

Course Outcomes

Students should be able to apply the Environmental Engineering concepts to control and management of various types of pollutants.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction:** Environmental pollution, Importance of environmental pollution control, Concept of ecological balance, Role of environmental engineer, Hydrological & nutrient cycles, Environmental Legislation & Regulations, Industrial pollution emissions & Indian standards, Water (prevention & control of pollution) act, Air (prevention & control of pollution) act.	06
2	**Water Pollution:** Classification, 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, TOC. **Determination of inorganic substances:** nitrogen, phosphorus, trace elements, alkalinity. **Physical characteristics:** suspended solids, dissolved solids, colour and odour, Bacteriological measurements.	08
3	**Waste Water Treatment:** **Primary treatment:** pretreatment, 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.	12

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Module	Contents	No. of hrs
. . . cont.	**Tertiary treatment:** advanced methods for removal of nutrients, suspended and dissolved solids, Advanced biological systems, Chemical oxidation, Recovery of materials from process effluents.	
4	**Air Pollution:** Air pollutants, sources and effect on man and environment, acid rain, smog, greenhouse effect, Ozone depletion, global warming, Temperature lapse rate and stability, Plume behaviour, Dispersion of air pollutants, Gaussian plume model, Estimation of plume rise, Air pollution sampling and measurement, Analysis of air pollutants.	08
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.	12
6	**Solid Waste Management:** Solid waste including plastic, nuclear and hazardous waste management.	03
7	**Noise Pollution:** Noise pollution: measurement and control, effect on man and environment.	03

References

1. Rao, C.S., Environmental Pollution Control Engineering, New Age International (P) Limited.

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.

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHC804	Energy System Design	3.0	1.0	4.0

Prerequisites

- The students should have knowledge of Heat transfer to carry out Energy balance and Heat Exchanger Networking.
- 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 are expected to have ability to design a energy system 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, identify, formulate and solve engineering problems.
- The graduates are expected to have an understanding of professional and ethical responsibility.
- The graduates are expected to posses ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Detail syllabus

Module	Contents	No. of hrs
1	**Global Energy Scenario:** Broad classification of energy sources: primary, secondary, commercial, non-commercial, renewable, non-renewable. Global primary energy reserves and energy consumption, Ratio of energy demand to GDP: significance. Indian energy scenario: w.r.t above points.	02

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Module	Contents	No. of hrs
. . . cont.	Energy policies, regulations, consumption and production, installed capacity, energy intensive sectors in India. Energy management:aim, key principles, steps to be taken to improve energy efficiency of systems. Energy conservation act (India). Energy and environment, Causes of high energy intensity and energy demand in developing countries: technological, managerial, economic, structural causes	
2	**Energy Audit:** Definition, need and steps of energy audit. **Energy audit methodology:** interview with key facility personal, facility tour, document review, facility inspection, staff interviews, utility analysis, identifying energy conservation opportunities/measures, economic analysis, preparing audit report, review and recommendations. **Types of energy audit:** preliminary (walk-through) audit, general (mini) audit, investment grade (maxi/detailed) audit. **Energy profiles:** energy profile by use, cost, function. **Energy sub-audits:** envelope, functional, process, transportation and utility audit. **Instrumentation part of energy audit:** equipments for measuring light intensity, electrical performance, temperature, pressure, humidity, performance of combustion system and HVAC system during energy audit; energy auditors tool box and its contents. **Preparing for energy audit visit:** to study the facility in view of energy use data, energy rate structure, physical and operational data. **Safety considerations during energy audit:** related to electrical, respiratory, hearing, etc. **Post audit analysis:** identifying ECOs, evaluate feasibility of ECOs with help of simple pay back period analysis, preparing summarized energy audit report	04
3	**Energy Efficient Technologies:** Basic energy consuming systems in chemical industries and energy efficient modifications in those systems: lighting system; motors, belt and drives system; fans and pumps system; compressed air system; steam system; refrigeration system; material handling system; hydraulic system; drying system. Examples of energy efficient technologies: pressure swing adsorption purification; ethylene by thermal cracking.	03

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Module	Contents	No. of hrs
4	**Energy Integration in The Process Industries:** Energy integration in process: concept. Pinch analysis: evaluation of minimum utility requirement by temperature interval method and composite curve method. Design of Heat Exchanger Network (HEN) for process system: minimum approach temperature difference (ΔT_{min}); Linnhoff rules for HEN design; pinch decomposition diagram; concept of minimum number of heat exchangers ($NH_{x,min}$); design of HEN with $NH_{x,min}$ using breaking loop method and stream splitting method. Concept of Threshold approach temperature difference (ΔT_{thresh}) and Optimum approach temperature difference (ΔT_{opt}) during HEN. Determining annualized cost of HEN	10
5	**Heat Integration in Process Units:** **Multiple effect evaporators (MEE):** types forward feed, backward feed, parallel feed; advantage of MEE over single effect evaporator in terms of energy saving. Effect of process variables on evaporator operation: feed temperature, operating pressure, steam pressure, Boiling point rise. 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.	12
6	**Co-generation:** Introduction and basic concepts related to co-generation: advantages of co-generation over conventional power plants; basic terms related to co-generation like, process heat, process returns, net heat to process, heat to power ratio, prime mover, etc. Basic thermodynamic cycles supporting working of co-generation plant: Brayton cycle, Rankine cycle. Basic types of co-generation systems: topping cycle, bottoming cycle, combined cycle. Different types of co-generation power plants: steam turbine system, gas turbine system, combined gas steam turbine system, diesel engine system. Distributed generation (DG) co-generation technologies: reciprocating engine system, micro turbines, fuel cells, photovoltaic cells, Co-generation design procedure, Applications of co-generation	06

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Module	Contents	No. of hrs
7	**Waste Heat Recovery (WHR):** Classification and applications of WHR: waste heat sources, quality of waste heat and its application; high temperature WHR, medium temperature WHR, low temperature WHR . Benefits of WHR: direct and indirect benefits. Different techniques used for WHR / Commercial devices used for WHR: recuperators, radiation/convective hybrid recuperator, ceramic recuperator, regenerator, heat wheel, heat pipe, waste heat boiler, economizer, heat pumps	03

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. G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers.
4. Larmine James, .Fuel Cells Explained., John Wiley and Sons, 2000.
5. Kreith F., .Principles of Solar Energy., McGraw Hill Book Co., 1978.
6. Freris L. L., .Wind Energy Conversion System., Prentice Hall, 1990.
7. Wayne C. Turner, Steve Doty (Ed.), Energy Management Hand Book., John Wiley and Sons, 2000
8. Biegler L. T., Grossman E. I. and Westerberg A. W., .Systematic Methods of Chemical Process Design., Prentice Hall International Ltd., 1997.
9. P K Nag, Power Plant Engineering, The McGraw-Hill Publishing Company Limited.
10. H.M.Robert, J.H.Collins, Handbook of Energy Conservation-Volume 1, CBS Publishers & Distributors.
11. Robin Smith, Chemical Process Design and Integration, Wiley India, 2005.
12. Serth, Robert W., Process Heat Transfer Principles and Applications, Elsevier Science & Technology Books, 2007.

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHE805	Elective – III: Total Quality Management	4.0	–	4.0

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 methodologies.
- To give and an insight into the ongoing global trends in quality approach and practices with specific 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 and 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.

Detail syllabus

Module	Contents	No. of hrs
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-off between quality and cost.	06
2	**Planning for quality and Quality improvement:** **Planning for quality:** Need for quality policies and objectives. Significance of top management commitment, strategic planning for quality. **Quality improvement:** Management of controllable defects, 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.	08

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Module	Contents	No. of hrs
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 and reliability, product life cycle, trade-off between maintainability.	05
4	**Vendor relations:** Vendor as a partner, vendor selection, vendor evaluation. Push-Pull view of supply chain and cycle view of chain management.	05
5	**SQC Tool:** Histograms, Pie charts, Scatter diagrams, Cause and effect diagram. Statistical Process Control: **Process variability:** Variables and process variation, measures of accuracy and centring, precision or spread, normal distribution. **Process Control:** Control charts for variables ($\bar{X}$-chart, R-chart, σ-chart) and attributes (np-charts, p-chart, c-charts, U-charts). **Process capability:** OC curve, acceptance sampling, single and double sampling – producer's and consumer's risk.	14
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 Shainin concepts of quality. Productivity improvement techniques like 5S, POKAYOKE, SMED, KAIZEN and Concurrent Engineering.	14

Note: Seminar/Case study presentation with report by individual or in groups comprising of not more than **three** students should be considered for tutorials.

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		
		Theory	Tut.	Total
CHE805	Elective – III: Advanced Separation Technology	4.0	–	4.0

Prerequisites

Basic knowledge regarding fundamental separation processes and its applications 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,
- foam fractionation process with equipments and application in waste water treatment,
- liquid chromatography – types and separation and of enzymes using it,
- Types of membranes, membrane characterization, membrane material, membrane molecules, membrane applications in biotechnology.

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 posses ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Detail syllabus

Module	Contents	No. of hrs
1	**Adsorption Process:** Modern 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	13

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Module	Contents	No. of hrs
2	**Foam Fractionation Process:** Foam Formation, coalescence, collapse and drainage phenomena Adsorption properties of foams. Modes of operation of foam fraction equipment. Principal of froth flotation, properties of foam relevant to the flotation equipment. Application of froth flotation to mineral processing, protein and enzyme separation, waste water treatment.	13
3	**Liquid Chromatographic Process:** Basic concept of chromatography, phenomena and characterization. Various chromatography options. Typical Chromatographic separation systems for preparative chromatography. Equipment characteristics of solids, their selection for various applications. Column design and filling. Applications of chromatography in separation of enzymes and proteins. Industrial Examples	13
4	**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, transport through porous membranes, transport through non- porous membranes and transport in ion-exchange membranes.Polarization phenomenon and fouling concentration polarization, characteristic flux behaviour in pressure driven membrane preparation, various models, temperature polarization, membrane fouling, methods to reduce fouling. Modules and process design plate, and frame, spiral wound, tubular, capillary, hollow fibre modules and their comparison, system design.	13

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.

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.

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHE805	Elective – III: Biotechnology	4.0	–	4.0

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 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.

Detail syllabus

Module	Contents	No. of hrs
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.	10
2	**Biological polymers:** Lipids, Proteins, Amino acids, Nucleic acids, Carbohydrates, Macronutrients and micronutrients.	06

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Module	Contents	No. of hrs
3	**Enzyme Technology:** Nomenclature and classification of enzymes. Enzyme kinetics. Immobilization of enzymes. Industrial applications of enzymes.	10
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, Introduction to Bio-informatics. Potential lab biohazards of genetic engineering. Bioethics.	06
5	**Applications of biotechnology:** Biotechnology in agriculture, food and beverage industries, chemical industries, environment and energy sectors.	10
6	**Product recovery operations:** Dialysis, Reverse osmosis, ultrafiltration, microfiltration, chromatography, electrophoresis, elecrodialysis, crystallization and drying.	10

References

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		
		Theory	Tut.	Total
CHE805	Elective – III: Nanotechnology	4.0	–	4.0

Prerequisites

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, Students are expected to have an understanding of basic chemical and physical concepts.

Course Objectives

- Understand the basic scientific concepts nanoscience and nanotechnology.
- Understand the properties of materials and biomaterials at the atomic/molecular level and the scaling laws governing these properties.
- To facilitate skills transfer from another relevant area of engineering or science and technology to the study of nanotechnology.
- Understand what nanotechnology is about and how to use it.

Course Outcomes

- Understand the essential concepts used in nanotechnology.
- Appreciate the development of modern nanotechnology.
- Understand the application of nanotechnology in major scientific fields.
- Understand the challenges nanotechnology poses to our environment.
- Gain knowledge of structure, properties, manufacturing and applications of silicon and carbon materials.
- Gain knowledge of fabrication methods in nanotechnology and characterization methods in nanotechnology.

Detail syllabus

Module	Contents	No. of hrs
1	**Fundamentals of Science behind Nanotechnology:** Electron , Atom and Ions, Molecules, Metals, Biosystems, Molecular Recognisation, Electrical Conduction and Ohms Law ,Quantum Mechanics and Quantum Ideas,Optics	06
2	**Fullerenes:** Combustion Flame Synthesis, Crystal Formation, Sintering, Organic Synthesis Method Super Critical Oligomerization, Solar Process, Electric Arc Process.	07

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Module	Contents	No. of hrs
3	**Carbon NanoTubes (CNT):** Synthesis of CNT, Electric Arc Discharge Process, Laser Ablation Process, CVD, HIPCO Process, Surface Mediated growth of Vertically Aligned Tubes, Physical Properties of CNTs, Morphology of CNT.	08
4	**Nanostructuring Methods:** Vacuum Synthesis, Gas Evaporation Tech, Condensed Phase Synthesis, Sol Gel Processing, Polymer Thin Film, Atomic Lithography, Electro deposition, Plasma Compaction. **Characterization of Nanostructures:** Transmission Electron Microscope, Scanning Electron Microscope, Microwave Spectroscopy, Raman Microscopy, X ray Diffraction.	12
5	**Calculations in Nanotechnology:** Particle Size Distribution, Particle Size & Measurement Methods, Fluid Particle Dynamics, Particle Collection Mechanisms, Particle Collection Efficiency.	12
6	**NanoBiology:** 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

Note: A minimum of 08 Tutorials involving a report based on literature survey and an oral presentation to the class on topic from any one Tutorial during tutorial session is envisaged. In addition numerical problems on various topics as included above. The performance of the students should be evaluated based on report and presentations.

References

1. Nano-structuring Operations in Nanoscale Science and Engineering- Kal Ranganathan Sharma, McGraw-Hill Companies

2. Nanotechnology: Basic Calculations for Engineers and Scientists - Louis Theodore, A John Willy & Sons

3. Nanotechnology: A Gentle Introduction to the Next Big Idea-By Mark Ratner, Daniel Ratner

4. Nano-The Essentials, Understanding Nanoscience and Nanotechnology, T. Pradeep

5. Introduction to Nanotechnology- Charles P. Poole, Jr. and Frank J. Owens, John Wiley & Sons, 2003

6. Nanotechnology: Basic and Emerging technologies, - Michael Wilson, Chapman & Hall
7. Principal of Nanotechnology-Molecular Based Study of Condensed Matter in Small Systems, - G .Ali Mansoori
8. Nanotechnology Assessment and Prospective - Schmid et al., Springer

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHE805	Elective – III: Advanced Process Control	4.0	–	4.0

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 analyse 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.

Detail syllabus

Module	Contents	No. of hrs
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	08
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	08

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Module	Contents	No. of hrs
5	**Batch Process Control:** Batch Control Systems, Sequential and Logic Control, Control During The Batch, Run-to-Run Control	06
6	**Introduction To Plantwide Control:** Plantwide Control Issues, Hypothetical Plant for Plantwide Control Studies, Internal Feedback of Material and Energy, Interaction of Plant and Control System Design	06
7	**Plantwide Control System Design:** Procedures for the Design of Plantwide Control Systems. A Systematic Procedure for Plantwide 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

References

1. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp, 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 Chemical Engineers,2 Ed., McGraw Hill Publishing Co.

3. Stephanopoulos, Chemical Process Control, PHI Learning Pvt. Ltd.

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
CHE805	Elective – III: Advanced Transport Phenomenon	4.0	–	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. Knowledge of numerical methods to solve ODE and PDE.

Course Objectives

- Students will get in depth knowledge of momentum, heat and mass transport.
- Applications of fundamental subjects learned, towards chemical engineering problems.
- Students will learn the modelling of engineering operations and structured approach towards engineering problems.

Course Outcomes

- Students will get useful base from which to start for analysing given chemical engineering problem.
- Students will able to apply conservation principles, along with the flux expressions from mass and heat transfer to frame a model for any chemical engineering problem.
- By applying boundary conditions students can approach to structured solution to a given chemical engineering problem.

Detail syllabus

Module	Contents	No. of hrs
1	Differential equations of heat transfer (Conduction), mass transfer (molecular diffusion) with application like CVD reactors.	06
2	**Shell balance :** velocity distribution in laminar flow, temperature distribution in solids and laminar flow, concentration distributions in solids and in laminar flow.	08
3	Convective momentum transport in boundary layer. Convective heat transport in boundary layer. Convective Mass transport in boundary layer. Formulation of differential equations for wetted wall column, thin film evaporator (only model formulation, solution not expected).	10
4	Simplification of continuity equation and equation of motion in Cartesian, cylindrical and spherical coordinates for different steady state engineering problems e.g. flow through trough, pipes and ducts, conical sections, etc for Newtonian and Power law fluids.	10

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Module	Contents	No. of hrs
5	Simplification of equation of energy with and without viscous dissipation for steady state chemical engineering problems. Applications should be limited to Newtonian and Power law fluids. Simplification of continuity equation for multicomponent system with applications to chemical engineering problems like absorption, absorption with reaction, adsorption, diffusion, extraction, etc.	10
6	Unsteady state microscopic balances with and without generation: laminar flow in a tube, conduction with/without heat generation, gas absorption in liquid droplets with/without reaction. Solution to partial differential equations developed in earlier modules using various numerical methods like finite element method, Crank-Nicholson method, Laplace equation. Emphasis should be given to write the computer programs and analysis of simulated values using SciLab/MATLAB for home/class assignments.	08

References

1. Bird, R.B., W.E. Stewart and E.N. Lightfoot, Transport Phenomena, Wiley, New York, 2nd ed., 2002.

2. Welty, James R., Wicks, C. E., Wilson, R. E., Rorrer, Gregory L., Fundamental of Momentum, Heat, and Mass Transfer, Wiley India (P.) Ltd., 5th ed., 2008.

3. Ismail Tosun, Modelling in Transport Phenomena A Conceptual Approach, ELSEVIER SCIENCE B.V, Amsterdam, 2002.

4. Slattery, J.C., Advanced Transport Phenomena, Cambridge University Press, Cambridge, 1999.

5. Brodkey, R.S. and H.C. Hershey, 1988, Transport Phenomena: A Unified Approach, McGraw-Hill, New York.

6. Fahien, R.W., 1983, Fundamentals of Transport Phenomena, McGraw-Hill, New York.

7. Santosh K. Gupta, Numerical Methods for Engineers, New Age Publishers, 2nd ed., 2010.

8. L. Gary Leal, Advanced Transport Phenomena, Cambridge University Press, Cambridge, 2007.

9. Yang, Cao, Chung, and Morris, Applied Numerical Methods Using MATLAB, John Wiley & Sons, Inc., New York, 2005.

10. G. R. Liu, S. S. Quek, The Finite Element Method: A Practical Course, Butterworth-Heinemann, Oxford, 2003.

Course Code	Course/ Subject Name	Credits
CHP806	Project – B	6.0

Details

- 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 were allotted in Project A,B to the students.
- Students are advised to take up industrial/ experimental oriented/ simulation and/or optimization based topics for their projects.

Course Code	Course/Subject Name	Credits
CHL807	Chemical Engineering Lab (EE)	1.0

Concepts for experiments:

Students should be able to apply the Environmental Engineering concepts to control and management of various types of pollutants. A minimum of eight 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.

Course Code	Course/Subject Name	Credits
CHL808	Chemical Engg Lab (MSO)	1.5

Concepts for experiments:

The following are suggestions for experiments using using any available computing software:

- Simulation of multi-component flash calculations in ideal and non-ideal systems.
- Simulation of Pipe and pump network flows.
- Simulation of operation of batch, semi-batch and continuous reactors.
- Simulation of unit operations.
- Simulation of flowsheet calculations.
- Optimization of chemical processes.

Biomedical Engineering

Sr. No.	Subject Code	Subject Name	Count
1	SEBM302	Electronic Circuits and Design – I	1
2	SEBM304	Human Anatomy and Physiology	1
3	SEBM306	Object Oriented Programming & Methodology $	1
4	SEBM402	Electronic Circuits and Design – II	1
5	SEBM403	Transducers and Sensors for Medical Applications	1
6	SEBM404	Logic Circuits	1
7	SEBM406	Electronic Instruments and Control System	1
8	BMC501	Biomedical Instrumentation-I	1
9	BMC502	Microprocessors	1
10	BMC503	Analog and Digital Circuits Design	1
11	BMC504	Biomedical Digital Signal Processing	1
12	BMC505	Principles of Communication Engineering	1
13	BML506	Business Communication and Ethics	1
14	BMC601	Biomedical Instrumentation –II	1
15	BMC603	Biological Modeling and Simulation	1
16	BMC604	Microcontrollers and Embedded Systems	1
17	BMC605	Medical Imaging –I	1
18	BMC606	Digital Image Processing	1
19	BMC701	Biomedical Instrumentation-III	1
20	BMC702	Medical Imaging – II	1
21	BMC703	Biomechanics Prosthesis and Orthosis	1
22	BMC704	Very Large Scale Integrated Circuits	1
23	BMC705	Networking and Information System in Medicine	1
24	BMP706	Project Stage – I	1
25	BMC802	Biomedical Microsystems	1
26	BME804	Elective	1
27	BMP805	Project Stage – II	1
		Total	27

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Biomedical Engineering (Second Year - Sem III- IV)

Revised course (Rev- 2012)

From Academic Year 2012 -13

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

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) 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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, 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 also to achieve recognition of the institution or program meeting certain specified standards. The main 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 undergraduate program in Electrical Engineering, more than twenty senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for undergraduate program in Electrical Engineering are listed below;

- To provide the overall strong technical foundation to formulate, solve and analyse engineering problems during undergraduate program.
- To prepare students to demonstrate an ability to identify, formulate and solve electrical based issues.
- To prepare students to demonstrate an ability in the area of design, control, analyse and interpret the electrical and electronics systems.
- To prepare students for successful career in industry, research and development.
- To develop the ability among students for supervisory control and data acquisition for power system application.
- To provide opportunity for students to handle the multidisciplinary projects.
- To create the awareness of the life-long learning and to introduce them to professional ethics and codes of professional practice.

The affiliated institutes may include their own PEOs in addition to the above list

To support the philosophy of outcome based education, in addition to stated PEOs, objectives and expected outcomes are also included in the curriculum. I know, this is a small step taken to enhance and provide the quality education to the stake holders.

Dr. M. V. Bhatkar
Chairman,
Board of Studies in Electrical Engineering,
University of Mumbai

Syllabus Scheme for S.E. Semester III Biomedical Engineering

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM301	Applied Mathematics-III$	4	-	1	4	-	1	5
SEBM302	Electronic Circuits and Design – I	4	2	-	4	1	-	5
SEBM303	Electrical Network Analysis and Synthesis	4	-	1	4	-	1	5
SEBM304	Human Anatomy and Physiology	4	2	-	4	1	-	5
SEBM305	Biomaterials	4	-	1	4	-	1	5
SEBM306	Object Oriented Programming & Methodology $	-	4#	-	-	2	-	2
	TOTAL	20	8	3	20	4	3	27

Out of 4 hours, 2 hours theory shall be taught to the entire class followed by 2 hrs. practical in batches.

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM301	Applied Mathematics-III $	20	20	20	80	25	-	-	125
SEBM302	Electronic Circuits and Design – I	20	20	20	80	25	25	-	150
SEBM303	Electrical Network Analysis and Synthesis	20	20	20	80	25	-	-	125
SEBM304	Human Anatomy and Physiology	20	20	20	80	25	-	25	150
SEBM305	Biomaterials	20	20	20	80	25	-	25	150
SEBM306	Object Oriented Programming & Methodology $	-	-	-	-	50	50*	-	100
TOTAL				100	400	175	75	50	800

*Both Practical and Oral examination

$ Subject common for Electronics and Telecommunication Engineering, Electronics Engineering, Biomedical Engineering, Electrical Engineering and Instrumentation Engineering.

Syllabus Scheme for S.E. Semester IV Biomedical Engineering

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM401	Applied Mathematics-IV $	4	-	1	4	-	1	5
SEBM402	Electronic Circuits and Design – II	4	2	-	4	1	-	5
SEBM403	Transducers and Sensors for Medical Applications	4	2	-	4	1	-	5
SEBM404	Logic Circuits	4	2	-	4	1	-	5
SEBM405	Signals and Systems	4	-	1	4	-	1	5
SEBM406	Electronic Instruments and Control System	4	2	-	4	1	-	5
	TOTAL	24	8	2	24	4	2	30

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM401	Applied Mathematics-IV $	20	20	20	80	25	-	-	125
SEBM402	Electronic Circuits and Design – II	20	20	20	80	25	25	-	150
SEBM403	Transducers and Sensors for Medical Applications	20	20	20	80	25	-	25	150
SEBM404	Logic Circuits	20	20	20	80	25	25	-	150
SEBM405	Signals and Systems	20	20	20	80	25	-	25	150
SEBM406	Electronic Instruments and Control System	20	20	20	80	25	-	25	150
TOTAL				120	480	150	50	75	875

$ Subject common for Electronics and Telecommunication Engineering, Electronics Engineering, Biomedical Engineering, Electrical Engineering and Instrumentation Engineering.

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM301	**Applied Mathematics-III**	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM301	**Applied Mathematics-III**	20	20	20	80	25	-	-	125

Course Objectives	To provide students with a sound foundation in Mathematics and prepare them for graduate studies. To provide students with mathematics fundamental necessary to formulate, solve and analyze engg. problems. To provide opportunity for students to work as part of teams on multi disciplinary projects.
Course Outcomes	Students will demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable. Students will demonstrate an ability to identify formulate and solve electronics and telecommunication Engg. problem using Applied Mathematics. Students will show the understanding of impact of Engg. Mathematics on Telecom Engg. Students who can participate and succeed in competitive exams like GATE, GRE.

Module	Contents	Time
1.	**Laplace Transform (LT) of Standard Functions:** Definition. unilateral and bilateral Laplace Transform, LT of *sin(at), cos(at),* e^{at}, t^n , *sinh(at), cosh(at), erf(t),* Heavi-side unit step, dirac-delta function, LT of periodic function **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, initial and final value theorem, Parsavel's identity **Inverse Laplace Transform:** Partial fraction method, long division method, residue method **Applications of Laplace Transform:** Solution of ordinary differential equations	12 hrs.
2.	**Introduction:** Definition, Dirichlet's conditions, Euler's formulae **Fourier Series of Functions:** Exponential, trigonometric functions, even and odd functions, half range sine and cosine series Complex form of Fourier series, orthogonal and orthonormal set of functions, Fourier integral representation.	10 hrs.
3.	**Solution of Bessel Differential Equation:** Series method, recurrence relation, properties of Bessel function of order +1/2 and -1/2 Generating function, orthogonality property Bessel Fourier series of functions	08 hrs.
4.	**Scalar and Vector Product**: Scalar and vector product of three and four vectors and their properties **Vector Differentiation:** Gradient of scalar point function, divergence and curl of vector point function **Properties:** Solenoidal and irrotational vector fields, conservative vector field **Vector Integral:** Line integral, Green's theorem in a plane, Gauss' divergence theorem, Stokes' theorem	12 hrs.
5.	**Complex Variable** Analytic Function: Necessary and sufficient conditions, Cauchy Reiman equation in polar form Harmonic function, orthogonal trajectories **Mapping:** Conformal mapping, bilinear transformations, cross ratio, fixed points, bilinear transformation of straight lines and circles	10 hrs.

Text books:

1. P. N. Wartikar and J. N. Wartikar, *"A Text Book of Applied Mathematic"*, Vol. I & II, Vidyarthi Griha Prakashan
2. A. Datta, *"Mathematical Methods in Science and Engineering"*, 2012
3. B.S. Grewal, *"Higher Engineering Mathematics"*, Khanna Publication

Reference Books:

1. B. S. Tyagi, *"Functions of a Complex Variable,"* Kedarnath Ram Nath Publication
2. B. V. Ramana, *"Higher Engineering Mathematics"*, Tata Mc-Graw Hill Publication
3. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
4. Erwin Kreysizg, *"Advanced Engineering Mathematics"*, John Wiley & Sons, Inc
5. Murry R. Spieget, *"Vector Analysis"*, Schaum's outline series, Mc-Graw Hill Publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

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.

Term Work:

At least 08 assignments covering entire syllabus must be given during the **‗class wise tutorial'**. The assignments should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per **‗credit and grading system'** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM302	**Electronic Circuits and Design – I (abbreviated as ECAD-I)**	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM302	**Electronic Circuits and Design – I**	20	20	20	80	25	25	-	150

Course Objectives	This course provides basic platform to understand various electronic components and concepts used in electronic systems. Working, analysis, advantages, shortcomings and application of various electronic systems such as diodes, various transistors, multistage amplifiers etc. is covered in detail. Designing and implementing these electronic systems in laboratory is the key component of the course.
Course Outcomes	Student will be able to design and implement amplifiers as per the specifications given. It will be possible to analyze given electronic system at the circuit level.

Module	Contents	Time
1.	**Diode Circuits:** Basics of PN junction diode - Equation, characteristics. Clipper and Clamper Circuits, Zener Diode –working, Characteristics.	05 hrs.
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 hrs.
3.	**A.C. Equivalent Model** – $\mathbf{r_e}$ model, h-parameter model (Exact and Approximate). A.C. Analysis: A.C. load line, A.C. analysis of amplifiers using CE, CB and CC configurations considering effect of Rs and RL, Comparison between various amplifiers. Low frequency and High frequency model, Frequency response of Single stage amplifier. Design of single stage amplifier using BJT.	10 hrs.
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 configurations. considering effect of Rs and RL, Comparison between various amplifiers. Low frequency and High frequency model, Frequency response of Single stage amplifier. Design of single stage amplifier using JFET.	12 hrs.
5.	**MOSFET:** Working of Depletion and Enhancement MOSFET. Characteristics and equations. Basic MOSFET Applications: Switch, Digital Logic Gate and Amplifier.	03 hrs.
6.	**Multistage Amplifiers:** Cascade: BJT-BJT, FET-BJT. Cascode – DC and AC analysis, characteristics and applications. Darlington - DC and AC analysis, characteristics and applications.	08 hrs.

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.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

Term work consists of minimum eight experiments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :15 marks
Attendance (Practical and Theory) :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Experiments:

1. Clippers and Clampers
2. BJT characteristics in CE configurations
3. Biasing of BJT
4. BJT as a switch
5. BJT as CE Amplifier
6. Frequency response of BJT
7. FET Characteristics
8. FET as a CS Amplifier
9. Frequency response of JFET
10. Simulations of transistorized circuits

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 edtion, sroff publishers.
4. Donald Schilling & charles belove, electronic circuits discrete and integrated, third edition, Mcgraw Hill.

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM303	**Electrical Network Analysis and Synthesis (abbreviated as ENAS)**	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM303	**Electrical Network Analysis and Synthesis**	20	20	20	80	25	-	-	125

Course Objectives	To provide a methodical approach to problem solving. To learn a number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, theorems, source transformation and several methods of simplifying networks. To understand the concept of graphical solution to electrical network To understand frequency response in electrical circuits.
Course Outcomes	Students will develop expertise in designing and analyzing basic electronic circuits that are used as basic building blocks in various communication systems. The knowledge gained will develop ability in them for understanding industry requirement and to design/offer customized solutions as needed. The student will be able to obtain solution to problems in electrical network using different techniques, obtain graphical solution to electrical network, solve problems on frequency response, and synthesize transfer functions in different forms.

Module	Contents	Time
1.	**Introduction:** Review of D.C. & A.C. circuits, DC Circuits: Current & Voltage Source Transformation, Source Shifting **Mesh & Node Analysis:** Mesh & Node Analysis of D.C. & A.C. circuits with independent & dependent sources. (Introduction to coupled circuits).	07 hrs.
2.	**Network Theorems (** D.C. & A.C. circuits)**:** Superposition, Thevenin‘s & Norton‘s Theorem (with independent and dependent sources), Maximum power transfer theorem.	06 hrs.
3.	**Circuit Analysis:** Introduction to Graph Theory. Tree, link currents, branch voltages, cut set & tie set, Mesh & Node Analysis, Duality.	06 hrs.
4.	**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.	09 hrs.
5.	**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.	10 hrs.
6.	**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.	10 hrs.

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.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Term work:

Term work consists of minimum eight assignments. The distribution of the term work shall be as follows,

Laboratory work (Assignments, Journal & visit) :15 marks
Attendance (Practical and Theory) :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Experiments:

Minimum Three experiments from the below mentioned list should be performed

1. a) To study Z parameters of a two port network.
   b) To study Y parameters of a two port network.

2. To study the cascade network of two port network
3. To study and verify Maximum power theorem
4. To study the second order frequency response of an RLC circuit

To study Time Response of first order system

List of Tutorials:

Minimum seven tutorials from the below mentioned list should be conducted

1. Mesh & Node Analysis and Network Theorems
2. Circuit Analysis
3. Time and Frequency Response of Circuits (Transient Analysis)
4. Time and Frequency Response of Circuits (Laplace Transform Analysis)
5. Two-Port Networks (Two-Port Parameters)
6. Two-Port Networks (Inter Relationship of different parameters. Interconnections of two-port networks)
7. Fundamentals of Network Synthesis (Hurwitz polynomials and Positive real functions)
8. Fundamentals of Network Synthesis (Driving Point Synthesis with L-C, R-C, R-L and R-L-C networks)

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.

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM304	**Human Anatomy and Physiology (abbreviated as HAP)**	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM304	**Human Anatomy and Physiology**	20	20	20	80	25	-	25	150

Course Objectives	To understand the human anatomy and functions of various body structures. To understand different physiological processes taking place inside human body.
Course Outcomes	Students will be well versed with the anatomy and physiology of human body. By this they will be able to correlate the knowledge of medicine and engineering for development of various instrumentation.

Module	Contents	Time
Anatomy		
1.	**Cell:** Structure and functions of cell. Polarization and depolarization of cell. **Body Structure:** Basic tissues and their functions in brief. Outline of structures of the following system. Cardiovascular System, Respiratory System, Alimentary System, Central Nervous System. Reproductive System, Urinary System, Skeletal System, Muscular System, Endocrine System**,** Special Organs – Eye and Ear, Integumentary system (Skin Study)	10 hrs.
Physiology		
2.	**Cardiovascular System**: Heart, Conductive tissues of heart, Cardiac cycle, Heart Valves, System and Pulmonary Circulation, Transmission of Cardiac Impulse, Blood Pressure, ECG (Einthoven's Triangle, Various leads and Waveforms). **Respiratory System:** Respiration external (Ventilation) Exchange in gases in the alveoli, Artificial respiration. Spiro meter (Forced expiratory volumes) peak flow meter.	10 hrs.
3.	**Blood:** Composition of Blood – Blood cells and their functions. Cell counting, Hemoglobin, Blood groups, Coagulation, Blood transfusion. **Muscle Physiology:** Muscle physiology and aspects of skin resistance	06 hrs.
4.	**Alimentary System:** All organs of the digestive system, other secretions and main Functions. Deglutition and defecation. **Excretory System:** Structure of Nephron, formation of urine and function of Kidney, Urinary Bladder, urethra, internal / external sphincters.	08 hrs.
5.	**Nervous System:** Different parts, their functions. Reflex actions and reflex are, Function of Sympathetic and Parasympathetic nervous system. Never conduction and action potentials. **Eyes and Ears:** Eyes-Structure, Refractive Medias of the eye, formation of image on the Retina, Ophthalmoscope. Ear – Structure of Cochlea, Hearing mechanism, type of Deafness. Hearing aid.	08 hrs.
6.	**Reproductive System:** (Male and Female) Different organs and their functions. Main actions of Androgens, Oestrogens and Progesterone. **Endocrine System:** All glands, their secretions and functions. Control of secretions.	06 hrs.

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.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:
Oral exam will be based on entire subject and the tutorials conducted.

Term work:
Term work consists of minimum eight assignments. The distribution of the term work shall be as follows,

Laboratory work (Assignments, Journal & visit)	:15 marks
Attendance (Practical and Theory)	:10 marks

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

List of Experiments:
1. To measure Blood Pressure using sphygmomanometer using occlusive cuff method.
2 To determine hemoglobin count in the blood by Shali‘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 the Defibrillator
7. To study external Pacemaker
8. To study ECG Machine

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)

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM305	**Biomaterials**	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM305	**Biomaterials**	20	20	20	80	25	-	25	150

Course Objectives	To understand the fundamentals of materials used for manufacturing implants, prosthesis and orthoses that has wide application in healthcare industry. To understand the optimal performance of the biomaterials biologically and its biocompatibility with the human system. Students should know the basis of manufacturing processes, effective implementation of biomaterials after surface testing and final implantation. They should be aware of the properties of different biomaterials used and several biological substitutes. They should be aware of the quality testing and the approval by ASTM (American Society of Testing and Materials).
Course Outcomes	This course assigned lectures, tutorials, assignments and industrial visit which enables the students to: Understand the definition of biomaterials, its classification and its surface analysis techniques. The various metallic and ceramic material used for manufacturing of the implants. Several biodegradable polymers and ceramics are utilized for the comfort of the patients, which hydrolizes in situ. Bioglass like 45S5 which has certain amounts of elements in specified proportion, used for biomedical applications in optical areas. The students get awareness about the testing of the biomaterials done biologically before implantation in the human body.

Module	Contents	Time
1.	**Introduction**: Introduction of Biomaterials, Classification of Biomaterials, General Applications. **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.	10 hrs.
2.	**Properties and Applications of Polymeric Biomaterials:** Classification, polyurethanes, PTFE, Polyethylene, Polypropylene, Polyacrylates, PMMA, PHEMA, Hydrogel, Silicone rubber, Biopolymer in fabrication of biodevices and implants, Thermoplastic and thermosetting plastics. **Composite Biomaterials:** Properties and Applications of Composite Biomaterials in fabrication of biodevices and implants, Different fabrication processes.	10 hrs.
3.	**Properties and Applications of Ceramic Biomaterials:** Classification, Alumina, Zirconia and types, Bioglass, Calcium Phosphate, Tricalcium phosphate in fabrication of biodevices and implants. **Properties and Applications of Degradable Biomaterials:** Polymers & Ceramics in fabrication of biodevices and implants.	08 hrs.
4.	**Biomaterials for Soft Tissue Replacements:** Properties and Applications of biomaterials for Soft Tissue Replacements, Bulk Space Fillers, Maxillofacial implants, Fluid transfer Implants, Functional Load carrying and supporting implants, Percutaneous devices, Biomaterials in urological practice, Drug delivery systems, Heart valves, Artificial kidney (dialyzer membrane)	08 hrs.
5.	**Techniques for characterization of Surface properties of Biomaterials:** Electron Spectroscopy for Chemical Analysis(ESCA), Secondary Ion Mass Spectrometry(SIMS), Infrared Spectroscopy, Contact Angle Method, Scanning Electron Microscope(SEM).	06 hrs.
6.	**Biological Testing of Biomaterials:** Physiochemical Test, Mechanical Test, Invitro and Invivo types, Different forms of corrosion, Wear, Electrochemical Corrosion Testing.	06 hrs.

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.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:

Oral exam will be based on entire subject and the tutorials conducted.

Term work:

Term work consists of minimum eight assignments. The distribution of the term work shall be as follows,

Laboratory work (Assignments, Journal & visit) :15 marks

Attendance (Practical and Theory) :10 marks

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

List of Tutorials:

1) Introduction of Biomaterials.
2) Techniques for characterization of Surface properties of Biomaterials.
3) Biological Testing of Biomaterials.
4) Properties and Applications of Metallic Biomaterials and its Biocompatibility.
5) Properties and Applications of Polymeric Biomaterials.
6) Properties and Applications of Ceramic Biomaterials.
7) Biomaterials for Soft Tissue Replacements.
8) Report based on visit or demonstration within the institution.

Visit to Biomaterial manufacturing industry to study the manufacturing of the Biomaterial from raw material to finished product. During the visit the students are required to study.

i. The manufacturing/fabrication steps of Biomaterials. (Related to specific application).
ii. Design considerations/ selection criteria of Biomaterials.(Related to specific application).

The student should submit the detailed report depending on the observations made. The concerned teachers of subject Biomaterial will co-ordinate the visit.

Books Recommended:

Text Books:

1. Biomaterial Science and Engineering: J.V. Park (Plenum Press- New York)
2. Fundaments of Biomedical Engineering: G S. Sawhney (New Age International Publication)
3. Biomaterial Science: An Introduction to Materials in Medicine, Ratner & Hoffmann

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, 2^{nd} Edition – Jonathan Black, Marcel Dekker Inc. New York. Basel. Hong Kong

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM306	Object Oriented Programming & Methodology	-	4 #	-	-	2	-	2

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM306	Object Oriented Programming & Methodology	-	-	-	-	50	50*	-	100

Course Objectives	To understand the concept of Object Oriented Programming To help student to understand use of programming language such as JAVA to resolve problems. To impart problems understanding, analyzing skills in order to formulate Algorithms. To provide knowledge about JAVA fundamentals: data types, variables, keywords and control structures. To understand methods, arrays, inheritance, Interface, package and multithreading and concept of Applet.
Course Outcomes	Students will be able to code a program using JAVA constructs. Given an algorithm a student will be able to formulate a program that correctly implements the algorithm. Students will be able to generate different patterns and flows using control structures and use recursion in their programs. Students will be able to use thread methods, thread exceptions and thread priority. Students will implement method overloading in their code. Students will be able to demonstrate reusability with the help of inheritance. Students will be able to make more efficient programs.

Module	Topic	Time
1.	**Fundamental concepts of object oriented programming** Overview of programming: Introduction to the principles of object-oriented programming: Classes, objects, messages, abstraction, encapsulation, inheritance, polymorphism, exception handling, and object-oriented containers Differences and similarity between C++ and JAVA	4 hrs.
2.	**Fundamental of Java programming** Features of Java , JDK Environment & tools ,Structure of Java program ,Keywords , data types, variables, operators, expressions. Decision making, looping, type casting, Input output using scanner class	4 hrs.
3.	**Classes and objects** Creating classes and objects, Memory allocation for objects Passing parameters to Methods ,Returning parameters Method overloading ,Constructor and finalize ( ) Arrays: Creating an array Types of array : One dimensional arrays ,Two Dimensional array, string	6 hrs.
4	**Inheritance, interface and package** Types of inheritance: Single, multilevel, hierarchical Method overriding, super keyword, final keyword, abstract class Interface, Packages	4 hrs.
5.	**Multithreading** Life cycle of thread, Methods, Priority in multithreading	6 hrs.
6.	**Applet** Applet life cycle ,Creating applet, Applet tag	2 hrs.

Note: Out of four hours of practical two hours to be conducted as theory

Text Books:

1. Rajkumar Buyya, –*Object-oriented programming with JAVA"*, Mcgraw Hill
2. E Balgurusamy, *"Programming with JAVA",* Tata McGraw Hill

Reference Books:

1. Herbert Schildt, *"The Complete Reference JAVA",* Tata McGraw Hill
2. Barry Holmes and Daniel T. Joyce, *"Object Oriented Programming with Java"*, Jones &

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.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per **Credit and Grading** System manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

The Practical / Oral examination will be based on entire syllabus.

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM401	**Applied Mathematics-IV**	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM401	**Applied Mathematics-IV**	20	20	20	80	25	-	-	125

Course Objectives	This course will present the method of calculus of variations (CoV), basic concepts of vector spaces,matrix theory, concept of ROC and residue theory with applications. To provide students with a sound foundation in mathematics and prepare them for graduate studies in Electronics and Telecommunication Engineering To provide students with mathematics fundamental necessary to formulate, solve and analyse engineering problems. To provide opportunity for students to work as part of teams on multi disciplinary projects
Course Outcomes	Students will able to apply method of calculus of variations to specific systems, demonstrate ability to manipulate matrices and compute eigenvalues and eigenvectors, Identify and classify zeros, singular points, residues and their applications. Students will demonstrate an ability to identify formulate and solve Telecommunication Engineering problem using applied mathematics. Students who can participate and succeed in competitive exams like GATE, GRE

Module	Content	Time
1.	**Calculus of variation** Euler 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 Isoperimetric problems, several dependent variables **Functions involving higher order derivatives:** Rayleigh-Ritz method	10 hrs.
2.	**Linear algebra: vector spaces** **Vectors in n-dimensional vector space**: Properties, dot product, cross product, norm and distance properties in n-dimensional vector space. Metric spaces, vector spaces over real field, properties of vector spaces over real field, subspaces. Norms and normed vector spaces Inner products and inner product spaces The Cauchy-Schwarz inequality, orthogonal Subspaces, Gram-Schmidt Process	12 hrs.
3.	**Linear Algebra: Matrix Theory** Characteristic equation, Eigenvalues and Eigenvectors, properties of Eigenvalues and Eigenvectors Cayley-Hamilton theorem, examples based on verification of Cayley-Hamilton theorem Similarity of matrices, Diagonalisation of matrix Functions of square matrix, derogatory and non-derogatory matrices Quadratic forms over real field, reduction of quadratic form to a diagonal canonical form, rank, index, signature of quadratic form, Sylvester‘s law of inertia, value-class of a quadratic form of definite, semidefinite and indefinite Singular Value Decomposition	15 hrs.
4.	**Complex Integration:** Line Integral, Cauchy‘s Integral theorem for simply connected regions, Cauchy‘s Integral formula Taylor‘s and Laurent‘s series. **Complex Variables:** Zeros, singularities, poles of f(z), residues, Cauchy‘s Residue theorem Applications of Residue theorem to evaluate real Integrals of different types	15 hrs.

Text books:

1) A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune

2) Mathematical Methods in science and Engineering, A Datta (2012)

3) Higher Engg. Mathematics by Dr. B.S. Grewal, Khanna Publication

Reference Books:

1) Todd K.Moon and Wynn C. Stirling, Mathematical Methods and algorithms for Signal Processing, Pearson Education.

2) Kreyszig E., Advanced Engineering Mathematics, 9th edition, John Wiley, 2006.
3) Linear Algebra- Hoffman & Kunze (Indian editions) 2002
4) Linear Algebra- Anton & Torres (2012) 9th Indian Edition.
5) Complex Analysis – Schaum Series.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

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.

Term Work:

At least 08 assignments covering entire syllabus must be given during the **Class Wise Tutorial**. The assignments should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per **Credit and Grading System** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM402	**Electronic Circuits and Design – II (abbreviated as ECAD-II)**	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM402	**Electronic Circuits and Design – II**	20	20	20	80	25	25	-	150

Course Objectives	The course covers the basic principles of Linear Integrated Circuit and Operational Amplifiers in particular their analysis, design and applications. Few practical and specific IC chips are studied.
Course Outcomes	To acquire the ability to design practical circuits by selecting proper IC chips needed for a particular application.

<table>
<tr><th>Module</th><th>Contents</th><th>Time</th></tr>
<tr><td>1.</td><td>Feedback and Stability:
Introduction to Feedback, Basic Feedback Concepts.
Ideal Close-Loop Gain, Gain Sensitivity Bandwidth Extension, Noise Sensitivity, Reduction of Non-Linear Distortion.
Ideal Feedback Topologies, Series-Shunt, Shunt-Series, Series-Series, Shunt-Shunt Configurations, Voltage (Series-Shunt) Amplifiers, Current (Shunt-Series) Amplifiers, Trans-Conductance (Series-Series) Amplifiers, Trans-Resistance (Shunt-Shunt) Amplifiers, Stability of Feedback Circuit.</td><td>10 hrs.</td></tr>
<tr><td>2.</td><td>Output Stage and Power Amplifiers :
Classes of Power amplifiers, Class-A Operation, Class-B operation, Class AB Operation, Class C Operation,
Analysis of: 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, design of Heat Sinks.</td><td>05 hrs.</td></tr>
<tr><td>3.</td><td>Differential Amplifiers:
Basic Concept, characteristics.
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 and active loads.</td><td>05 hrs.</td></tr>
<tr><td>4.</td><td>Operational Amplifier Circuit Design :
Introduction to an Ideal Operational Amplifier , Operational Amplifier internal circuit, Block Diagram, DC Characteristics, AC Characteristics and equivalent circuit of Op-amp,
Op-amp IC 741 characteristics and its features (Ideal and Practical), Open loop, closed loop concept, frequency response and concept of virtual ground.
Modes of operation: Inverting, Non-inverting, Differential mode.</td><td>05 hrs.</td></tr>
<tr><td>5.</td><td>Operational Amplifiers Applications :
Applications without using any Feedback:
Voltage comparators (Inverting and Non- inverting) and Window detectors, zero detector.
Applications using Negative Feedback:
Adder, Subtractor/differential Amplifier, Voltage follower, Integrator (practical and Ideal), Differentiator (practical and Ideal), Instrumentation amplifier, Voltage to Current and Current to Voltage converters, Precision diodes, Active Half wave rectifiers, Active Full wave rectifier, Clipper, Clampers, Log and Antilog amplifiers, Sample & hold circuits, Peak detector, Gyrator, Negative Impedance convertor, Multipliers and Dividers,</td><td>15 hrs.</td></tr>
</table>

	Isolation Amplifier, Operational Transconductance Amplifiers. • **Applications using Positive Feedback (Waveform generators):** - Schmitt Trigger (Regenerative comparator), Square wave generator (Astable Multivibrator), Monostable Multivibrator, Triangular wave generator, Saw tooth wave generator, Sine wave Generator (Oscillators)	
6.	**Oscillators using Op-Amp:** • 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, Twin T oscillator, Tuned collector oscillator. (Phase shift, Frequency of oscillation, condition of sustained oscillation, circuit operation and Amplitude stability in the above oscillators).	08 hrs.

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.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :15 marks

Attendance (Practical and Theory) :10 marks

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

List of Experiments:

1. Differential Amplifier
2. Negative Feedback.
3. Op-Amp Parameters
4. Op-Amp as integrator.
5. Op-Amp as differentiator
6. Opamp as adder and substractor
7. RC Phase shift oscillator using opamps
8. Wein Bridge Oscillator using opamps
9. Instrumentation Amplifier
10. Schmitt triggers
11. Comparator

12. Class A design
13. Simulations of various circuits

Books Recommended:

Text Books:

3. Electronic Circuit Analysis and Design- Donald A Neamen,
4. Electronic Devices and circuits – R Bolystead.
5. Op-Amps and linear integrated circuits – R. Gayakwad
6. Linear Integrated Circuits: Roy Chaudhary

Reference Books:

1. Integrated Electronics –Millman & Halkias
2. Opamps and linear integrated circuits, Theory and Applications- James Fiore

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM403	**Transducers and Sensors for Medical Applications (abbreviated as TSMA)**	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM403	**Transducers and Sensors for Medical Applications**	20	20	20	80	25	-	25	150

Course Objectives	To provide the knowledge of basic concepts such as 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, biopotential 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	After completion of the above course the students shall be competent in the following ways: 1) They have a clear understanding of generalized medical instrumentation system, general properties of input transducers, static and dynamic characteristics of transducers and sensors. 2) They have a thorough understanding of various transducers and sensors taught in the course. 3) They are able to apply the transducers and sensors learnt in the course in suitable medical contexts. 4) They have a working knowledge of some the transduces and sensors that they have learnt in the course.

Module	Contents	Time
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.	06 hrs.
2.	**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.	08 hrs.
3.	**Temperature Measurement:** Thermistor, Thermocouple, Resistive Temperature Detector, IC based Temperature Measurement Radiation Sensors and Applications	08 hrs.
4.	**Biopotential 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)	08 hrs.
5.	**Chemical Sensors:** Blood gas and Acid- Base Physiology Potentiometric Sensors, Ion Selective Electrodes, ISFETS. Amperometric Sensors, Clark Electrode with examples - pH, pO2, pCO2 Electrodes, Transcutaneous Arterial Oxygen Tension, Carbon Dioxide measurements: capnostat. **Fiber Optic Sensors:** Design Principles in Fabrication of Fiber Optic Sensors - Temperature, Chemical, Pressure.	10 hrs.
6.	**Biosensor:** Classifications: Biological phenomenon, Transduction Phenomenon i.e. Enzyme Sensor and Electrode based: Affinity Sensors (Catalytic Biosensors), Two examples of each Biosensors and Immunosensors. Fiber optic sensor:	08 hrs.

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.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:

Oral exam will be based on entire subject and the tutorials conducted.

Term work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows,

Laboratory work (Assignments and Journal) :15 marks

Attendance (Practical and Theory) :10 marks

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

List of Experiments

1. To study the dynamic behavior of thermometer system.
2. To study the characteristics of a thermistor.
3. To study thermistor linearization.
4. To study the characteristics of a light dependent resister.
5. To study the principle and working of a thermocouple.
6. To study principle and working of LVDT.
7. To study principle and working of a capacitive Transducer.
8. To study principle and working of a strain gage sensor.
9. To study principle and working of a pressure sensor.
10. To study biopotential electrodes.
11. To study electrode skin interface (Contact Impedance).
12. To study pH electrode.

Books Recommended:

Text Books:

1. Medical Instrumentation-Application and Design by John G. Webster.
2. Transducers for Biomedical Measurements: Principles and Applications, Richard S.C. Cobbold, John Wiley & Sons, 1974.
3. Instrument Transducer – An Intro to their performance and design, Hermann K P. Neubert.
4. Biomedical sensors – fundamentals and application by Harry N, Norton.
5. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamma and P. Ake Öberg.
6. 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. Doeblin, McGraw-Hill, 1985.
5. Handbook of Modern Sensors – Physics, Design and Application, Jacob Fraden, AIP press.

<table>
<tr><th rowspan="2">Sub Code</th><th rowspan="2">Subjects</th><th colspan="3">Teaching Scheme</th><th colspan="4">Credits Assigned</th></tr>
<tr><th>Theory</th><th>Pract.</th><th>Tut</th><th>Theory</th><th>Pract.</th><th>Tut</th><th>Total</th></tr>
<tr><td>SEBM404</td><td>Logic Circuits
(abbreviated as LC)</td><td>4</td><td>2</td><td>-</td><td>4</td><td>1</td><td>-</td><td>5</td></tr>
</table>

<table>
<tr><th rowspan="4">Sub Code</th><th rowspan="4">Subject Name</th><th colspan="8">Examination scheme</th></tr>
<tr><th colspan="4">Theory Marks</th><th rowspan="3">Term work</th><th rowspan="3">Pract.</th><th rowspan="3">Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal Assessment</th><th rowspan="2">End Sem exam</th></tr>
<tr><th>Test 1</th><th>Test 2</th><th>Avg.</th></tr>
<tr><td>SEBM404</td><td>Logic Circuits</td><td>20</td><td>20</td><td>20</td><td>80</td><td>25</td><td>25</td><td>-</td><td>150</td></tr>
</table>

Course Objectives	To make students aware of basics of Digital circuits, Logic design various Logic Families, Flip-flops, Design of various counters, registers and their applications.
Course Outcomes	Students will gain expertise on developing analog and digital circuits for various applications in the field of Electronics and Instrumentation.

Module	Contents	Time
1.	**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. **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. **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.	08 hrs.
2.	**Combinational Circuits:** K-MAPS and their use in specifying Boolenan 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.	6 hrs.
3.	**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 Lookaheard adder, Serial adder, Multiplier Magnitude Comparators, 7485 comparator, Arithmetic Logic units. **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.	10 hrs.
4.	**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, 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.	10 hrs.
5.	**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. **Memories:** RAM, ROM the basic cell IC bipolar, CMOS, RAM dynamic RAM cell. Magnetic core NVRAM, bubble memory, CCD, PAL, PLA.	08 hrs.
6.	**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.	06 hrs..

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.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:
Oral exam will be based on entire subject and the practicals conducted.

Term work:
Term work consists of minimum eight experiments. The distribution of the term work shall be as follows,
Laboratory work (Assignments and Journal) :15 marks
Attendance (Practical and Theory) :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Experiments
1. To study the various Logic gates.
2. To design various gates using Universal gates.
3. To design binary to gray code converter and gray to binary converter.
4. To design BCD to Excess3 converter.
5. To design parity generator and parity checker circuits.
6. 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 Synchronous counter.

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.

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM405	**Signals and Systems (abbreviated as SS)**	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM405	**Signals and Systems**	20	20	20	80	25	-	25	150

Course Objectives	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 familiarise with techniques suitable for analysing and synthesising signals and systems both in continuous as well as discrete time domain.
Course Outcomes	Upon the completion of this course, the students should demonstrate the ability to: Represent signals and system mathematically, determine basic parameters ,transformation signal independent variable, describing continuous and discrete systems in terms of differential and difference equations respectively. Derive and calculate convolution sum and integral of LTI systems, properties of system in terms of impulse response. Determine Fourier series representation of CT &DT signals, properties of Fourier series, determine CT and DT Fourier transform of both periodic and non periodic signals, Properties, and convergence issues. Derive and determine Laplace transform, region of convergence, application of Laplace transform .inverse Laplace transform. Derive and determine z-transform, ROC and the properties .inverse z-transform, application of z-transform. Block diagram representation of the system function. Pole zero plots .

Module	Contents	Time
1.	**Introduction to Signals and Systems:** Definition of signals and systems, communication and control systems as examples, Classification of signals: Continuous time and discrete time, even, odd, periodic and non periodic, deterministic and non deterministic, energy and power. Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration (accumulator for DT), time scaling, time shifting and folding, precedence rule. Elementary signals: exponential, sine, step, impulse and its properties, ramp, rectangular, triangular, signum, sinc functions. Systems: Definition, Classification: linear and non linear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.	10 hrs.
2.	**System Analysis:** System modeling: Input output relation, impulse response, block diagram, integro-differential equation. Definition of impulse response, convolution integral, convolution sum, computation of convolution integral using graphical method and analytical method. Properties of convolution, system interconnection, system properties in terms of impulse response, step response in terms of impulse response.	08 hrs.
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, Power Density Spectrum. convergence of Fourier series, Gibbs phenomenon, Fourier transform and its properties. Fourier transform of singular functions. Energy density spectrum.	08 hrs.
4.	**Fourier series of discrete time signal** Harmonically related complex exponential, Determination of discrete time Fourier series – Properties, Discrete time Fourier transform – Properties, Fourier Transform of periodic signals	06 hrs.
5.	**Laplace Transform:** Double sided Laplace transforms, Region of Convergence, properties, Unilateral Laplace Transform, properties, applications of Laplace transform to the solution of differential equations. Relationship between Laplace and Fourier transform.	08 hrs.
6.	**Z-Transformation:** Definition, Region of Convergence, properties and inverse of z transform. Long division method, partial fraction expansion method, residue method – one-sided Z-transform –properties – initial value & final value theorem - solution of LCCDE with initial conditions – zero input response and zero state response - system function – poles and zeros – basic concept of BIBO stability. Analysis of discrete time systems using Z−transform. Relationship between Laplace and Z transform.	08 hrs.

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.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:

Oral exam will be based on entire subject and the tutorials conducted.

Term work:

Term work consists of minimum eight assignments.(Tutorials) The distribution of the term work shall be as follows,

Laboratory work (Assignments, Journal & visit)	:15 marks
Attendance (Practical and Theory)	:10 marks

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

Books Recommended:

Text Books:

1. Oppenheim A. V. & Alan S.Wllisky, Signals and Systems, Pearson Education
2. Simon Haykin & Barry Van Veen, Signals and Systems, Wiley-India

Reference Books:

1. ProakisJ. 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 & EveARiskin, Signals, Systems and Transforms, Pearson Education

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM406	**Electronic Instruments and Control System (abbreviated as EICS)**	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM406	**Electronic Instruments and Control System**	20	20	20	80	25	-	25	150

Course Objectives	To make students learn basic principle of working and applications of various Electronic Instruments. Time domain and Frequency domain analysis of dynamic systems with concepts of stability.
Course Outcomes	Students will be able to effectively use Electronic Instruments in the laboratory for various experiments. They will be able to analyze given systems and suggest modifications.

Module	Contents	Time
Electronic Instruments		
1.	**Electronic and Digital Voltmeter:** Principle of Operation: Ammeter, Voltmeter and Ohmmeter, Advantages of EVM over Conventional type Analog Voltmeter. Factors involved in selection of Voltmeter. 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, ADC 0808. DVM: Ramp type, Dual Slope type, Successive Approximation type, Flash type DVM. Resolution & Sensitivity. Multimeter: Working, Specifications	06 hrs.
2.	**Frequency meter, Phase meter and Function generator:** Digital frequency meter with various applications. Digital Phase meter: Block diagram and working. Signal Generator: Block diagram, Specifications. Function Generator: Block diagram and working, Specifications.	06 hrs.
3.	**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. Measurement of phase and frequency - Lissajous Patterns, Intensity modulation, Velocity modulation. Component testing. Types: Dual trace, Dual beam, Sampling, Analog Storage, Digital Storage, Digital readout oscilloscope – Block diagram, working, applications and comparison.	08 hrs.
Control Systems		
4.	**Introduction to Control Systems:** Basic concepts of control systems, open loop and closed loop systems, difference between open loop and closed loop systems, classifications. Mathematical model of physical systems, transfer function, block diagram algebra, signal flow graph (SFG), Masoin's gain formula, application of SFG to control systems.	08 hrs.
5.	**Time domain analysis :** Standard test signals: Step, ramp, parabolic and impulse signals. Time response of 1st order systems to unit step and unit ramp inputs. Time response of 2nd order to unit step input. Time response specifications. Steady state errors and error constants of different types of control systems Generalized error series method Transient Response	07 hrs.
6.	**Concepts of stability :** Necessary conditions of stability, Hurwitz stability criterion, routh stability criterion, application of routh stability criterion to linear feed back systems, relative stability. Root locus techniques : Root locus concepts, rules for construction of root loci, determination of root locus, root contours. Frequency domain analysis: Introduction, bode plots, determination of stability from Bode plots, Nyquist stability criterion.	13 hrs.

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.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:

Oral exam will be based on entire subject and the tutorials conducted.

Term work:

Term work consists of minimum eight experiments and assignments. The distribution of the term work shall be as follows,

Laboratory work (Assignments, Journal & visit)	:15 marks
Attendance (Practical and Theory)	:10 marks

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

List Of Experiments:

1. FET, Peak Reading and Average reading Voltmeter
2. D to A converter
3. A to D converter
4. Digital Phase meter
5. Study of Front panel of CRO
6. Lissajous Patterns and component testing using CRO

Books Recommended:

Text Books:

1. Cooper W. D. & Helfrick A.D.- Electronic Instrumentation & Measurement Techniques
2. Kalasi H.S.- Electronic Instrumentation
3. Rangan, Sharma and Mani- Instrumentation devices and system
4. A.K. Sawhney- Electrical & Electronic Measurement & Instrumentation.
5. Modern Control Engineering : D.Roy Choudhury, PHI
6. Modem Control Engineering : K. Ogata , PHI
7. Control Systems Engineering : L.J. Nagrath, M. Gopal, Third Edition, New Age International Publishers.

Reference Books:

1. Control System, Theory & Applications : Samarjit Ghosh, Pearson Education
2. System Dynamic and Control : Eroni Umez Erani., PWS Publishing, International Thompson Publishing Company

AC 7/6/2014
Item No. – 4.23

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Biomedical Engineering (Third Year Sem V & VI)

Revised Course (Rev- 2012)

With effect from Academic Year 2014 -15

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

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) 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 Learners'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.

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to Learners-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 Learners's performance. Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, 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 also to achieve recognition of the institution or program meeting certain specified standards. The main focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a Learner 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 undergraduate program in Electrical Engineering, more than twenty senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for undergraduate program in Electrical Engineering are listed below;

- To provide the overall strong technical foundation to formulate, solve and analyse engineering problems during undergraduate program.
- To prepare Learners to demonstrate an ability to identify, formulate and solve electrical based issues.
- To prepare Learners to demonstrate an ability in the area of design, control, analyse and interpret the electrical and electronics systems.
- To prepare Learners for successful career in industry, research and development.
- To develop the ability among Learners for supervisory control and data acquisition for power system application.
- To provide opportunity for Learners to handle the multidisciplinary projects.
- To create the awareness of the life-long learning and to introduce them to professional ethics and codes of professional practice.

The affiliated institutes may include their own PEOs in addition to the above list

To support the philosophy of outcome based education, in addition to stated PEOs, objectives and expected outcomes are also included in the curriculum. I know, this is a small step taken to enhance and provide the quality education to the stake holders.

Dr. M. V. Bhatkar
Chairman,
Board of Studies in Electrical Engineering,
University of Mumbai

Syllabus Scheme for T.E. Semester V Biomedical Engineering

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC501	Biomedical Instrumentation-I	4	2	-	4	1	-	5
BMC502	Microprocessors	4	2	-	4	1	-	5
BMC503	Analog and Digital Circuits Design	4	2	-	4	1	-	5
BMC504	Biomedical Digital Signal Processing	4	2	-	4	1	-	5
BMC505	Principles of Communication Engineering	4	2	-	4	1	-	5
BML506	Business Communication and Ethics	-	2*+2	-	-	2	-	2
	TOTAL	**20**	**14**	**-**	**20**	**7**	**-**	**27**

* Theory for entire class to be conducted

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC501	Biomedical Instrumentation-I	20	20	20	80	25	-	25	150
BMC502	Microprocessors	20	20	20	80	25	-	-	125
BMC503	Analog and Digital Circuits Design	20	20	20	80	25	25	-	150
BMC504	Biomedical Digital Signal Processing	20	20	20	80	25	-	25	150
BMC505	Principles of Communication Engineering	20	20	20	80	25	-	-	125
BML506	Business Communication and Ethics	-	-	-	-	50	-	-	50
TOTAL				**100**	**400**	**175**	**25**	**50**	**750**

Syllabus Scheme for T.E. Semester VI Biomedical Engineering

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC601	Biomedical Instrumentation –II	4	2	-	4	1	-	5
BMC602	Biostatistics	4	-	1	4	-	1	5
BMC603	Biological Modeling and Simulation	3	2	-	3	1	-	4
BMC604	Microcontrollers and Embedded Systems	4	2	-	4	1	-	5
BMC605	Medical Imaging –I	3	2	-	3	1	-	4
BMC606	Digital Image Processing	4	2	-	4	1	-	5
	TOTAL	**22**	**10**	**1**	**22**	**5**	**1**	**28**

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC601	Biomedical Instrumentation –II	20	20	20	80	25	25	-	150
BMC602	Biostatistics	20	20	20	80	25	-	-	125
BMC603	Biological Modeling and Simulation	20	20	20	80	25	-	-	125
BMC604	Microcontrollers and Embedded Systems	20	20	20	80	25	-	25	150
BMC605	Medical Imaging –I	20	20	20	80	25	-	25	150
BMC606	Digital Image Processing	20	20	20	80	25	25	-	150
TOTAL				**120**	**480**	**150**	**50**	**50**	**850**

Syllabus Scheme for T.E. Semester V Biomedical Engineering

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC501	Biomedical Instrumentation-I	4	2	-	4	1	-	5
BMC502	Microprocessors	4	2	-	4	1	-	5
BMC503	Analog and Digital Circuits Design	4	2	-	4	1	-	5
BMC504	Biomedical Digital Signal Processing	4	2	-	4	1	-	5
BMC505	Principles of Communication Engineering	4	2	-	4	1	-	5
BML506	Business Communication and Ethics	-	2*+2	-	-	2	-	2
	TOTAL	**20**	**14**	**-**	**20**	**7**	**-**	**27**

* Theory for entire class to be conducted

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC501	Biomedical Instrumentation-I	20	20	20	80	25	-	25	150
BMC502	Microprocessors	20	20	20	80	25	-	-	125
BMC503	Analog and Digital Circuits Design	20	20	20	80	25	25	-	150
BMC504	Biomedical Digital Signal Processing	20	20	20	80	25	-	25	150
BMC505	Principles of Communication Engineering	20	20	20	80	25	-	-	125
BML506	Business Communication and Ethics	-	-	-	-	50	-	-	50
TOTAL				**100**	**400**	**175**	**25**	**50**	**750**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC501	Biomedical Instrumentation-I (abbreviated as BMI-I	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC501	Biomedical Instrumentation-I	20	20	20	80	25	-	25	150

Course Objectives	1. To understand the basic principle, working and design of various automated diagnostic equipments. 2. To develop skills enabling Biomedical Engineers to serve Hospitals, National and International Industries and Government Agencies. 3. To develop core competency in the field of Biomedical Engineering to gain technical expertise in biology and medicine for effective contribution in the development and improvement of health care solutions. 4. To study various medical instrumentation systems, drug delivery systems and health management systems.
Course Outcomes	Learner will be able to 1. Demonstrate the principles of electronics used in designing various diagnostic equipment. 2. Have in-depth knowledge about different streams in Biomedical Engineering with greater emphasis on health care equipments and the advanced technologies such as Telemedicine, Telemetry, Medical Imaging, etc. 3. Exhibit competency in suggesting, designing and offering the apt, reliable and optimum solution after understanding customer's requirement completely. 4. Demonstrate ability of correlating theoretical concepts with their practical implementation while performing laboratory exercises and project work. 5. Provide a better technical support with exposure to the hospitals and health care industry. 6. Use modern methodologies, multi-disciplinary skill set and knowledge while working on real time projects that demand convergence of engineering, science and technology.

Module	Contents	Time
1.	**Basic principle, technical specification, working and applications of Laboratory Instruments.** 1. Spectrophotometer	10

	2. Colorimeter 3. Electrolyte Analyser 4. Blood cell counter 5. Auto-analyser 6. Blood gas analyser	
2.	**Basic principle, technical specification, working and applications of Laboratory Instruments.** Electrophoresis and types Chromatography ELISA concepts (direct and indirect), reader & washer Microscopes and its types: optical compound, electron microscope, fluorescence microscope.	10
3.	**Blood Flow Measurement:** Electromagnetic, Ultrasonic, NMR and Laser Doppler flowmetry, cardiac output measurement, impedance plethysmography.	08
4.	**Pulmonary Function Analyser and Ventilator:** Respiration measurement technique: Lung volume and capacities. Spirometry, Pulmonary function measurement and analyser, Oximetry, Ventilators and Anesthesia Equipment	12
5.	**Heart Lung machine and types of artificial oxygenator**	03
6.	**Audiometers:** Basic audiometer, Pure tone and Speech audiometer, evoked response Audiometry.	05

Text books:

1. Handbook of Biomedical Enginerring By R.S. Khandpur (TMH Pub).
2. Handbook of Analytical Instruments By R.S. Khandpur (TMH Pub).
3. Medical Instrumentation, Application and Design By J.G. Webster.
4. Medical Electronics – A.G. Patil ,R K Jha, R Hariharan(Excel Books, New Delhi)

Reference Books:

1. Encyclopedia of medical devices and instrumentation - J.G. Webster Vol I, II, III, IV (John Willey).
2. Introduction to Biomedical Equipment Technology By Carr.-Brown (Pearson Education Pub)
3. Introduction to Biomedical Engineering – Joseph Bronzino (CRC Press)
4. Various Instruments Manuals
5. Various internet resources

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal)	:20 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC502	**Microprocessors (abbreviated as MP)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC502	**Microprocessors**	20	20	20	80	25	-	-	125

Course Objectives	1. To develop background knowledge and core expertise in microprocessor. 2. To study the concepts and basic architecture of 8086 Pentium processor and Co-processor 8087. 3. To know the importance of different peripheral devices and their interfacing to 8086. 4. To know the design aspects of basic microprocessor based system. 5. To write assembly language programs in microprocessor for various applications.
Course Outcomes	A Learner will be able to 1. Understand the architecture and software aspects of microprocessor 8086 2. Design assembly language program in 8086 for various applications. 3. Understand co-processor configurations. 4. Interface techniques with 8086 for various applications. 5. Use basic concepts of 8087 Co-processor.

Module	Contents	Time
1.	**Introduction to Microprocessor** Introduction to Microprocessor and Microcontroller, Microcomputer based system elements ,Generalized block diagram of Microprocessor, RISC & CISC CPU Architectures, Harvard & Von-Neumann CPU architecture, Microprocessor Programming languages, Microcomputer System software, Evolution of Microprocessor	04
2.	**Architecture of Intel 8086 Microprocessor** 8086 Architecture and organization, Pin configuration, Pin Functions, Memory segmentation concept, Minimum and Maximum modes of 8086, 8288 Bus Controller, Read and Write bus cycle of 8086, 8086 Memory organization	08
3.	**Instruction set and Programming of 8086** 8086 Addressing modes,8086 Instruction encoding formats and instruction set, Assembler directives, 8086 programming and debugging of assembly language program	10

4.	**Memory Interfacing with 8086:** Introduction, Address Decoding, Interfacing 8086 with RAM and ROM, Comparison between Memory Mapped I/O and I/O Mapped I/O	04
5.	**Peripherals interfacing with 8086** 8086Interrupt structure, Programmable interrupt controller 8259,8259 interfacing with 8086,Programmable Peripheral Interface 8255, , 8086 interfacing with ADC, keyboard and seven segment display using 8255, DMA controller 8237,8086 interfacing with 8237	10
6.	**8087 Math coprocessor** Introduction, 8087 Architecture, Interfacing of 8086 with 8087, 8087 Instruction set, Assembly language Programming based on 8086-8087 system	12

List of Experiments:

1. 16 bit Arithmetic operations - Addition, Subtraction, Multiplication, Division using 8086
2. Logical operations – AND, OR, NOT using 8086
3. Searching Largest and smallest number using 8086
4. Sorting –the numbers in Ascending and Descending order using 8086
5. Code Conversion using 8086 (BCD to Hex, BCD to binary, Hex-BCD etc.)
6. String Manipulation using 8086
7. Interfacing ADC with 8086
8. Interfacing DAC with 8086
9. Parallel Communication between two microprocessor kits using Mode 1 and Mode 2 of 8255.
10. Interfacing 8259 using 8086
11. Computation of area of circle using 8087.
12. Computation of Hypotenuse using 8087.
13. Computation of Roots of Quadratic equation using 8087.

Text books:

1. "8086/8088 family: "Design, Programming an Interfacing", John Uffenbeck: Prentice Hall, 2nd Edition
2. Microcomputer systems 8086/8088 family, Architecture, Programming and Design - Yu-Cheng Liu & Glenn A Gibson, 2nd Edition- July 2003, Prentice Hall of India.
3. "Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing", A.K.Ray & K.M Bhurchandi, Tata Mc Graw Hill , 2006.

Reference Books:

1. "Microprocessors and Interfacing : Programming and Hardware", Douglas V.Hall, second edition , Tata Mc Graw Hill ,2006.
2. " IBM PC Assembly language and programming"Peter Abel, , fifth edition
3. "Pentium Processor System Architecture", Don Anderson, Tom Shanley: MindShare Inc., 2nd Edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks

of both the tests will be considered for final Internal Assessment.
End Semester Examination:
Question paper will comprise of 6 questions, each carrying 20 marks.
The Learners 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.

Term Work:
Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal)	:20 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC503	**Analog and Digital Circuits Design (abbreviated as ADCD)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC503	**Analog and Digital Circuits Design**	20	20	20	80	25	25	-	150

Course Objectives	1. To understand and provide knowledge of various Analog And Digital Circuits Such as Timer IC 555, PLL IC, VCO, 723 voltage regulator . 2. To understand different types of filters and design them for the given specifications. 3. To understand, learn and analyze fundamentals of Electronics and Digital circuits. 4. To develop analytical aptitude and to understand basic electronic concepts related to engineering profession. 5. To develop competency in terms of logical thinking, programming and application skills. 6. To design and develop various circuits for biomedical applications and to develop logical thinking of students.
Course Outcomes	Learner will be able to 1. Acquire the ability to design practical circuits by selecting proper IC chips needed for a particular application 2. Demonstrate knowledge of important concepts from basic sciences and mathematics thus building upon the base obtained in higher school. 3. Demonstrate capability of designing, executing, debugging electronics circuits thus developing an analytical aptitude. 4. Exhibit competency in suggesting, designing and offering the apt, reliable and optimum solution after understanding customer's requirement completely. 5. Demonstrate ability of correlating theoretical concepts with their practical implementation while performing laboratory exercises and project work. 6. Use modern methodologies, multi-disciplinary skill set and knowledge while working on real time projects that demand convergence of engineering, science and technology.

Module	Contents	Time
1.	**Waveform Generation IC's:** • IC 555 Functional Block diagram, Circuit diagram. • IC 555 in Astable Multivibrator(AMV) functional diagram, circuit diagram with application • IC 555 in Monostable Multivibrator (MMV) functional diagram, circuit diagram with application • PLL (IC 565 or equivalent) circuit diagram, and its applications • VCO(IC 566) Circuit diagram and its applications. Function Generator (IC 8038 or equivalent) Circuit diagram and its applications	12
2.	**Special Function IC's:** • F-V convertors and V-F convertors: Circuit diagram and its applications • Instrumentation Amplifier (AD 624 /AD 620) Circuit diagram and its applications, • Monolithic Isolation Amplifier module • Opto-couplers and Opto-isolators PWM (SG 3525 or equivalent) Circuit diagram and its applications	06
3.	**Active Filters:** • Frequency response, design of first order (LP, HP, BP) filter and applications. • Frequency response, design of 2^{nd} order (Chebyshev, Butterworth, Elliptical filters) LP, HP, BP, All pass, Notch, band reject • KRC filter. • Capacitor filter, switched capacitor filter. Generalized Impedance Convertor (GIC)	12
4.	**Power Devices and Circuits:** • SCR's: Basic structure, characteristics, Two transistor and Operations. series and parallel connections of SCRs. • DIAC and TRIAC: Basic Structure and characteristics, applications • UJT: Operation, characteristics, parameters and UJT as a relaxation oscillator Power MOSFET : Device structure, equivalent circuit and characteristics	06
5.	**Voltage Controllers and Regulators :** • Analog switches, Relays : Basic Types • Functional block diagram of Voltage Regulators • Types of voltage regulators: Fixed voltage regulators (78XX and 79XX), Adjustable voltage regulators, linear voltage regulator IC 723, Design of low voltage regulator and high voltage regulator using 723. Switching Mode Power Supply (SMPS)	06
6.	**Motors And Drivers :** Stepper, Servo, DC/AC Motors drivers and geared motors (Basic operation and application)	06

List of Experiments:

1. Design AMV for Duty cycle >=50%
2. Design MMV given duty cycle
3. Application of AMV square wave generator /

4. Application of MMV as a missing pulse detector / frequency divider
5. PLL
6. VCO
7. Function Generator IC
8. Design for Band pass Filter /Band reject
9. Design of Notch filer / Twin T filter
10. Design of Low Pass Filter/ High pas Filter
11. Instrumentation Amplifier
12. IC 723 Voltage regulator

Text books:

1. Op-Amps and linear integrated circuits – R. Gayakwad
2. Linear Integrated Circuits: Roy Chaudhary
3. Design with operational amplifiers and analog integrated circuits. Sergio Franco,
4. Integrated Circuits K.R.Botkar.
5. Power Electronics, Ned Mohan.
6. Power Electronics, M.H.Rashid.
7. Power Electronics, M.D.Singh and K.B.Khanchandani,

Reference Books:

1.Integrated Electronics –Millman & Halkias
2. Opamps and linear integrated circuits, Theory and Applications- James Fiore.
3. Power Electronics, P.C.Sen.
4. Power Electronics, Dr.P.S.Bimbhra,

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Practical and Oral Examination:

Practical and oral examination will be based on experiments performed during the term and the Course - project.

Term Work:

Term work consists of minimum six experiments and a Course – project based on the syllabus. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal)	:10 marks
Course project	:10 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC504	**Biomedical Digital Signal Processing (abbreviated as BDSP)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC504	**Biomedical Digital Signal Processing**	20	20	20	80	25	-	25	150

Course Objectives	1. To build a strong base for developing algorithms for signal processing systems and Imaging systems. 2. To develop competency in terms of logical thinking, programming and application skills. 3. To train and motivate students for pursuing higher education and research for developing cutting edge technologies.
Course Outcomes	A learner will be able to 1. Understand the fundamental techniques and applications of digital signal processing with emphasis on biomedical signals. 2. Implement algorithms based on discrete time signals. 3. Understand Circular and linear convolution and their implementation using DFT analyse signals using discrete Fourier transform. 4. Understand efficient computation techniques such as DIT and DIF FFT algorithms 5. Design FIR filters using window method, digital IIR filters by designing prototype analog filters and then applying analog to digital conversion.

Module	Contents	Time
1.	Basic Elements of DSP concepts of frequency in analog and digital signals –sampling theorems –Discrete time signals and systems- Properties –Z-transform- linear & circular convolution- Correlation –DTFT	08
2.	Introduction to DFT-Properties of DFT,	06
3.	Introduction DIT and DIF FFT algorithms. Use of FFT in linear filtering, Discrete Cosine transforms	06
4.	Review of Design of analog Butterworth and Chebyshev Filters, Frequency transformation in analog domain, Design of IIR Digital Filters using Impulse invariance method-Design of digital Filters using Bilinear transformation	12
5.	Structure of FIR filters-Linear phase filters –Filter design using window technique-	10

	Frequency sampling techniques –Finite Word length effects in digital filters. Realisation of FIR &IIR filters Direct ,cascade and parallel forms	
6.	Introduction to Digital signal Processors–Architecture –Features-addressing formats –functional mode-introduction to commercial Processors. Application of DSP in Biomedical Applications	06

List of Experiments:

1. Basics of Programming
2. Simulations of standard signals
3. Concept of Aliasing
4. Linear convolution circular convolution
5. Discrete Fourier Transform(DFT)
6. Design and simulation of FIR filter
7. IIR filters using Butterworth approximation
8. IIR filter using Chebyshev approximation

Text books:

1. Digital signal processing Principles Algorithms and Application –Proakis &Manolakis –Third edition PHI
2. Digital Signal Processing –Sanjit K. Mithra Tata Mc-graw Hill
3. Digital Signal Processing – S. Salivahanan, C.Gnanapriya, 2/ed Tata McGraw Hill

Reference Books:

1. Digital signal processing – A.V. Oppenheim and R.W.Schafer- PHI
2. Understanding Digital Signal Processing –Richard G. Lyons-3/ed Pearson Publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal) :20 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC505	**Principles of Communication Engineering (abbreviated as PCE)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC505	**Principles of Communication Engineering**	20	20	20	80	25	-	-	125

Course Objectives	1. Provides introduction to the basic principles and techniques used in analog and digital communications. 2. To covers a range of digital modulation techniques which are frequently used in modern communication systems.
Course Outcomes	A Learner will be able to 1. Use the concepts of communication in various biomedical application such as telemetry system, telemedicine.

Module	Contents	Time
1.	**Introduction to communication system :** Elements of communication system, types of communication system, Noise, Signal to Noise ratio, Noise factor, Noise figure, Noise Temperature	04
2.	**Amplitude Modulation :** Mathematical analysis of Am wave, Different types of AM Spectrum, Bandwidth, waveform, DSBFC(Grid Modulated, Plate Modulated, Collector Modulated),DSBSC(FET Balanced Modulator, Ring Diode modulator),SSB(Phase shift method, Filter method, Third method) and Introduction of ISB and VSB, Low level and high level modulator transmitter **AM Receiver:** Receiver Parameters sensitivity, selectivity, fidelity, double spotting, Image frequency and its rejection, dynamic range TRF receiver, superetrodyne receiver, double conversion receiver AM detectors –Simple and Practical Diode detector, Principles and types of tracking, Principles and types of AGC, Demodulation of DSBSC and SSB waves	13
3.	**FM Modulation :** Principles of FM waveform, spectrum, Bandwidth ,FM generation –	09

	Direct and Indirect FM, Principles of AFC, Pre-emphasis and Deemphasise in FM, Effect of noise in FM, Noise Triangle FM demodulation – Simple Slope detector, Balanced slope detector, Foster Seeley discriminator, Ratio detector, Quadrature detector, Block diagram of FM receivers, Capture effect in FM receivers, Difference between AM and FM system	
4.	**Analog Pulse Modulation Techniques :** Sampling Theorem for low pass signals and band pass signals, Proof of Sampling theorem, Concept of Aliasing, PAM, PWM,PPM – Generation, Detection, Advantages, Disadvantages, comparison	06
5.	**Digital Pulse Modulation And Transmission Techniques :** Advantages and Disadvantages of digital transmission, PCMTrasmitter, Receiver, Quantization, Companding, DPCM,DM,ADM – Transmitter, Receiver, Advantages and Disadvantages Digital Transmission – Types of digital transmission (ASK,FSK,PSK) Generation, Detection, Advantages Disadvantages	11
6.	**Multiplexing techniques :** Concept of multiplexing and multiple access, FDM, TDM Transmitter and Receiver, Hierarchy, Application, Advantages Disadvantages, PCM-TDM system, FDMA, TDMA, CDMA	05

List of Experiment:

1. DSB-SC, DSB-FC, SSB AM generation and detection
2. FM generation and detection
3. Pre-emphasis and De-emphasis
4. Sampling and reconstruction
5. PAM generation and detection
6. PWM generation and detection
7. PPM generation and detection
8. PCM generation and detection
9. DM generation and detection
10. Time division multiplexing
11. Frequency division multiplexing

Text books:

1. Electronic communication system – Wayne Tomasi,Pearson Education
2. Electronic communication system – Roy Blake, Thomson Learning
3. Electronic communication system - Kennedy and Devis,TMH

Reference Books:

1. Digital and Analog communication system – Leon W Couch, Pearson Education
2. Principles of communication system – Taub and Schilling ,TMH

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:
Question paper will comprise of 6 questions, each carrying 20 marks.
The Learners 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.

Term Work:
Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal)	:20 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BML506	**Business Communication and Ethics (abbreviated as BCE)**	-	2*+2	-	-	2	-	2

* Theory for entire class to be conducted

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BML506	**Business Communication and Ethics**	-	-	-	-	50	-	-	50

Course Objectives	1. To inculcate in students professional and ethical attitude, effective communication skills, teamwork, skills, multidisciplinary approach and an ability to understand engineer's social responsibilities. 2. 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. 3. To inculcate professional ethics and codes of professional practice 4. To prepare students for successful careers that meets the global Industrial and Corporate requirement' provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.
Course Outcomes	A learner will be able to 1. Communicate effectively in both verbal and written form and demonstrate knowledge of professional and ethical responsibilities 2. Participate and succeed in Campus placements and competitive examinations like GATE, CET. 3. Possess entrepreneurial approach and ability for life-long learning. 4. Have education necessary for understanding the impact of engineering solutions on Society and demonstrate awareness of contemporary issues.

Module	Contents	Time
1.	**Report Writing**	07
	Objectives of report writing	
	Language and Style in a report	
	Types of reports	

	Formats of reports: Memo, letter, project and survey based	
2.	**Technical Proposals**	02
	Objective of technical proposals	
	Parts of proposal	
3.	**Introduction to Interpersonal Skills**	07
	Emotional Intelligence	
	Leadership	
	Team Buliding	
	Assertiveness	
	Conflict Resolution	
	Negotiation Skills	
	Motivation	
	Time Management	
4.	**Meetings and Documentation**	02
	Strategies for conducting effective meetings	
	Notice	
	Agenda	
	Minutes of the meeting	
5.	**Introduction to Corporate Ethics and etiquettes**	02
	Business Meeting etiquettes, Interview etiquettes, Professional and work etiquettes, Social skills	
	Greetings and Art of Conversation	
	Dressing and Grooming	
	Dinning etiquette	
	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions)	
6.	**Employment Skills**	06
	Cover letter	
	Resume	
	Group Discussion	
	Presentation Skills	
	Interview Skills	
	Total	26

References

1. Fred Luthans, “*Organizational Behavior*” , Mc Graw Hill, edition
2. Lesiker and Petit, “*Report Writing for Business*” , Mc Graw 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. R.C Sharma and Krishna Mohan, “*Business Correspondence and Report Writing*”,

7. B N Ghosh, "*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. K. Alex ,"Soft Skills", S Chand and Company
11. Dr.KAlex,"SoftSkills",S Chand and Company
12. R.Subramaniam, "Professional Ethics" Oxford University Press 2013.

List of Assignments

1. Report Writing (Synopsis or the first draft of the Report)
2. Technical Proposal (Group activity, document of the proposal)
3. Interpersonal Skills (Group activity and Role play)
4. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
5. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
6. Corporate ethics and etiquettes (Case study, Role play)
7. Cover Letter and Resume
8. Printout of the PowerPoint presentation

Term Work

Term work shall consist of all assignments from the list.

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

- Assignments **:** **20 marks**
- Project Report Presentation**:** **15 marks**
- Group Discussion**:** **10 marks**
- Attendance **:** **05 marks**

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

Syllabus Scheme for T.E. Semester VI Biomedical Engineering

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC601	Biomedical Instrumentation –II	4	2	-	4	1	-	5
BMC602	Biostatistics	4	-	1	4	-	1	5
BMC603	Biological Modeling and Simulation	3	2	-	3	1	-	4
BMC604	Microcontrollers and Embedded Systems	4	2	-	4	1	-	5
BMC605	Medical Imaging –I	3	2	-	3	1	-	4
BMC606	Digital Image Processing	4	2	-	4	1	-	5
	TOTAL	**22**	**10**	**1**	**22**	**5**	**1**	**28**

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC601	Biomedical Instrumentation –II	20	20	20	80	25	25	-	150
BMC602	Biostatistics	20	20	20	80	25	-	-	125
BMC603	Biological Modeling and Simulation	20	20	20	80	25	-	-	125
BMC604	Microcontrollers and Embedded Systems	20	20	20	80	25	-	25	150
BMC605	Medical Imaging –I	20	20	20	80	25	-	25	150
BMC606	Digital Image Processing	20	20	20	80	25	25	-	175
TOTAL				**120**	**480**	**150**	**50**	**50**	**850**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC601	**Biomedical Instrumentation-II (abbreviated as BMI-II)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC601	**Biomedical Instrumentation-II**	20	20	20	80	25	25	-	150

Course Objectives	1. To understand the basic principle, working and design of various automated diagnostic equipments. 2. To develop skills enabling Biomedical Engineers to serve Hospitals, National and International Industries and Government Agencies. 3. To develop core competency in the field of Biomedical Engineering to gain technical expertise in biology and medicine for effective contribution in the development and improvement of health care solutions. 4. To study various medical instrumentation systems, drug delivery systems and health management systems.
Course Outcomes	Learner will be able to 1. Demonstrate the principles of electronics used in designing various diagnostic equipment. 2. Have in-depth knowledge about different streams in Biomedical Engineering with greater emphasis on health care equipments and the advanced technologies such as Telemedicine, Telemetry, Medical Imaging, etc. 3. Exhibit competency in suggesting, designing and offering the apt, reliable and optimum solution after understanding customer's requirement completely. 4. Demonstrate ability of correlating theoretical concepts with their practical implementation while performing laboratory exercises and project work. 5. Provide a better technical support with exposure to the hospitals and health care industry. 6. Use modern methodologies, multi-disciplinary skill set and knowledge while working on real time projects that demand convergence of engineering, science and technology.

Module	Contents	Time
1.	**Generation of Bioelectric Potentials:** Basic cell physiology, Nerve, Muscle, Pacemaker and Cardiac muscle	05

2.	**Biophysical signal capture, processing and recording systems (with technical specifications):** Typical medical recording system and general design consideration. Sources of noise in low level recording circuits and their removal techniques. ECG, EMG, EEG, Electrode placement and Measuring techniques for EOG, ERG and Phonocardiography. Measurement of skin resistance. **Biofeedback Technique:** EEG, EMG	13
3.	**Patient Monitoring System:** Measurement of Heart Rate, Pulse rate, Blood pressure, Temperature and Respiration rate, Apnea Detector. Electrical Safety in Biophysical Measurements. Heart rate variability measurement and applications.	10
4.	**Arrhythmia and Ambulatory Monitoring Instruments:** Cardiac Arrhythmias, waveforms and interpretation from them. Stress test measurement. Ambulatory monitoring instruments-Holter monitor **Point of care devices and their design considerations for homecare devices:** glucometer (kidney function), disposable lung function test.	08
5.	**Foetal and Neonatal Monitoring System:** Cardiotocograph, Methods of monitoring of Foetal Heart rate , Incubator and Infant warmer. Non stress test monitoring.	06
6.	**Biotelemetry, Telemedicine concepts and its application**	06

Text books:

1. Handbook of Biomedical Engineering by R.S. Khandpur, PHI
2. Medical Instrumentation, Application and Design by J.G. Webster, TMH.
3. Introduction to Biomedical Equipment Technology by Carr.-Brown (Pearson Education Pub)
4. Introduction to Biomedical Engineering by J Bronzino

Reference Books:

1. Encyclopaedia of medical devices and instrumentation - J.G. Webster Vol I, II, III, IV (John Willey).
2. Principles of applied Biomedical Instrumentation by Geddes and Becker, Wiley interscience publication.
3. Principles of Biomedical Instrumentation and Measurement by Richard Aston
4. Various Instruments Manuals.
5. Various internet resources.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:
Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal)	:20 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC602	**Biostatistics (abbreviated as BST)**	4	-	1	4	-	1	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC602	**Biostatistics**	20	20	20	80	25	-	-	125

Course Objectives	1. To cover basic concepts and theory related to statistics. 2. To focus on various statistical abilities such as analysis of variance, hypothesis testing, estimation, etc.
Course Outcomes	A learners will be able to 1. Apply statistical methods to sample data and analyse it. 2. Develop a strong foundation for designing algorithms for computation.

Module	Contents	Time
1.	Descriptive statistics and probability Frequency distribution, Measures of central tendency, Measures of dispersion Basic probability and Bayes theorem.	04
2.	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	10
3.	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	07
4.	Hypothesis testing Hypothesis testing for – Population mean, difference between two population means, population proportions, difference between two population proportions, population variance, ratio of two population variances Type – I and II error and power of test	07
5.	Analysis of variance Completely randomized design, Randomized complete block design, repeated	13

	measures design, factorial experiment. Regression and Correlation Simple linear regression, correlation model, correlation coefficient, multiple regression, multiple correlation	
6.	Chi square distribution and analysis of frequency Chi-square distribution – properties Test of goodness of fit, independence and homogeneity	07

List of Tutorials:

1. Descriptive statistics and probability
2. Discrete probability distributions
3. Continuous probability distributions
4. Sampling distributions
5. Estimation
6. Hypothesis testing
7. Analysis of variance
8. Regression and Correlation
9. Chi square distribution and analysis of frequency

Text books:

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 Publisher
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

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

At least 08 tutorials covering entire syllabus must be given during the '**class wise tutorial'**. The tutorials should be learners' centric and meaningful, interesting and innovative.

The distribution of the term work shall be as follows,
Tutorials :20 marks

Attendance (Tutorial and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance in tutorial. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC603	**Biological Modeling and Simulation (abbreviated as BMS)**	3	2	-	3	1	-	4

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC603	**Biological Modeling and Simulation**	20	20	20	80	25	-	-	125

Course Objectives	1. To understand basic concepts of modeling for designing biological model. 2. To simulate physiological processes for better understanding. 3. To develop competency in terms of logical thinking, programming and application skills 4. To train and motivate students for pursuing higher education and research for developing cutting edge technologies.
Course Outcomes	A learner will be able to 1. Design hardware and develop software for various biomedical systems. 2. To use various simulation software for modeling biological systems.

Module	Contents	Time
1.	**Physiological Modeling**: Steps in Modeling, Purpose of Modeling, lumped parameter models, distributed parameter models, compartmental modeling, modeling of circulatory system, regulation of cardiac output and respiratory system.	04
2.	**Model of Neurons:** Biophysics tools, Nernst Equation, Donnan Equilibrium, Active Transport (Pump) GHK equation, Action Potential, Voltage Clamp, Channel Characteristics, Hodgkin- Huxley Conductance Equations, Simulation of action potential, Electrical Equivalent model of a biological membrane, impulse propagation- core conductor model , cable equations.	11
3.	**Neuromuscular System:** modeling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex, reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson’s syndrome.	06
4.	**Eye Movement Model:** Four eye movements, quantitative eye movement models, validity criteria.	06
5.	**Thermo regulatory systems:** Thermoregulatory mechanisms, model of thermoregulatory system, controller model, validation and application.	03

6.	**Modelling of other physiological systems.** **Modelling the Immune response:** Behavior of the immune system, linearized model of the immune response. **Modelling of Drug delivery systems.** **Modelling of Insulin Glucose feedback system** and Pulsatile Insulin secretion	06

List of Experiments/Assignments:

Experiments can be carried out using any of these softwares.

1. Simulations using MATLAB
2. Simulations using HHSim
3. Simulations using Neurons in Action
4. Developing a model of neuron using NEURON

Text books:

1. Bioengineering, Biomedical, Medical and Clinical Engg.: A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

Reference Books:

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum six experiments and two assignments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal) :20 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC604	**Microcontrollers and Embedded Systems (abbreviated as MES)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC604	**Microcontrollers and Embedded Systems**	20	20	20	80	25	-	25	150

Course Objectives	1. To learn the basics of Microcontroller designing and interfacing. 2. To understand and improve programming concepts.
Course Outcomes	A learner will be able to 1. Develop understanding of hardware design and will be able to design controller based real time applications. 2. Develop programming skills for designing and developing automated and user friendly systems.

Module	Contents	Time
1.	**Embedded Systems** Definition of embedded systems, overview of embedded systems and its classification, design challenges, processor technology, IC technology, design technology and tradeoffs, examples of embedded systems	04
2.	**MCS-51 Microcontroller** 8051 architecture ; its variants and comparision, comparision of microprocessor and microcontrollers, CPU timing and machine cycle, memory organisation, SFR's, integrated prepherials such as timers/counters, serial ports, parallel I/O ports, interrupt structure, memory interfacing power saving and power down modes.	10
3.	**8051programming** Assembly language programming process, programming tools, Instruction set in detail and addressing modes, Programming practice using assembly and C compilers	12
4.	**Microcontroller design and interfacing case studies** Interfacing with external memories, Interfacing with 8255, Interfacing with 7 segment display, Interfacing with keyboard, interfacing with LCD, Interfacing with ADC,DAC and Sensors, Interfacing with stepper motor Interfacing with PC using RS232	12
5.	**Serial Communication Protocols** Operation of serial port, programming for asynchronous serial communication, Serial Communication using the 'I2C', SPI, Introduction to USB & CAN bus.	05

6.	**Real time operating system** Introduction to RTOS concept, RTOS scheduling models interrupt latency and response times of the tasks as performance metric. Example of any small RTOS system	05

Text books:

1.The 8051 microcontrollers-Kenneth J Ayala

2.Embedded systems-architecture, programming and design, Rajkamal, Tata McGraw Hill

3.Embedded System Design: A unified Hardware/Software Introduction Frank Vahid,Toney Givargis- John Wiley publication

3.An Embedded Software Primer David E. Simon - Pearson Education

4.The 8051 Microcontroller and Embedded Systems Muhammad A Mazidi, , Pearson Education

5.Using MCS-51 Microcontroller Han-Way Huang,.

6. 8051 microcontroller hardware, software applications.V U dayashankara, M S Mallikarjunaswamy,

Reference Books:

1. Sriram Iyer and Pankaj Gupta, Embedded Realtime systems programming, Tata McGraw Hill

2. Embedded Microcomputer Systems- Real time Interfacing -Valvano

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Oral Examination:

Oral examination will be based entire syllabus and on the Course -project.

Term Work:

Term work consists of minimum five experiments and a Course - project based on the syllabus.
The distribution of the term work shall be as follows:
Laboratory work (Experiments and Journal) :10 marks
Course project :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC605	**Medical Imaging-I (abbreviated as MI-I)**	3	2	-	3	1	-	4

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC605	**Medical Imaging-I**	20	20	20	80	25	-	25	150

Course Objectives	1. To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities. 2. To keep the learners abreast with the technological developments in the field of Medical Imaging
Course Outcomes	A Learner will able to 1. Understand essential physics, concepts of Medical Imaging and how they are employed in diagnosis and therapy. 2. Get familiar with the current techniques of medical Imaging along with their clinical applications. 3. To apprehend the importance of radiation constructive utilization and safety.

Module	Contents	Time
1.	**Ultrasound in Medicine:** Introduction , Production and Characteristics of Ultrasound Display System : A mode ,B mode and M mode display and applications. Ultrasound transducers and Instrumentation. Real time Ultrasound ,Continuous wave and Pulsed wave Doppler Ultrasound systems, color flow imaging,applications.	10
2.	**X- ray Imaging:** Properties of X rays,production of X rays, X ray interaction with matter . Total radiographic System : X –ray tubes, Rating of X ray tubes. X –ray generators, X ray Image and beam Limiting Deices, Controls, X ray Film Development Technique.	12
3.	**Flouroscopic Imaging and x ray Image Intensifier Digital subtraction Angiography**	05
4.	**Computed Radiography and Digital Radiography ,Mammography**	04
5.	**Medical Thermography: Physics of thermgraphy, Thermographic equipment, applications.**	03

6.	**Endoscopy : Equipment , Imaging and its applications**	02

Text books:

1. Christensen's Physics of Diagnostic Radiology
2. Medical Imaging Physics William .R.Hendee

Reference Books:

1. Biomedical Technology and Devices by James Moore .
2. Biomedical Engineering Handbook by Bronzino
3. Physics of Diagnostic images –Dowsett

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The Learners 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:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal) :20 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC606	**Digital Image Processing (abbreviated as DIP)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC606	**Digital Image Processing**	20	20	20	80	25	25	-	150

Course Objectives	1. To introduce the learners the basic theory of digital image processing. 2. To expose learners to various available techniques and possibilities of this field. 3. To understand the basic image enhancement, transforms, segmentation, compression, morphology, representation, description techniques & algorithms. 4. To prepare learners to formulate solutions to general image processing problems. 5. To develop hands-on experience in using computers to process images. 6. To familiarize with MATLAB / C/ Labview/ similar software for processing digital images.
Course Outcomes	A learners will be able to 1. Acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description. 2. Analyze images in the spatial domain. 3. Analyze images in the frequency domain through the Fourier transform. 4. Design and implement with MATLAB/C/Labview algorithms for digital image processing operations such as point processing, histogram processing, spatial and frequency domain filtering, denoising, transforms, compression, and morphological processing.

Module	Contents	Time
1.	**Basics of Image Processing**: Image acquisition, Processing, Communication, Display; Electromagnetic spectrum; Elements of visual perception - Structure of the human eye, Image formation in the eye, Brightness adaptation and discrimination, Image formation model, Uniform and non-uniform sampling, Quantization, Image formats.	05
2.	**Image Enhancement**: Spatial domain - Point processing techniques, Histogram processing, Neighbourhood processing, Frequency domain techniques - 2D-DFT, Properties of 2D-DFT, Low pass, High pass, Noise removal, Homomorphic filters,	12

	Basics of colour image processing.	
3.	**Image Segmentation**: Basic relationships between pixels - Neighbours, Adjacency, Connectivity, Regions, Boundaries, Distance measures; Detection of discontinuities, Point, Line, Edge detection, Edge linking, Hough transform, Thresholding-based segmentation, Region-based segmentation.	08
4.	**Image Transforms**: DFT, FFT, DCT, DST, Hadamard, Walsh, Haar, Slant, K-L Transforms, Basis functions and basis images, Introduction to wavelet transform.	08
5.	**Image Compression**: Fundamentals of image compression models, Lossless compression - RLE, Huffman, LZW, Arithmetic coding techniques. Lossy compression - IGS coding, Predictive coding, Transform coding, JPEG, JPEG 2000.	08
6.	**Morphology, Representation and Description**: Dilation, Erosion, Open, Close, Hit-or-miss, Boundary extraction, Region filling, Thinning and thickening; Chain Codes, Polygonal approximations, Signatures; Fourier descriptors, Moments.	07

List of Experiments (using Matlab / C/ Labview/ similar software)

1. Point Processing techniques (At least 4 experiments).
2. Spatial domain Filtering.
3. Histogram Processing (Histogram Stretching and Equalisation).
4. Frequency Domain Filtering (Plotting 2D-DFT, Low pass and High Pass- Ideal, Butterworth and Gaussian Filters).
5. Segmentation-Gradient operators.
6. Transforms-DCT.
7. Morphology-Dilation Erosion.

Text books:

1. Digital Image Processing, Gonzalez and Woods- Pearson Education.
2. Fundamentals of Digital Image Processing, A.K. Jain –P.H.I.
3. Digital Image Processing and Analysis, Chanda Majumder-Printice Hall India.

Reference Books:

1. Digital Image Processing and Computer Vision, Sonka, Hlavac, Boyle-Cengage learning.
2. Digital Image Processing, William Pratt- John Wiley.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal)	:20 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

AC 7/6/2014
Item No. – 4.24

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Biomedical Engineering (Fourth Year Sem VII & VIII)

Revised Course (Rev- 2012)

With effect from Academic Year 2015 -16

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

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) 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 Learners'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.

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to Learners-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 Learners's performance. Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, 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 also to achieve recognition of the institution or program meeting certain specified standards. The main focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a Learner 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 undergraduate program in Electrical Engineering, more than twenty senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for undergraduate program in Electrical Engineering are listed below;

- To provide the overall strong technical foundation to formulate, solve and analyse engineering problems during undergraduate program.
- To prepare Learners to demonstrate an ability to identify, formulate and solve electrical based issues.
- To prepare Learners to demonstrate an ability in the area of design, control, analyse and interpret the electrical and electronics systems.
- To prepare Learners for successful career in industry, research and development.
- To develop the ability among Learners for supervisory control and data acquisition for power system application.
- To provide opportunity for Learners to handle the multidisciplinary projects.
- To create the awareness of the life-long learning and to introduce them to professional ethics and codes of professional practice.

The affiliated institutes may include their own PEOs in addition to the above list

To support the philosophy of outcome based education, in addition to stated PEOs, objectives and expected outcomes are also included in the curriculum. I know, this is a small step taken to enhance and provide the quality education to the stake holders.

Dr. M. V. Bhatkar
Chairman,
Board of Studies in Electrical Engineering,
University of Mumbai

Syllabus Scheme for B.E. Semester VII Biomedical Engineering

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC701	Biomedical Instrumentation-III	4	2	-	4	1	-	5
BMC702	Medical Imaging – II	4	2	-	4	1	-	5
BMC703	Biomechanics Prosthesis and Orthosis	4	2	-	4	1	-	5
BMC704	Very Large Scale Integrated Circuits	4	2	-	4	1	-	5
BMC705	Networking and Information System in Medicine	4	2	-	4	1	-	5
BMP706	Project Stage – I	-	*	-	-	3	-	3
	TOTAL	**20**	**16**	**-**	**20**	**8**	**-**	**28**

* Learner is allotted 6hrs per week for the project work.

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC701	Biomedical Instrumentation-III	20	20	20	80	25	-	25	150
BMC702	Medical Imaging – II	20	20	20	80	25	-	25	150
BMC703	Biomechanics Prosthesis and Orthosis	20	20	20	80	25	-	-	125
BMC704	Very Large Scale Integrated Circuits	20	20	20	80	25	-	-	125
BMC705	Networking and Information System in Medicine	20	20	20	80	25	-	25	150
BMP706	Project Stage – I	-	-	-	-	25	-	25	50
TOTAL				**100**	**400**	**150**	**-**	**100**	**750**

Syllabus Scheme for B.E. Semester VIII Biomedical Engineering

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC801	Nuclear Medicine	4	-	1	4	-	1	5
BMC802	Biomedical Microsystems	4	2	-	4	1	-	5
BMC803	Hospital Management	4	-	1	4	-	1	5
BME804	Elective	4	2	-	4	1	-	5
BMP805	Project Stage – II	-	**	-	-	6	-	6
	TOTAL	**16**	**16**	**2**	**16**	**8**	**2**	**26**

** Learner is allotted 12hrs per week for the project work.

Electives:
BME8011. Lasers and Fiber Optics
BME8012. Robotics in Medicine
BME8013. Health care Informatics
BME8014. Rehabilitation Engineering

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC801	Nuclear Medicine	20	20	20	80	25	-	25	150
BMC802	Biomedical Microsystems	20	20	20	80	25	-	25	150
BMC803	Hospital Management	20	20	20	80	25	-	25	150
BME804	Elective	20	20	20	80	25	-	25	150
BMP805	Project Stage – II	-	-	-	-	50	-	100	150
TOTAL				**80**	**320**	**150**		**200**	**750**

Syllabus Scheme for B.E. Semester VII Biomedical Engineering

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC701	Biomedical Instrumentation-III	4	2	-	4	1	-	5
BMC702	Medical Imaging – II	4	2	-	4	1	-	5
BMC703	Biomechanics Prosthesis and Orthosis	4	2	-	4	1	-	5
BMC704	Very Large Scale Integrated Circuits	4	2	-	4	1	-	5
BMC705	Networking and Information System in Medicine	4	2	-	4	1	-	5
BMP706	Project Stage – I	-	*	-	-	3	-	3
	TOTAL	**20**	**16**	**-**	**20**	**8**	**-**	**28**

* Learner is allotted 6hrs per week for the project work.

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC701	Biomedical Instrumentation-III	20	20	20	80	25	-	25	150
BMC702	Medical Imaging – II	20	20	20	80	25	-	25	150
BMC703	Biomechanics Prosthesis and Orthosis	20	20	20	80	25	-	-	125
BMC704	Very Large Scale Integrated Circuits	20	20	20	80	25	-	-	125
BMC705	Networking and Information System in Medicine	20	20	20	80	25	-	25	150
BMP706	Project Stage – I	-	-	-	-	25	-	25	50
TOTAL				**100**	**400**	**150**	**-**	**100**	**750**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC701	**Biomedical Instrumentation-III (abbreviated as BMI-III)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC701	**Biomedical Instrumentation-III**	20	20	20	80	25	-	25	150

Course Objectives	1. To understand the basic principle, working and design of various automated diagnostic equipments. 2. To develop skills enabling Biomedical Engineers to serve Hospitals, National and International Industries and Government Agencies. 3. To develop core competency in the field of Biomedical Engineering to gain technical expertise in biology and medicine for effective contribution in the development and improvement of health care solutions. 4. To study various medical instrumentation systems, drug delivery systems and health management systems.
Course Outcomes	A Learner will be able to 1. Demonstrate the principles of electronics used in designing various diagnostic equipment. 2. Have in-depth knowledge about different streams in Biomedical Engineering with greater emphasis on health care equipments and the advanced technologies such as Telemedicine, Telemetry, Medical Imaging, etc. 3. Exhibit competency in suggesting, designing and offering the apt, reliable and optimum solution after understanding customer's requirement completely. 4. Demonstrate ability of correlating theoretical concepts with their practical implementation while performing laboratory exercises and project work. 5. Provide a better technical support with exposure to the hospitals and health care industry. 6. Use modern methodologies, multi-disciplinary skill set and knowledge while working on real time projects that demand convergence of engineering, science and technology.

Module	Contents	Time
1.	**Physiotherapy, Electrotherapy Equipments**: Basic principle, working and technical specifications of Shortwave Diathermy, Ultrasonic therapy unit, Infrared and UV lamps, Nerve and Muscle Stimulator.	14
2.	**Surgical Instruments:** Surgical Diathermy machine, electrodes used with surgical diathermy, safety aspects in electronic surgical units, surgical diathermy analyzers.	10
3.	**Cardiac Pacemakers:** Modes of operation, leads and electrodes. Power supply sources. External and Implantable Pacemaker, Performance aspects of Implantable Pacemaker.	8
4.	**Cardiac Defibrillators:** DC defibrillator, Modes of operation and electrodes, Performance aspects of dc-defibrillator, defibrillator analyzers. Implantable defibrillator and defibrillator analyzer.	8
5.	**Hemodialysis Machine:** Basic principle of Dialysis and its type. Different types of dialyzer membrane, Portable type. Various monitoring circuits.	4
6.	**Laser Applications in Biomedical Engineering** Laser classifications, Types of Lasers, Medical Applications, Laser delivery Systems and safety.	4

Text books:

1. Handbook of Biomedical Instrumentation: R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)

Reference Books:

1. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
2. Various Instruments Manuals.
3. Various internet resources.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal) :20 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC702	**Medical Imaging-II (abbreviated as MI-II)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC702	**Medical Imaging-II**	20	20	20	80	25	-	25	150

Course Objectives	1. To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities. 2. To keep the learners abreast with the technological developments in the field of Medical Imaging
Course Outcomes	A Learner will able to 1. Understand essential physics, concepts of Medical Imaging and how they are employed in diagnosis and therapy. 2. Get familiar with the current techniques of medical Imaging along with their clinical applications. 3. To apprehend the importance of radiation constructive utilization and safety.

Module	Contents	Time
1.	**Principle of Computed tomography** Scanner configurations/generations, CT system: Scanning unit(gantry), detectors, data acquisition system, spiral CT, scanner parameters, CT Number Reconstruction techniques, Radon Transform, Filtered Back projection, Fourier Reconstruction Technique, Iterative reconstruction Technique, Image quality and artifacts, Clinical applications of CT	10
2.	**Advancements in CT** Multi-detector computed tomography (MDCT), Flat panel detectors CT-Angiography contrast agents in CT	06
3.	**Nuclear Magnetic Resonance:** Physics of MRI, Relaxation Parameters and Spin Echoes, Magnetic Field Gradients, Slice selection and Frequency Encoding	06
4.	**Magnetic Resonance Imaging** Hardware: Magnets, Gradient systems, RF coils, Fourier Reconstruction techniques, Image contrast, Resolution and Factors affecting signal-to-noise. Safety Considerations/Biological Effects of MRI	10

5.	Pulse sequences in MRI,Contrst agents MR Angiography,Perfusion MRI, Clinical applications	08
6.	**Magnetic Resonance Spectroscopy (MRS)** Basic Principle of MRS and localization techniques, Chemical Shift Imaging, Single-voxel and Multivoxel MRS, Water Suppression techniques	08

Text books:

1. Physics of Diagnostic Radiology :Christensen
2. Medical Imaging Physics William .R.Hendee

Reference Books:

1. Biomedical Technology and Devices by James Moore .
2. Biomedical Engineering Handbook by Bronzino
3. Physics of Diagnostic images –Dowsett

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal) :20 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC703	**Biomechanics Prosthesis and Orthosis (abbreviated as BPO)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC703	**Biomechanics Prosthesis and Orthosis**	20	20	20	80	25	-	-	125

Course Objectives	1. To recall the general characteristics, mechanical properties of bone and tissues. 2. To analyze the forces at joints for various static and dynamic human activities; analyze the stresses and strains in biological tissues. 3. To understand principles used in designing orthoses and prostheses. 4. To study different materials used for orthoses and prosthesis. 5. To understand the fabrication of prostheses and orthoses.
Course Outcomes	A learner will be able to 1. Understand the definition of biomechanics, prostheses orthoses and its classification and design principles. 2. Develop a better understanding of how mechanical principles influence human motion during everyday life.

Module	Contents	Time
	BIOMECHANICS	
1.	**Force system:** Classification of force system. Equilibrium of force system.	02
2.	**Tissue Biomechanics**: Direct shear, bending and torque actions and the corresponding stresses and strains in biological tissues. Stress relaxation and creep. Bone structure & composition, Mechanical properties of bone, Fracture mechanism & crack propagation in bones. Soft connective (skin, tendon, ligaments, etc.) covering structure function, and physiological factors.	12
3.	**Movement Biomechanics:** Study of joints and movements. Anatomical levers, Gait Analysis.	08
4.	**Joint analysis**: Instrumentation for gait analysis: Measurement devices-footswitches, instrumented	07

	walkway, Motion analysis- interrupted light photography, film/video, Selspot, Goniometers.	
	PROSTHETICS AND ORTHOTICS	
5.	**Principles in designing orthoses and prostheses:** Principles of three point pressure, total contact, partial weight bearing.	06
6.	**Classification in prosthetics and orthotics:** Lower Extremity orthoses and prostheses, Upper Extremity orthoses and prostheses. Spinal orthoses.	13

List of Experiments:

1. To study the concurrent coplanar force system.
2. To study the Stress – Strain relation of Mild steel
3. To study the Classification of the human bones
4. To study different types of joints in human body and joint movements
5. To study the Classification of Muscles
6. To simulate elbow joint using bell crank lever.
7. To study the human gait cycle
8. To study the Gait Cycle Parameters
9. Fabrication of PTB/socket.

The concerned teachers of the Course BPO can arrange the visit in rehabilitation centre.

Text books:

1. Basic Biomechanics- Susan J. Hall, MC Graw Hill.
2. Basics of Biomechanics" by Dr. Ajay Bahl and others
3. Basic Biomechanics of the Musculoskeletal System,M. Nordin, V.Frankel
4. Human Limbs and their substitutes – Atlas, C. V. Mosby
5. American Atlas of Orthopedics: Prosthetics, C. V. Mosby.
6. American Atlas of Orthopedics: Orthotics, C. V. Mosby
7. Biomechanics - Prof Ghista (Private Publication UAE)
8. Biomechanics – By White and Puyator (Private Publication UAE)

Reference Books:

1.Introductory Biomechanics: from cells to tissues by Ethier and Simmons
2.Biomechanics: Mechanical properties of living tissues by Y. C. Fung

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:
Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal)	:20 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC704	Very Large Scale Integrated Circuits (abbreviated as VLSI)	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC704	Very Large Scale Integrated Circuits	20	20	20	80	25	-	-	125

Course Objectives	1. To introduce to various fabrication technologies for electronic devices. 2. To expose to hardware description language which will help them to understand and design various tools for the devices.
Course Outcomes	A Learner will be able to 1. Understand the technology behind the integrated circuits and will be able to design them as for various VLSI applications.

Module	Contents	Time
1.	Introduction to VHDL hardware description language, core features of VHDL, data types, concurrent and sequential statements, data flow, behavioral, structural architecture. Architecture of Xilinx XC4000 FPGA family	08
2.	Combinational and Sequential Logic design using VHDL .Using VHDL combinational circuit design examples- multipliers, decoders and encoders, cascading comparator. VHDL sequential circuit design features. Implementation of counters and registers in VHDL	08
3.	Very Large Scale Integration (VLSI) Technology Physics of NMOS, PMOS, enhancement and depletion mode transistor, MOSFET, threshold voltage, flatband condition, linear and saturated operation, FET capacitance, short channel and hot electron effect.	08
4.	MOS Transistors, MOS transistor switches, Basic MOS inverter and its working, types of MOS invertors viz active load nMOS inverter, MOSFET Inverter with E-nMOS as pull up, MOSFET Inverter with D- nMOS as pull up, MOSFET Inverter with pMOS as pull up, cmos inverter, voltage transfer characteristics, noise immunity and noise margins, power and area considerations ,Parameter measurement in MOS circuits	08
5.	Silicon Semiconductor Technology Wafer processing, mask generation, oxidation,	08

	epitaxy growth diffusion, ion implantation, lithography, etching, metalization, basic NMOS and PMOS processes. Latch up in CMOS and CMOS using twin tub process. Scaling of MOS circuits, types of scaling and limitations of scaling.	
6.	Design rules and Layout NMOS and CMOS design rules and layout, Design of NMOS and CMOS inverters, NAND and NOR gates. Interlayer contacts, butting and buried contacts, stick diagrams, layout of inverter, NAND and NOR gates. Design of basic VLSI circuits Design of circuits like multiplexer, decoder, priority encoder, Flip flops, shift registers using MOS circuits	08

List of Experiments:

1. Study of NMOq W modulation of NMOS channel (Using ORCAD or similar software)
2. Study of CMOS Inverter characteristics (Using ORCAD or similar software)
3. Basic Logic gates (using VHDL)
4. Binary to gray and Gray to Binary code conversion(using VHDL)
5. Binary to Excess-3 code conversion(using VHDL)
6. Implementation of 4:1/8:1 Mux(using VHDL)
7. Implementation of 3:8 Deoder(using VHDL)
8. Implementation of one bit Half Adder a Full adder (using VHDL)
9. Implementation of 4 bit full adder using half adder as component(using VHDL)
10. Implementation of JK flip flop(using VHDL)

Text books:

1. Introduction to VLSI design, E. D. Fabricus, McGraw Hill Publications, first edition, 1990
2. Basic VLSI Design D.A. Pucknell and Eshraghian,
3. Digital Design Principles and Practises John F Wakerly,
4. CMOS Digital Integrated Circuits, Kang , Tata McGraw Hill Publications

Reference Books:

1. VHDL Programming by Examples Douglas Perry, , Tata McGraw Hill Publications, 2002
2. Principles of CMOS VLSI Design : ASystems Perspective Neil H.E. Weste, Kamran Eshraghian second edition, Addison Wesley Publications, 1993
3. Digital Integrated Circuits: A Desiqn Perspective, Rabaey Jan M., Chandrakasan Anantha, Nikolic Borivoje, second edition, Prentice Hall of India

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal)	:20 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC705	**Networking and Information System in Medicine (abbreviated as NISM)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC705	**Networking and Information Systems in Medicine**	20	20	20	80	25	-	25	150

Course Objectives	1. To understand the fundamental component of computer Networking. 2. To understand the functioning and configuration of various networking devices and components. 3. To understand a concept about network security. 4. To understand the healthcare IT infrastructure and also the prevalent standards in healthcare informatics.
Course Outcomes	A Learner will be able to 1. Design and configure basic computer network. 2. Understand the information system of healthcare.

Module	Contents	Time
	Networking Technology	
1.	LAN, MAN, WAN, Performance of network/device parameters Ethernet Technology: Ethernet types, Types of cables and connectors, Crossover and straight through cables, Colour coding of cables OSI Model, TCP/IP, Addressing types (IP, MAC & Port)	08
2.	IP V4 addressing, Subnetting, Supernetting, IP V6, Detailed working of networking equipment: HUB, Switch, Router, Modem, Bridge; Packet switching, Circuit switching.	08
3.	Basic Security Concepts Security Mechanism and security services, Authentication, Authorization, Confidentiality, Integrity, Symmetric and Asymmetric Key cryptography, RSA algorithm	06
	Information Systems in Medicine	
4.	PACS Components, Generic workflow, PACS architectures stand-alone, client-server, and Web-based, PACS and Teleradiology, Enterprise PACS and ePR System with Image Distribution	10

5.	Introduction to RIS and HIS, HIS/RIS/PACS integration, PIR, Storage Area Network, Network Attached storage, RAID, PACS Server & Archive and operating systems	08
6.	Introduction to Healthcare informatics standard HL7 and DICOM, IHE, IHE Domains, Legal issues in PACS, HIPAA.	08

List of Experiments:

1. Study of various networking cables, demonstration of crimping of cables and configuring networking parameters for computer.
2. Tutorial on IP addressing.
3. Introduction and basic commands used in various network simulation software.
4. Internetwork Communcation through Router and Switch, See the Mac Table of each switch and Routing table of Router
5. Static routing configuration.
6. Generating the HL7 message format.

Text books:

1. PACS and Imaging Informatics by Huang, Second Edition, Wiley and Blackwell
2. PACS Guide to Digital Revolution by Keith J. Dreyer (Springer)
3. Data Communication and Networking by Behrouz A. Forouzan McGrow Hill
4. Computer Networks by A.S. Tanenbaum, Pearson Education

Reference Books:

1. Governance of Picture Archiving and Communications Systems by Carrison K.S. Tong (Medical Information Science Reference)
2. Practical Imaging Informatics, By Barton F. Branstetter, Springer
3. PACS fundamentals- By Herman Oosterwijk
4. Cryptography and Network Security By William Stalling, Pearsons

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal) :20 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMP706	Project Stage - I	-	*	-	-	3	-	3

* Learner is allotted 6hrs per week for the project work.

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMP706	Project Stage - I	-	-	-	-	25	-	25	50

Guidelines for Project

- Learners should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Learners should use multiple literatures and understand the problem. Learners should attempt solution to the problem by experimental/simulation methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Project I

- Project I should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
- Project II should be assessed through a presentation jointly by Internal and External Examiners approved/appointed by the University of Mumbai

Project Guidelines

Project Groups: Learners can form groups with minimum 2 (Two) and not more than 4 (Four)

Faculty Load: In semester VII – 1/2 (half) period of 1/2 hour per week per project group

Each faculty is permitted to take (guide) maximum 4 (Four) project groups.

Syllabus Scheme for B.E. Semester VIII Biomedical Engineering

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC801	Nuclear Medicine	4	-	1	4	-	1	5
BMC802	Biomedical Microsystems	4	2	-	4	1	-	5
BMC803	Hospital Management	4	-	1	4	-	1	5
BME804	Elective	4	2	-	4	1	-	5
BMP805	Project Stage – II	-	**	-	-	6	-	6
	TOTAL	**16**	**16**	**2**	**16**	**8**	**2**	**26**

** Learner is allotted 12hrs per week for the project work.

Electives:
BME8011. Lasers and Fiber Optics
BME8012. Robotics in Medicine
BME8013. Health care Informatics
BME8014. Rehabilitation Engineering

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC801	Nuclear Medicine	20	20	20	80	25	-	25	150
BMC802	Biomedical Microsystems	20	20	20	80	25	-	25	150
BMC803	Hospital Management	20	20	20	80	25	-	25	150
BME804	Elective	20	20	20	80	25	-	25	150
BMP805	Project Stage – II	-	-	-	-	50	-	100	150
TOTAL				**80**	**320**	**150**		**200**	**750**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC801	**Nuclear Medicine (abbreviated as NM)**	4	-	1	4	-	1	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC801	**Nuclear Medicine**	20	20	20	80	25	-	25	150

Course Objectives	1. To enable the learners to understand the basic science of nuclear medicine, operating principles and quality control aspects of various nuclear medicine equipment. 2. To keep the Learners abreast with the technological developments in the field of nuclear medicine.
Course Outcomes	A Learners will able to 1. Understand essential physics, concepts of radiopharmaceuticals and how they are employed in nuclear medicine diagnosis and therapy. 2. Be familiar with the current In-vivo and In-vitro techniques of nuclear medicine along with their clinical applications. 3. Apprehend the importance of radiation safety and radioactive waste management.

Module	Contents	Time
1.	**Basics of Nuclear Physics**: Radioactivity, Radioactive Decay Law, Radioactive Decay Processes, Units of Radioactivity Measurement, Successive Decay Equations. Statistics of Counting, Interaction of Radiation with Matter **Production of Radionuclide:** Methods of radionuclide production: Nuclear Reactor, Medical Cyclotron & Radionuclide Generators Spectra of commonly used radio nuclides e.g. I-131, Tc-99m, Cr-51, Cs-137. Problems in radiation measurements.	10
2.	**Radiopharmaceuticals:** Ideal Radiopharmaceutical, Methods of Radiolabeling **Internal Radiation Dosimetry:** Absorbed Dose Calculations to Target & Non-Target Tissues, MIRD Methodology **Radiation Safety:** Natural & Artificial Radiation Exposure, External & Internal Radiation Hazard, Methods of Minimizing External Exposure, Methods of Preventing Internal Exposure, Evaluation of External & Internal Hazard, Biological Effects of Radiation, Radioactive Waste Management,	08

	Ethics in Nuclear medicine.	
3.	**Detectors in Nuclear Medicine & Counting and Measuring System:** Gas filled Detectors, Scintillation Detectors and Solid State Detectors, Scintillation Counting System, Gamma Ray Spectrometry, Radionuclide Dose Calibrator, Properties of Detectors. **In Vitro techniques(Brief Description):** Introduction, Single and Double Isotope method, Radioimmunoassay, RIA Counting System, Liquid scintillation Counting system, RIA Applications.	10
4.	**In Vivo Techniques:** General Principle, Uptake Monitoring System, Rectilinear Scanner, Gamma Camera Fundamentals, Position Circuitry and working, Computer Interface, Performance Parameters, Quality Control Functions	09
5.	**Emission Tomography Techniques and Clinical Applications**: Introduction, Principles and applications of SPECT, Principles and applications of PET, System performance parameters and Quality Control Functions. **Introduction to Hybrid Modalities:** PET/CT, SPECT/CT **Clinical Applications** Clinical Applications of PET, SPECT and Hybrid Modalities in Cardiology, Neurology and Oncology.	08
6.	**Radionuclide Therapy** Choice of a Radionuclide in Therapeutic Nuclear Medicine Treatment of Benign & Malignant Diseases Palliative & Curative Procedures:	03

Text books:

1. Textbook of Nuclear medicine: J. Harbert and A.F.G. Rocha, Second Edition, Lea& Febiger.
2. Handbook of Nuclear medicine Instruments, B.R. Bairi, Balvinder Singh, N.C. Rathod and P.V. Narurkar, Tata McGraw – Hill.
3. Fundamentals of Nuclear Pharmacy, Gopal B. Saha, Springer Science Business Media
4. Introductory Physics of Nuclear Medicine, Ramesh Chandra, Lea& Febiger

Reference Books:

1. Medical Radiation Physics William R. Hendee, , Year Book Medical Publishers
2. Instrumentation of Nuclear medicine G. Hine, , Academic Press
3. Radiation Detection & Measurement Glenn F. Knoll, , John Wiley & Sons.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Only 4 questions need to be solved.

Q.1 will be compulsory and based on the entire syllabus.

Remaining questions will be mixed in nature.

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

Term Work:

Term work consists of minimum eight experiments / assignments and one presentation based on any topic on the recent trends in the Course . Learners are supposed carryout thorough literature survey, collect data and prepare their presentation.

The distribution of the term work shall be as follows:

Laboratory work (Experiments / assignment and Journal):10 marks
Presentation :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC802	**Biomedical Microsystems (abbreviated as BM)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC802	**Biomedical Microsystems**	20	20	20	80	25	-	25	150

Course Objectives	1. To understand various fabrication technology for MEMS devices. 2. To apply the knowledge of MEMS in Biomedical field. 3. To understand recent advancements in Biomedical Engineering for a successful career in the area of nanotechnology.
Course Outcomes	A learner will be able to 1. Use the knowledge of MEMS to develop various miniaturized Biomedical devices.

Module	Contents	Time
1.	**BASICS OF MINIATURIZATION & MATERIALS** Dimensional effect on engineering systems Clean room classification Scaling Laws in Miniaturization MEMS & Micro system products Substrates and Wafers Properties of Silicon Compounds SiO2, Si3N4, Polysilicon, Amorphous silicon Polymers: Dielectric polymers, Conducting polymers, and piezoelectric polymers	08
2.	**MEMS FABRICATION PROCESSES** Fabrication techniques in MEMS: Bulk micromachining, Surface micromachining, and LIGA Cleaning processes: RCA, Piranha Deposition processes for metals: e-beam evaporation, thermal evaporation and DC Sputter Deposition processes for dielectrics: Physical (RF Sputter) and Chemical Techniques (CVD: APCVD, LPCVD, PECVD, and HWCVD). Polymers coating techniques: spinning, spraying and electrodeposition	16

	Photolithography: light sources (UV, DUV, and EUV), photoresist, mask design and fabrication using EBL, dark and bright field photo-mask, different projection systems in lithography, detailed study of lithography process, study of fabrication processes like optical grating structure, SiO2 cantilever , SiNx cantilever and basics of EBL Etching Processes : Dry (RIE, DRIE) and wet etching Doping – ion implantation and diffusion Soft lithography: Micro contact Printing, Imprinting or hot embossing, and Replica Molding Surface characterization techniques: AFM, SEM, Profilometer, Elipsometer, Fluorimeter	
3.	**MICRO TOTAL ANALYSIS SYSTEMS (µTAS)** Basic block diagram: importance of µ-TAS Flow techniques in µ-fluidics: pressure driven force, electro-kinematics; electro-osmosis, electrophoresis, dielectrophoresis Components in µ-TAS: Micropump, microvalves, microchannels µ-TAS: separation and mixing techniques fabrication of micro-channels: SU8 channel, glass channel, silicon channel	08
4.	**MICRO/ NANO BIOSENSORS** Biosensor: definition, block diagram and working Classification based on the basis of detection techniques: Electric Magnetic, Optical, Thermal, Mechanical, and Chemical. Basic steps involved in the development of biosensors: surface modification, immobilization, integration with transducer Examples: (i) Design, fabrication of SiO cantilever for antibody detection, (ii) Design, fabrication of Optical waveguide biosensor, (iii) Microfluidics based biosensor	08
5.	**DRUG DELIVERY DEVICES** Overview of drug delivery systems, Types of drug delivery systems, Different parts of drug delivery system, MEMS based drug delivery systems: Implantable drug delivery systems (IDDS), Micro needles and its fabrication, Micro particles for oral drug delivery	04
6.	**MICROSYSTEM PACKAGING** Importance of packaging Packaging materials Packaging techniques Wafer bonding	04

List of Experiment/ Tutorials:

1. Literature review on MEMS technology and growth
2. Materials in MEMS technology: Single crystal Silicon, Dielectrics, and metals

3.Numericals on Polymer spinning, Dry and Wet oxidation
4.Detailed fabrication process for SiO2 cantilever
5.Importance of soft-lithography with example (compare with traditional method)
6.Different flow techniques in μ-TAS
7.Detailed fabrication process for glass-glass microfluidic channel
8.Design, fabrication of Biosensor (all three listed in Chapter 6)
9.Drug delivery systems
10. Over view on MEMS packaging

Text books:

1. MEMS & Microsystems: Design, Manufacture, and Nanoscale Engineering, 2nd Edition Tai-Ran Hsu, ISBN: 978-0-470-08301-7
2. MEMS and Microsystems: Design and Manufacture," mcgraw-Hill, Boston, 2002 (ISBN 0-07-239391-2).

Reference Books:

1. "Fundamentals of Microfabrication" Marc Madou, by, CRC Press, 1997.Gregory Kovacs,
2. "Fundamentals of BioMEMS and Medical Microdevices", Steven S. Saliterman, (SPIE Press Monograph Vol. PM153 by Wiley Interscience
3. "Microsystem Technology", W. Menz, J. Mohr, 0. Paul, WILEY-VCH, ISBN 3-527-29634-4
4. "Electro Mechanical System Design", James J. Allen, Taylor & Francis Group, LLC, ISBN-0-8247-5824-2, 2005
5. "MICROSYSTEM DESIGN",Stephen D. Senturia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-306-47601-0
6. "Introduction to Microfabrication", Sami FranssilaJohn Wiley & Sons Ltd, ISBN 0-470-85106-6
7. "Microelectromechanical Systems", Nicolae Lobontiu, Ephrahim Garcia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-387-23037-8
8. "BIOMEDICAL NANOTECHNOLOGY", Neelina H. MalschCRC PRESS, Taylor and Francis Group, ISBN 10: 0-8247-2579-4

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:
Question paper will comprise of 6 questions, each carrying 20 marks.
The Learners 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.

Term Work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal)	:20 marks
Attendance (Practical and Theory)	:05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMC803	Hospital Management (abbreviated as HM)	4	-	1	4	-	1	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMC803	Hospital Management	20	20	20	80	25	-	25	150

Course Objectives	1. To promote the development of high quality of hospital care in the community. 2. To provide a satisfactory environment to the patient and also to the doctors for clinical research. 3. To understand the design considerations in a hospital for designing of various departments in the hospital. 4. To develop skills enabling Biomedical Engineers to serve Hospitals, National and International Industries and Government Agencies. 5. To understand the role of Biomedical Engineer in hospitals.
Course Outcomes	A learner will be able to 1. Understand and apply resource management concepts (personnel, finance, and material resources) and the processes and strategies needed in specific hospital sectors. 2. Communicate effectively and develop their leadership and teambuilding abilities. 3. Apply modern change management and innovation management concepts to optimize structures. 4. Analyze existing hospital service policies and enhance their alignment within the local and national context.

Module	Contents	Time
1.	**Process of management:** Principles of management, Leadership, Motivation, Time management, Communication in hospital, H.R. management (Recruitment, Performance appraisal, Reward management, Training and development, Conflict resolution and labor relations), Accounting - Types of Budget	10
2.	**Organization of the hospital & Hospital Planning:** Management structure, Types of hospitals, Governing body, Hospital committee and hospital functionaries ,Duties and responsibilities of various positions Guiding principles in planning hospital facilities and services and planning the hospital building	06
3.	**Planning for Clinical and Supportive Services :**	14

	A) Clinical Services: Emergency, IN patient, OUT patient, Intensive care unit, Operation Theatre, Laboratory, Blood Bank, Radiology B) Utility/ Supportive services: Registration Medical record department, Central Sterile Service Dept, Pharmacy, Laundry and Linen Medical social service Dept. Hospital security, Housekeeping, Dietary (Food services)	
4.	**Planning for Engineering and Auxiliary Services :** A) Engineering Services : Maintenance, Biomedical Dept**.**: Need and responsibilities, Installation, Maintenance, Calibration, Electrical & HVAC (Hospital Ventilation and Air Conditioning),Medical Gas systems,Communication,Transport Services (Ambulance)Hospital information systems B) Auxiliary Services :Waste management, Hospital Infection control, Disaster management Marketing Department	11
5.	**Material Management & Inventory Control** Classification of Materials Purchase Management: Purchase system(Centralized, Decentralized, Local purchase), Purchase Procedures: Selection of Suppliers, Tendering procedures, Analyzing bids, Price negotiations, Issue of purchase orders, Rate Contracts, Follow up action Store Management: Organization & layout, Functions of Store Manager, Materials handling, Flow of goods/FIFO, Computerization of inventory transactions, Security of stores, Disposal of scrap/unserviceable materials Inventory Control**:** Lead-time, Buffer stock, Reorder level, Two Bin System, EOQ	04
6.	**Legal Aspects in a hospital:** Medico legal aspects (with reference to Biomedical Engineer), Preventive Steps for Doctors/Hospitals to Avoid Litigation : Consent Form, Life Support Dying Declaration, Death Certificate, High Risk Post Mortem	03

Text books:

6. Hospital Management by Dr. Pradyna Pai
7. Hospital Planning, Designing and Management: Kunders G D, Gopinath, A katakam (Private Pub Bangalore)

Reference Books:

1. Computers in Medicine: R. D. Lele (TMH Pub)
2. Hospital Care and Hospital Management AICTE Journal Vol. 1,2,3 by Dr. Kalanidhi. (AICTE Pub Bangalore
3. Careers in Biomedical : Shantanu Thatte.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments / assignments and one presentation based on the any one department in the hospital. Learners are supposed to visit hospital, collect data and prepare their presentation.
The distribution of the term work shall be as follows:
Laboratory work (Experiments / assignment and Journal):10 marks
Presentation :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BME8011	**Elective:** **Lasers and Fiber Optics (abbreviated as LFO)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BME8011	Lasers and Fiber Optics	20	20	20	80	25	-	25	150

Course Objectives	1. To understand the fundamentals in Laser and Fiber Optics. 2. To understand the applications of Laser and Fiber optics in health sector.
Course Outcomes	A Learners will be able to 1. Understand the fundamentals and clinical applications of Laser and Fiber Optics. 2. Correlate the knowledge of medicine and engineering for the wellness of human being. 3. Understand the safety aspects while dealing with Laser and Fiber Optic Units.

Module	Contents	Time
1.	**Laser Fundamentals** Fundamental wave properties and quantum properties of light, Energy levels and Radiative properties, Absorption and Stimulated Emission, Laser Amplifiers, Laser Oscillation above threshold, Requirements for obtaining Population Inversion, Laser pumping requirements and techniques, Laser Resonators, Cavity modes, Laser interaction with tissue- Effects and principles, Thermal interaction between laser and tissue.	10
2.	**Laser Types ,construction and working** Laser system involving low density gain medium: He-Ne laser, Argon Ion Laser, He-Cadmium laser, Carbon dioxide Laser, Excimer laser, Nitrogen Laser Laser system involving high density gain medium: Solid State laser like Ruby laser, Nd-YAG Laser,Titanium Sapphire Laser,Fiber Lasers, Semiconductor Diode Laser	10
3.	**Laser safety:** Practical Laser Safety requirements, Environmental safety, Equipment safety, personnel protection, Education/training for handling laser equipments, Role of Laser Safety officer, Standards of practice for the use of Laser in medicine and Surgery, Recommendation Regarding the Laser safety officer, Hospital Laser Committee	06
4.	**Optic Fibers Fundamentals**	10

	Light transmission in optical fibers- principles, optical properties of optical fibers, Fiber materials ,Types of Optical fibers, Modes, Losses, Fabrication of optical fibers, Methods and Principle,Fiber Splicing, Fiber optic imaging, Biomedical Optical fibers, Invivo Applications.	
5.	**Laser and Fiber Optics in surgery** Introduction, fiber optic laser systems in cardiovascular disease, gastroenterology, gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, and flow diagram for laser angioplasty ,Laser and Fiber optics used in Skin	06
6.	**Endoscopy** Basic Principle, System components and functions, Types of endoscopes, Video Endoscopes, Accessories, Maintenance , Endoscopy Processing room requirements, Medical Application, Leakage tester and Trouble shooting	06

Text books:

1. Lasers and Optical Fibers in Medicine – AbrahimCatzir Academic press 1998
2. Optical Fiber Communication by Gerd Keiser

Reference Books:

1. Therapeutic Lasers – G David Baxter – Churchill Living stone publications
2. Medical Laser and their safe use – David H Shiny Stiffen and L Trokel Springer Publications
3. Element of Fiber optics – S. L. Wymer Regents PHI
4. Lasers in Urologic Surgery – Joseph A.Smith,Jr, Barry S.Stein, Ralph C.Benson,Jr, Mosby Publication
5. Laser Fundamentals-William T.Silfvast, Cambridge University Press
6.Lasers in Medicine, Volume-1,Hans K. Koebner, John Wiley & Sons

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments / assignments and one presentation based on any topic on the recent trends in the Course . Learners are supposed carryout thorough literature survey, collect data and prepare their presentation.

The distribution of the term work shall be as follows:
Laboratory work (Experiments / assignment and Journal):10 marks
Presentation :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BME8012	**Elective: Robotics in Medicine (abbreviated as RIM)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BME8012	**Robotics in Medicine**	20	20	20	80	25	-	25	150

Course Objectives	1. To introduce to basics of Robotics, Kinematics, Inverse Kinematics, vision and motion planning. 2. To introduce to various applications of Robots in Medicine.
Course Outcomes	A Learner will be able to 1. Design basic Robotics system and formulate Kinematic, Inverse Kinematic motion planning solutions for various Robotic configurations. 2. Design Robotic systems for Medical application.

Module	Contents	Time
1.	Introduction Automation and Robots, Classification, Application, Specification, Notations	06
2.	Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation, (Five- axis robot, Four-axis robot, Six-axis robot)	08
3.	Inverse Kinematics General properties of solutions tool configuration Five axis robots, Three-Four axis, Six axis robot(Inverse Kinematics). Workspace analysis and trajectory planning work envelope and examples, workspace fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.	10
4.	Robot Vision Image representation, Template matching, Polyhedral objects, Shane analysis, Segmentation (Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration).	10
5.	Task Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.	08
6.	Applications in Biomedical Engineering Application in rehabilitation, Clinical and Surgery	06

Text books:

1. Fundamentals of Robotics-Analysis and control, Robert Schilling, Prentice Hall of India.
2. Robotics, Fu,Gonzales and Lee, McGraw Hill
3. Introduction to Robotics, J.J,Craig,Pearson Education

Reference Books:

1. Robotics and AI, Staughard, Prentice Hall Of India.
2. Industrial Robotics - Grover, Wiess, Nagel, Oderey, , McGraw Hill.
3. Robotics and Mechatronics. Walfram Stdder,
4. Introduction to Robotics,Niku, Pearson Education.
5. Robot Engineering, Klafter, Chmielewski, Negin, Prentice Hall Of India.
6. Robotics and Control, Mittal, Nagrath, Tata McGraw Hill publications.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments / assignments and one presentation based on any topic on the recent trends in the Course . Learners are supposed carryout thorough literature survey, collect data and prepare their presentation.
The distribution of the term work shall be as follows:
Laboratory work (Experiments / assignment and Journal):10 marks
Presentation :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BME8013	**Elective:** **Health Care Informatics (abbreviated as HCI)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BME8013	**Health Care Informatics**	20	20	20	80	25	-	25	150

Course Objectives	1. To understand the healthcare interoperability semantic and syntactic. 2. To understand the standards of healthcare interoperability standards for Medical Images and Medical Messages.
Course Outcomes	A learner will be able to 1. Fabricate information messages associated with healthcare event. 2. Fabricate and understand the information exchange messages for transfer of medical image data.

Module	Contents	Time
1.	**Healthcare Interoperability** Introduction: Standards In Healthcare System, Categorizing Standards, Standard Development, Various Healthcare Informatics Standards	04
2.	**XML** The Need for XML, Concepts and Definition, XML Syntex, Content Of an XML Document, Structure of an XML document, Validation, Access to the content of the Document	06
3.	**Health Level 7** HL7 version 2.X, Message communication Concept, Segments, Fields, Components, Subcomponents, Message delimiters, Data types, Rules for message formation, Trigger Event, ADT Segments	10
4.	**DICOM standard** DICOM SOPs, Unit Identification on n/w, Services and Data, DIMSE Example: C-Echo, Storage, Query: Find, C-Find IOD, C-Find DIMSE, C-Cancel, Modality Worklist, Basic DICOM Retrieval: C-Get, Advanced DICOM Retrieval: C-Move, DICOM: Ping, Push and Pull	10
5.	**DICOM Communications** DICOM SOPs, Unit Identification on n/w, Services and Data, DIMSE Example: C-Echo, Storage, Query: Find, C-Find IOD, C-Find DIMSE, C-Cancel, Modality	08

	Worklist, Basic DICOM Retrieval: C-Get, Advanced DICOM Retrieval: C-Move, DICOM: Ping, Push and Pull	
6.	**DICOM Associations** Association Establishment, Transfer Syntax, Application Context, Presentation Context, User Information, Protocol Data Unit (PDU) **DICOM Media: Files, Folders, and DICOMDIRs** DICOM File Format, DICOM File Services, Storing DICOM Data in PACS	10

Text books:

1) CDA™ Book, By Keith Boone, Springer Publication
2) Digital Imaging and Communication in Medicine by Oleg S. Pianykh, Springer Publication

Reference Books:

1) Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards), Springer Publication by Tim Benson
2) Informatics in Medical Imaging, George C. Kagadis, Steve G. Langer CRC Press

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

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

Term Work:

Term work consists of minimum eight experiments / assignments and one presentation based on any topic on the recent trends in the Course . Learners are supposed carryout thorough literature survey, collect data and prepare their presentation.

The distribution of the term work shall be as follows:
Laboratory work (Experiments / assignment and Journal):10 marks
Presentation :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BME8014	**Elective: Rehabilitation Engineering (abbreviated as RE)**	4	2	-	4	1	-	5

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BME8014	**Rehabilitation Engineering**	20	20	20	80	25	-	25	150

Course Objectives	1. To introduce learners to basics of Kinetics and Kinematics, Flow properties of blood and give overview of Rehabilitation Engineering.
Course Outcomes	A learner will be able to 1. Build foundation for learners enabling the learners to pursue higher studies with specialization in Rehabilitation Engineering.

Module	Contents	Time
1.	**Introduction and socio-legal aspects of Rehabilitation Engineering:** Medical Rehabilitation, Epidemiology of Rehabilitation, preventive Rehabilitation, Impairment Disability and Handicap. Delivery of Rehabilitation Care: The team-Medical, Paramedical , Socio-vocational	06
2.	**Orthotics, Amputation, and Prosthetics, Activities of Daily Living (ADL):** Orthotics: General Principles of Orthotics, Biomechanics of orthotics, Classification: Upper & Lower Extremity orthotics, spinal Orthotics Amputation & Prosthetics: Causes of Amputation, Types of Amputation, and Levels of Amputation for upper and lower Extremity. Preoperative and post-operative period. Pre-prosthetic stage. Endo & Exo-skeletal Prosthetics. Classification: Upper & lower limb Prosthetics Activities of Daily Living: ADL grouping, Barthel's Index of ADL. Functional Independence, Measures, Environmental control system, communication, ADL training.	13
3.	**Mechanical principles of Kinematics and Kinetics:** Planar classification of position and motion, Rotary and translatory motion, Degree of freedom, Kinematic Chain Theories of motion, Levers, Torque, Parallel force, Resolution of force, Calculation of muscle and joint forces Clinical application on weight and center of gravity ,applied weights and resistance,	08

	muscle force and leverage, joint forces, Clinical application on stretching versus joint mobilization	
4.	**Flow properties of blood:** An outline of Blood Rheology, Constitutive equation of blood based viscometric Data and Casson's equation, laminar flow of blood in a tube, fluid mechanical interaction of RBCs with a solid wall, thrombus formation and dissolution, medical application of Blood Rheology	08
5.	**Common deformities and role of surgery in rehabilitation engineering.** Types of deformities, Management of 1^{st} and 2^{nd} degree deformities. Common deformities of lower limb. Treatment for partial foot deformities. Deformities of the foot. Arm deformities. Torticollis	05
6.	**An overview of rehabilitation of muscular dystrophy, paraplegia, and quadriplegia:** Muscular Dystrophy, Duchenne Muscular Dystrophy, Rehabilitation, facioscapulohumeral Muscular Dystrophy Paraplegia: Etiology, mechanism of injury, Identification of level of lesion, Management of active spinal cord injury, Rehabilitation, Gait training Quadriplegia: Mobility, Training, Level of injury & outcome, Management	08

Text books:

3. BRUNNSTROM'S CLINICAL KINESIOLOG, By Laura K Smith, Elizabeth Laurance Weiss; Jaypee brothers Publication
4. Mechanical properties of living tissues by Y. C. Fung
3. Textbook of Rehabilitation by S. Sundar,3rd edition Jaypee publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The Learners 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:

Term work consists of minimum eight experiments / assignments and one presentation based on any topic on the recent trends in the Course . Learners are supposed carryout thorough literature survey, collect data and prepare their presentation.

The distribution of the term work shall be as follows:

Laboratory work (Experiments / assignment and Journal):10 marks
Presentation :10 marks
Attendance (Practical and Theory) :05 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the learner.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMP805	**Project Stage - II**	-	**	-	-	6	-	6

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMP805	**Project Stage – II**	-	-	-	-	50	-	100	150

** Learner is allotted 12hrs per week for the project work.

Guidelines for Project

- Learners should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Learners should use multiple literatures and understand the problem. Learners should attempt solution to the problem by experimental/simulation methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Project II

- Project II should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Project II should be assessed through a presentation jointly by Internal and External Examiners approved by the University of Mumbai.
- Learners should be motivated to publish a paper based on the work in Conferences/students competitions.

Project Guidelines

Project Groups: Learners can form groups with minimum 2 (Two) and not more than 4 (Four)

Faculty Load: In semester VIII - 1 (One) periods of 1 hour each per week per project group
Each faculty is permitted to take (guide) maximum 4 (Four) project groups.

Biotechnology Engineering

Sr. No.	Subject Code	Subject Name	Count
1	BTL307	Microbiology Lab	1
2	BTL308	Biochemistry Lab	1
3	BTL309	Unit Operations-I Lab	1
4	BTL407	Fermentation Technology Lab	1
5	BTL408	Analytical Methods in Biotechnology Lab	1
6	BTL409	Unit Operations-II Lab	1
7	BTC506	Business Communication & Ethics	1
8	BTL507	Lab – I	1
9	BTL508	Lab – II	1
10	CHL607	Lab – III	1
11	CHL608	Lab – IV	1
12	CHL609	Lab – V	1
13	BTL706	LAB VI	1
14	BTL707	LAB VII	1
15	BTL806	LAB VIII	1
16	BTL807	LAB IX	1
		Total	16

AC 29/4/2013 Item no. 4.71

UNIVERSITY OF MUMBAI

Revised Syllabus

Program - Bachelor of Engineering

Course - Biotechnology

(Second Year – Sem.III & IV)

Under

FACULTY OF TECHNOLOGY

(As per Credit Based Semester and Grading System from 2013-14)

From Dean'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, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester 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 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande

Dean,

Faculty of Technology,

Member - Management Council, Senate, Academic Council

University of Mumbai, Mumbai

Preamble to the Revision of Syllabus in Biotechnology

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 Chemical Engineering and Bio-technology. 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 Chemical Engineering at Rizvi college of Engineering on 4th February 2013. It was attended by the various heads of departments of Biotechnology engineering as well as experts from industry.The program objectives and outcomes were thoroughly discussed in this meeting and the core structure of the syllabus was formulated. A second meeting was held in M.G.M College of Engineering on 5th of March 2013 to decide the subject experts and syllabus for the subjects of semesters III and IV.Finally the Board of studies meeting was conducted on 20th April 2013 at the Fort campus of University of Mumbai, where the final structure and detailed syllabus of Semesters III and IV were approved.

Dr. V. Ramesh

Chairman, Board of Studies in Chemical Engineering (Ad-hoc)

University of Mumbai, Mumbai

UNIVERSITY OF MUMBAI
SCHEME OF INSTRUCTION AND EXAMINATION
S.E: SEMESTER-III

Subject Code	Subject Name	Teaching Scheme (Contact Students)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BTC301	Applied Mathematics-III	3	--	1	3	--	1	4
BTC302	Microbiology	4	--	--	4	--	--	4
BTC303	Cell Biology	3	--	--	3	--	--	3
BTC304	Biochemistry	4	--	--	4	--	--	4
BTC305	Unit Operations-I	4	--	--	4	--	--	4
BTC306	Process Calculations	3	--	1	3	--	1	4
BTL307	Microbiology Lab	--	4	--	--	2	--	2
BTL308	Biochemistry Lab	--	3	--	--	1.5	--	1.5
BTL309	Unit Operations-I Lab	--	3	--	--	1.5	--	1.5
Total		21	10	2	21	5	2	28

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test1	Test 2	Avg.						
BTC301	Applied Mathematics-III	20	20	20	80	03	25	--	--	125
BTC302	Microbiology	20	20	20	80	03	--	--	--	100
BTC303	Cell Biology	20	20	20	80	03	25	--	--	125
BTC304	Biochemistry	20	20	20	80	03		--	--	100
BTC305	Unit Operations-I	20	20	20	80	03	25	--	--	125
BTC306	Process Calculations	20	20	20	80	03	25	--	--	125
BTL307	Microbiology Lab	--	--	--	--	--	--	25	--	25
BTL308	Biochemistry Lab	--	--	--	--	--	--	25	--	25
BTL309	Unit Operations-I Lab	--	--	--	--	--	--	--	--	--
Total		--	--	120	480	--	100	50	--	750

Student Contact Hrs Per week: 33

UNIVERSITY OF MUMBAI
SCHEME OF INSTRUCTION AND EXAMINATION
S.E: SEMESTER-IV

Subject Code	Subject Name	Teaching Scheme (Contact Students)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	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	4	--	--	4	--	--	4
BTC406	Unit Operations-II	4	--	--	4	--	--	4
BTL407	Fermentation Technology Lab	--	4	--	--	2	--	2
BTL408	Analytical Methods in Biotechnology Lab	--	3	--	--	1.5	--	1.5
BTL409	Unit Operations-II Lab	--	3	--	--	1.5	--	1.5
Total		**22**	**10**	**2**	**22**	**5**	**2**	**29**

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test1	Test 2	Avg.						
BTC401	Applied Mathematics-IV	20	20	20	80	03	25	--	--	125
BTC402	Molecular Genetics	20	20	20	80	03	25	--	--	125
BTC403	Fermentation Technology	20	20	20	80	03	--	--	--	100
BTC404	Analytical Methods in Biotechnology	20	20	20	80	03	--	--	--	100
BTC405	Immunology and Immunotechnology	20	20	20	80	03	25	--	--	125
BTC406	Unit Operations-II	20	20	20	80	03	25	--	--	125
BTL407	Fermentation Technology Lab	--	--	--	--	--	--	25	--	25
BTL408	Analytical Methods in Biotechnology Lab	--	--	--	--	--	--	25	--	25
BTL409	Unit Operations-II Lab	--	--	--	--	--	--	--	--	--
Total		**--**	**--**	**120**	**480**	**--**	**100**	**50**	**--**	**750**

Student Contact Hrs Per week: 34

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 work done over the entire semester.**
- It is suggested that each tutorial be graded immediately and an average be taken at the end.
- A minimum of ten tutorials will form the basis for final evaluation.

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 8 experiments out of 10 experiments in a Lab Course.

Project & 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.
- 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.

ANNEXURE -I
Program Structure for S.E. Biotechnology
Mumbai University

Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Students)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BTC301	Applied Mathematics-III	3	--	1	3	--	1	4
BTC302	Microbiology	4	--	--	4	--	--	4
BTC303	Cell Biology	3	--	--	3	--	--	3
BTC304	Biochemistry	4	--	--	4	--	--	4
BTC305	Unit Operations-I	4	--	--	4	--	--	4
BTC306	Process Calculations	3	--	1	3	--	1	4
BTL307	Microbiology Lab	--	4	--	--	2	--	2
BTL308	Biochemistry Lab	--	3	--	--	1.5	--	1.5
BTL309	Unit Operations-I Lab	--	3	--	--	1.5	--	1.5
Total		21	10	2	21	5	2	28

Subject Code	Subject Name	Examination Scheme								
		Theory					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test1	Test 2	Avg.						
BTC301	Applied Mathematics-III	20	20	20	80	03	25	--	--	125
BTC302	Microbiology	20	20	20	80	03	--	--	--	100
BTC303	Cell Biology	20	20	20	80	03	25	--	--	125
BTC304	Biochemistry	20	20	20	80	03		--	--	100
BTC305	Unit Operations-I	20	20	20	80	03	25	--	--	125
BTC306	Process Calculations	20	20	20	80	03	25	--	--	125
BTL307	Microbiology Lab	--	--	--	--	--	--	25	--	25
BTL308	Biochemistry Lab	--	--	--	--	--	--	25	--	25
BTL309	Unit Operations-I Lab	--	--	--	--	--	--	--	--	--
Total		--	--	120	480	--	100	50	--	750

Course Code	Course/Subject Name	Credits
BTC301	**Applied Mathematics III**	**4**

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 eigenvalues and eigenspaces 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	No. of Hrs.
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: Eigenvalues and eigenspaces of 2x2 and 3x3 matrices; existence of a basis and finding the dimension of the eigenspace (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 - v are given; Milne-Thomson method; cross-ratio (no proofs); conformal mappings; images of straight lines and circles.	07
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

References:

- Mathematical Methods in Chemical Engineering, V.G. Jenson and G.V. Jeffreys, Academic Press, 1970
- Laplace transforms, Murray Spiegel, Schaum's Outline Series, 1974
- Complex variables, Murray Spiegel, Schaum's Outline Series, 1964
- Linear Algebra, Murray Spiegel, Schaum's Outline Series, 1964
- Probability and Statistics: Murray R. Spiegel, Schaum's Outline Series, 1965
- Advanced Engineering Mathematics by *Erwin Kreyszig*, 9^{TH} 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	No. of Hrs.
01	**History and Scope of Industrial Microbiology:** • 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	07
02	**Classification of Micro organisms** • Types and general characteristics of microorganisms: 1) Bacteria- Archaebacteria, 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	08

	taxonomic arrangements, Bacterial phylogeny. • Aerobic and Anaerobic cultures **Microbial Pathogenesis** • Epidemiology of infectious diseases, Bacterial, Fungal, Protozoal, Viral Diseases; • Bacterial invasion and colonization • Bacterial toxins- types and mode of action	
02	**Microbial Nutrition:** • Nutritional requirements of microorganisms • Different types of media- Synthetic media, complex media Selective media, differential media, enrichment media.	06
03	**Microbial Growth:** • 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	04
04	**Microbiological Techniques:** • Sterilization and disinfection techniques, • Principles and methods of sterilization. • Physical methods - autoclave, hot-air oven, pressure cooker, laminar air flow, 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
05	**Antimicrobial Therapy:** • Antimicrobial sensitivity tests. • Agents used in treating infection: Antibacterial, antiviral, anti retroviral, antifungal, anti-protozoan & anti helminthes. • Resistance mechanism.	08
06	**Water & Soil Microbiology:** 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-	10

		chemical properties of soil, microbial community in soil, role of microorganisms in organic matter decomposition.	

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**	**3**

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:

The cell is the fundamental unit of all life. In this course, we 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	No. of Hrs.
1	**Cytology:** • Development history of cytology. • Cell – basic unit of life: Structure and function of cell, • Prokaryotic & Eukaryotic cell • Structure and function of various cells such as Viruses, Bacteria, Animals • Cell division and cell cycle	05
2	**Concept of Cyto-receptors:** • Function of membrane receptors. • Methods of introduction of substances to cells: endo and excocytosis, pinocytosis, phagocytosis. • Mechanism of transport substances through membrane: • diffusion • osmosis • ion channels • active and passive transport • ion pumps	06
3	**Structural organization andmechanism of sorting and regulation of intracellular transport, electrical properties of membranes:** • Cell wall, nucleus • Mitochondria • Golgi bodies • lysosomes • endoplasmic reticulum, • structure & function of cytoskeleton and its role in motility	06
4	**Cell signaling:** • Hormones and their receptors • cell surface receptor • signaling through G-protein coupled receptors • signal transduction pathways	05

	• second messengers, and regulation of signaling pathways	
5.	**Cellular communication:** • General principles of cell communication, • cell adhesion and roles of different adhesion molecules, • gap junctions • desmosomes • tight junction • extracellular matrix, integrins • neurotransmission and its regulation	06
6.	**Pathogenecity of cell:** • Living cells Vs dead cell • Necrotic Vspycnotic death • Prgrammed cell death • Regeneration of cell	05
7	**Cancer:** • Types of tumors • Molecular basis of cancer. • Characteristics of growing tumor cells: general and morphological changes, biochemical changes, Metastasis, Apoptosis.	06

References:

1. Cell and Molecular biology, Gerald Karp, John Wiley and sons Inc
2. Cell Biology by C.B. Powar.
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).
6. Molecular Cell Biology, H. Lodish, A. Berk, S. L. Zipursky, W. H. Preeman and Compa

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

CourseObjectives:

- 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 ofbiomolecules.
- 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**	**No. of Hrs.**
1	• 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	**Biomolecules:** Classification, Structure and Functions of : • Carbohydrates: • Lipids • Proteins • Nucleic acids	14
3	**Enzymes**	05

	• Working of Enzymes • Concept of Activation energy and transition state • Factors affecting enzyme activity- pH, Temperature, Substrate & Enzyme Concentration	
4	**Vitamins and Hormones** Vitamins: Classification, functions, role in metabolism, vitamins as cofactors. Hormones: Classification, endocrine glands, function and mechanism of action of hormones.	05
5	**Metabolism** • Carbohydrates- Glycolysis, TCA cycle • Lipids- Digestion by GI enzymes and breakdown of Triglycerides: α, β, ω oxidation of fatty acids • 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	18
6	**Bioenergetics:** • Laws of Thermodynamics • Concept of Enthalpy, Entropy • Energy rich compounds – ATP as energy currency	05

References:

1. Nelson, D.L. and M.M. Cox, "Lehninger's Principles of Biochemsitry", 4th Edition, W.H. Freemen & Co., 2005.
2. Murray, R.K., etal "Harper's Biochemistry", 23rd Edition, Prentice Hall International, 1993
3. LubertStryer. 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**	**4**

PREREQUISITES:

Basicknowledge 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 equipments 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 equipments.

Module	Details	No of Hrs.
01	**Intoduction:** 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
02	**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'snumber,Laminar flow in pipes, Turbulent flow in pipes, velocity and shear stress distribution across pipe,Boundary layer	08

	formation and seperation of boundary layer.	
03	**Flow of Incompressible fluids:**Relationship between skin friction and wall shear,Fanning friction fractor,friction factor law for smooth pipes,Formfriction,effect of roughness, energy relationships,pipefittings,major and minor losses in pipe flow. **Flow measurements**: Venturimeter, Orificemeter, Pitot tube, Rotameter. **Pumping**: Reciprocating pumps, Rotary pumps, centrifugal pumps(Characteristics,NPSH,Cavitation) and blowers.	09
04	**Particle Size distribution**: Importance of particle size in reactions, particle size, shape and mass distributions,measurement and analysis, concept of average diameter. **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. **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.	12
05	**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 **Size reduction equipments** : Grinder – Construction and operation of Hammer mill, Ball mill, Ultrafine grinder – Fluid energy mill, Cutting machines: knife cutters,	09
06	**Separation based on particle Mechanics through liquids** : Free settling and Hinderd settling, Stoke's law & Newton's law regimes of settling. Clarifiers and thickeners, flocculation, batch sedimentation(Kynch theory), rate of sedimentation. **Filtration:**Theory and principle of solid liquid filtration, cake filters, discontinuous pressure filter: principle and working of filter press. **Mixing & 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.	09

Text books

1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGrawHill, FourthEdition, 1984.
2. Coulson, J.M., Richardson, J.F., "Chemical Engineering", Volume 2, Third Edition, Pergamon Press, 1977..

References

1. Badger and Bencharo, " Introduction to Chemical Engineering". TMH,
2. Narayanan C.M.& Bhattacharya B.C. "Mechanical opeartions for chemical engineers", Khanna.
3. 3.R.S.Hiremath&A.Kulkarni. Mechanical Operations Vol. I.
4. 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 vapour
- 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	Contents	No. of Hrs.
01	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 behaviour 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.	08

	Biochemical stoichiometry: Limiting and excess reactants- conversion, degree of completion, selectivity, yield problems.	
02	Fundamentals of material balances- Law of conservation of mass- Types of material balances, material balance with recycle bypass and purge streams-	08
03	Material Balance for process involving chemical reaction, Calculations using Psychrometric chart; Humidity and saturation	07
04	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 balance for fermentation and downstream processing- problems.	08
05	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.	08

References:

1. David M.Himmelblau. 1989. Basic Principles and Calculations in Chemical Engineering. Prentice Hall of India (P) Ltd.
2. A.Hougen, 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
BTL307	**Microbiology Lab**	**2**

List of Experiments Suggested:

1. Study of different equipments- Bunsen burner, water bath, Autoclave, Laminar air flow, Incubator, Hot air oven, Centrifuge, and Refrigerator.
2. Study of Microscope- Compound Microscope & its parts. Use of oil Immersion objective.
3. Preparation of liquid medium -nutrients broth, nutrient agar, agar slant.
4. Staining: Simple, Differential staining methods, Capsule, Endospore; Study of shape and arrangement of bacterial cells
5. Isolation of microorganism by Pure Culture Techniques.
6. Effect of disinfectants on microbial flora
7. Isolation and identification of microorganisms from different sources – soil, water and milk
8. Antibiotic sensitivity assay
9. Effect of different parameters on bacterial growth (pH, temperature & UV irradiation)
10. Culture of aerobic &anaerobic bacteria
11. Effect of TDP & TDT on bacterial growth
12. Filter paper disc methods for evaluation of antiseptics
13. Study of growth curve of Ecoli
14. Bacterial colony counting using Haemocytometer

Course Code	Course/Subject Name	Credits
BTL308	**Biochemistry Lab**	**1.5**

List of Experiments Suggested:

1. Preparations of solutions –molar,normal,ppm, percent
2. Study of pH meter and preparation of buffers
3. Study of Beer and Lambert's Law and absorption maxima
4. Glucose estimation by DNSA method
5. Protein estimation by Biurette Test
6. DNA estimation by DPA method
7. RNA estimation by Orcinol method
8. Estimation of Vitamin C by Iodometry
9. Extraction and separation of plant pigment by paper chromatography
10. TLC of Fatty acids
11. Study of Enzyme Activity
12. Estimation of Lipids

Course Code	Course/Subject Name	Credits
BTL309	**Unit Operations - I Lab**	**1.5**

List of Experiments Suggested:

1. Viscosity by Stoke's Law
2. Venturimeter
3. Orificemeter
4. Flow through Helical coil
5. Reynold's Apparatus.
6. Bernoulli's apparatus
7. Sieve analysis
8. Screen effectiveness
9. Major and Minor losses
10. Ball mill
11. Hammer mill
12. Sedimentation
13. Centrifugal pumps
14. Vacuum Filtration

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Students)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	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	4	--	--	4	--	--	4
BTC406	Unit Operations-II	4	--	--	4	--	--	4
BTL407	Fermentation Technology Lab	--	4	--	--	2	--	2
BTL408	Analytical Methods in Biotechnology Lab	--	3	--	--	1.5	--	1.5
BTL409	Unit Operations-II Lab	--	3	--	--	1.5	--	1.5
Total		**22**	**10**	**2**	**22**	**5**	**2**	**29**

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)				
		Test1	Test 2	Avg.						
BTC401	Applied Mathematics-IV	20	20	20	80	03	25	--	--	125
BTC402	Molecular Genetics	20	20	20	80	03	25	--	--	125
BTC403	Fermentation Technology	20	20	20	80	03	--	--	--	100
BTC404	Analytical Methods in Biotechnology	20	20	20	80	03	--	--	--	100
BTC405	Immunology and Immunotechnology	20	20	20	80	03	25	--	--	125
BTC406	Unit Operations-II	20	20	20	80	03	25	--	--	125
BTL407	Fermentation Technology Lab	--	--	--	--	--	--	25	--	25
BTL408	Analytical Methods in Biotechnology Lab	--	--	--	--	--	--	25	--	25
BTL409	Unit Operations-II Lab	--	--	--	--	--	--	--	--	--
Total		**--**	**--**	**120**	**480**	**--**	**100**	**50**	**--**	**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, Know2ledge 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 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 problems coming across while studying higher level of Chemical Engineering .(Example: Flow of Liquid through Pipes/Gases etc.)

Module	Contents	No. of 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	**10**

	wave equation. (ONLY NUMERICAL PROBLEMS. NO PROOFS REQUIRED).	
04	**Vector Integration** Green's Theorem in the plain; Conservative &Solenoidal Fields. Gauss Divergence Theorem, Stokes' Theorem. (ONLY NUMERICAL PROBLEMS. NO PROOFS REQUIRED).	**10**

References:

- Advanced Engineering Mathematics by *Erwin Kreyszig*, 9^{TH} Edition, Wiley India.
- Schuam's outline series in Fourier series.
- Schuam's outline series in partial differential equations.
- 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:

The major objective of the paper is to provide knowledge of molecular biology and genetics of Prokaryotic and eukaryotic organisms to the students. This paper provides insight on Replication, Transcription and translation processes in prokaryotes and eukaryotes, various mutations, their Repair mechanisms and cancer genetics.

Module	Contents	No. of Hrs.
01	**Structure of Nucleic Acid:** • DNA, RNA: mRNA,tRNA, rRNA, • Denaturation and Renaturation of DNA, • Tm; GC content from Tm, • Renaturation kinetics of DNA • Complexity of DNA, Cot curves • Satellite DNA: Repetitive DNA, SNP, STR	04
02	**Mendelism and its extensions** • Law of segregation • Law of independent assortment • Chromosomal basis of segregation and independent • Assortment	08

	• Linkage • Crossing over • Multiple allelism • Pleiotropy • Recombination **Cytogenetics** • International System for Human Chromosome Nomenclature • Mechanisms of numerical and structural chromosomal aberrations • Chromosomal basis of sex determination • Non-chromosomal basis of sex determination; mutations	
03	**DNA Replication:** • Prokaryotic and eukaryotic DNA replication, • Mechanism of DNA replication • Enzymes and accessory proteins involved in DNA replication. • DNA Damage Mechanism • DNA Repair Mechanism	07
04	**Transcription** • Prokaryotic transcription • Eukaryotic transcription • RNA polymerases, • General and specific transcription factors • Regulatory elements and mechanisms of transcription regulation, 5'-Cap formation • Transcription termination • 3'-end processing and polyadenylation, Post-transcriptional gene silencing RNA splicing • Nuclear splicing: splice some • Group I and group II introns • tRNA splicing • Alternate splicing	07
05	**Translation** • Prokaryotic and eukaryotic translation: • Synthesis of aminoacyltRNA • Aminoacylsynthetases • Mechanism of initiation, elongation and termination • Regulation of translation, co-and post-translational modifications of proteins	07
06	**Regulation of gene expression** • Induction and repression, • Operon theory, lac operon, trp operon, ara operon • Attenuation • Positive and Negative Control • Catabolite repression • Regulation of transcription by cAMP and CRP	06

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) Gene VIII; Benjamin Lewin; Oxford Univ. Press, 8th edition (2004)
5) Advanced Molecular Biology; R. M. Twyman, 1st Edition, (2003)
6) Instant Notes on Molecular Biology; P.C. Turner, A. G. Mclennan, A. D. Bates & M. R. H. White, 2nd Edition (2002)

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	No. of hrs.
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** • 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	09

	• The selection of induced mutants synthesizing improved levels of products • The use of rDNA techniques	
04	**Regulatory Mechanisms controlling the catabolic and anabolic pathways of microbes** Induction, carbon catabolite repression, crab tree effect, feedback inhibition and repression	03
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	07
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	05
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 breverages: wine, beer; biomass : bakers yeast ; biofertilizers; biopesticides; biosurfactant; steroid transformation;biopolymers	11

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:

1) Basic knowledge of Physical and Analytical Chemistry
2) Knowledge of various types of spectra
3) 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	No of Hrs.
01	**Centrifugation:** • General principle- sedimentation velocity, sedimentation equilibrium • Types of centrifuges, preparative and analytical centrifugation, differential centrifugation, density gradient methods • Applications	08
02	**Chromatographic Techniques:** • Introduction to chromatography, General principles • Planar Chromatography: Thin layer chromatography, paper chromatography • Column chromatography–columns, stationary phases. Packing of columns, application of sample, column development, fraction collection and analysis. • Partition chromatography, Adsorption chromatography Affinity Chromatography, Ion Exchange Chromatography, Chromatofocussing, Size exclusion chromatography. • Gas Chromatography, HPLC: Principle & Components: pumping systems, detectors systems • Applications	14

03	**Electrokinetic methods of separation:** • Electrophoresis: General principle, factors affecting electrophoresis – voltage, current, resistance, buffer, composition, concentration, pH. • Agarose Gel electrophoresis • SDS-PAGE - gradient gels • Two dimensional gel electrophoresis • Isoelectric focusing • Capillary electrophoresis • Immunoelectrophoresis	13
04	**Spectroscopy:** • Spectroscopic Techniques; Beers Lamberts law, molar and extinction coefficient, limitations of Beers Lamberts law. • Visible and UV Spectrophotometry; Principles, Instrumentation and applications	09
05	**Radioisotopic techniques:** • Use of radioisotopes in life sciences, radioactive labeling, principle and application of tracer techniques • Detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger-Muller and Scintillation counters, Autoradiography • Applications	08

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, DilipCharegaonkar, 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.

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	No. of Hrs.
01	**Introduction to immune system** • Innate and adaptive immunity • Cells and organs of the immune system • Primary and secondary immune responses; • Cell mediated and humoral response	09

02	**Antigens & Antibodies** • Antigens • Antibodies and T cell receptors: Antigens, Structure and function of immunoglobulins, • B and T cell receptors and co-receptors	07
03	**Generation and regulation of immune responses** • Antigen processing and presentation • MHC-restriction; Cytokines • T Cell Maturation, activation andDifferentiation B Cell Generation,activation and differentiation • Clonal selection and immunological memory • Complement system, classical ,alternative and MBL pathway • Cell mediated cytotoxic responses • Regulation of immune responses; Immunological tolerance	10
04	**Antigen-antibody Reactions** • Strength of Antigen-Antibody Reactions • In Vivo Antigen-Antibody Reactions, In Vitro Antigen-Antibody Reactions • Precipitation (In Fluid and In Gel Immunoelectrophoresis), • Agglutination (Heamagglutination, Bacterial agglutination, Passive agglutination and Agglutination Inhibition). • Radio immuno Assay (RIA) • Enzyme Linked Immunosorbant Assay (ELISA), • Western Blot • Immune Fluorescence	10
05	**Disorders of Human Immune System** Primary and secondary immunodeficiency; Autoimmune disorders; Hypersensitive reactions; Cytokine related diseases	07
06	**Production of Monoclonal Antibodies and Recombinant Vaccines.** • Monoclonal antibody, polyclonal antibody. Production of monoclonal antibodies - Definition, production, applications. • Recombinant Vaccines - Definition, recombinant vector vaccines, DNAvaccines ,Multivalent subunit vaccines ,minicellvaccines,conjugate vaccines	09

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**	**4**

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 Bioprocessing.
- 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	No of Hrs.
01	Introduction: Various modes of heat transfer Viz. Conduction, Convection and Radiation. 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	08

	longitudinal fins, Fin effectiveness. Elementary treatment of unsteady state heat conduction. Problems	
02	Convection: Individual and overall heat transfer coefficient, LMTD, LMTD correction factor. 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.	09
03	Radiation: Properties and definitions, Absorptivity, Reflectivity, Emissive power and intensity of radiation, Black body radiation, 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.	09
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.	09

05	Mass Transfer in Bioprocess Operations: Role of Diffusion in Bioprocessing, 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.	09
06	Distillation. simple, steam & equilibrium distillation, fractionation. Mccabe-Thiele method, azeotropes. numericals.	08

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
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
BTL407	**Fermentation Technology Lab**	**2**

List of Experiments Suggested:

1) Alcohol production by baker's yeast
2) Spore counting by haemocytometer
3) Cell immobilization technique by immobilizing yeast cells in calcium alginate beads.
4) Production of citric acid by A.niger
5) Hydrolysis of sucrose by immobilized yeast cells
6) Determination of cell mass by different methods (dry weight method, density method and haemocytometer method)
7) Estimation of carbohydrates from fermentation media.
8) Production of amylase
9) Isolation of auxotrophic mutants of industrially important microorganisms
10) Study of substrate utilization kinetics of the organism
11) Study the set up of various types of bioreactors
12) Introduction to fermentor

Course Code	Course/Subject Name	Credits
BTL408	**Analytical Methods In Biotechnology Lab**	**1.5**

List of Experiments Suggested:

1) Chromatography of amino acids and sugars
2) Agarose gel electrophoresis
3) SDS-PAGE
4) Iso-electric Focussing
5) Centrifugation
6) Density gradient Centrifugation
7) Affinity chromatography
8) Ion exchange chromatography
9) Gel filtration chromatography
10) UV-Visible spectrophotometer
11) Thin Layer Chromatography
12) Paper Chromatography

Course Code	Course/Subject Name	Credits
BTL409	**Unit Operations - II Lab**	**1.5**

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
- Simple distillation
- Steam distillation
- Vapor-liquid equilibrium
- Diffusivity of a liquid
- Diffusion through porous solids
- Determination of Mass transfer coefficients in Gas Liquid sysytem by evaporation
- Determination of Mass transfer coefficients in Liquid Liquid system.

AC ??/??/2014 Item no. ?.??

UNIVERSITY OF MUMBAI

Revised Syllabus
Program - **Bachelor of Engineering**
Course - **Biotechnology**
(Third year - Sem V and VI)

under
Faculty of Technology
(As per Credit Based Semester and Grading System from 2014-15)

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 work done over the entire semester.
- It is suggested that each tutorial be graded immediately and an average be taken at the end.
- A minimum of ten (unless specified in course syllabus) tutorials will form the basis for final evaluation.

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(unless specified minimum requirement in syllabus).

University of Mumbai

Scheme for TE: Semester-V

Course Code	Course Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BTC501	Bioinformatics-1	04	–	–	4.0	–	–	4.0
BTC502	Genetic Engineering	04	–	–	4.0	–	–	4.0
BTC503	Biophysics	03	–	01	3.0	–	1.0	4.0
BTC504	Thermodynamics & Biochemical Engineering	03	–	01	3.0	–	1.0	4.0
BTC505	Bioreactor Analysis & technology	03	–	01	3.0	–	1.0	4.0
BTC506	Business Communication & Ethics	–	02* + 02	–	–	2.0	–	2.0
BTL507	Lab – I	–	03	–	–	1.5	–	1.5
BTL508	Lab – II	–	03	–	–	1.5	–	1.5
	Total	17	10	03	17.0	5.0	3.0	25.0

*Theory for entire class.

Examination Scheme

Course Code	Course Name	Examination Scheme							
		Theory marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
BTC501	Bioinformatics-1	20	20	20	80	–	–	–	100
BTC502	Genetic Engineering	20	20	20	80	–	–	–	100
BTC503	Biophysics	20	20	20	80	25	–	–	125
BTC504	Thermodynamics & Biochemical Engineering	20	20	20	80	25	–	–	125
BTC505	Bioreactor Analysis & technology	20	20	20	80	25	–	–	125
BTC506	Business Communication & Ethics	–	–	–	–	50	–	–	50
BTL507	Lab – I	–	–	–	–	–	25	–	25
BTL508	Lab – II	–	–	–	–	–	25	25	50
			Total	100	400	125	50	25	700

Course Code	Course Name	Credits
BTC501	Bioinformatics I	4.0

Prerequisites

Basic knowledge of computers, Biochemistry : Structures of DNA, RNA & Proteins.

Course Objectives

The objectives of this course are to :

- 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 to 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 :

- To cast a molecular biology problem as a bioinformatics problem, select relevant tools, optimize their settings and build pipelines to solve the set problem.
- To easily extract the required data from a given set of data & similarly be able to store it.
- To use conventional softwares and web-based applications.
- To analyze processed data with the support of analytical and visualization tools.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction to bioinformatics:** Types of biological data, Sequencing Methods : DNA (Maxim Gilbert Method, Sangers Method) & Protein (MS-MS Analysis), Genomic Sequencing, ESTs and SNPs, Applications of bioinformatics.	10
2	**Databases 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.	10
3	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 W Phylogenetic Analysis.	12

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Module	Contents	No. of hrs
4	**Visualization:** Methods for representing biological data, Rasmol, Swiss PDB, 3D Structure Viewers.	05
5	Proteins: Structure , Classification ,Classification databases Protein Structure prediction : Primary Structure Prediction, Secondary Structure Prediction, Tertiary Structure Prediction, Homology Modelling, Chao-Fasman Algorithm, Neural Networks, Ab-Initio Modelling, Fold recognition (Threading)	10
6	Drug discovery Markov chains Hidden markov models.	05

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. R6 : S. C. Rastogi , Bioinformatics concepts ,skills & applications , CBS publishers, 1st edition

Course Code	Course Name	Credits
BTC502	Genetic Engineering	4.0

Prerequisites

Knowledge of Biochemistry, Microbiology, Molecular Biology, Genetics.

Course Objectives

The objectives of this course are to

- 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, 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.

Detail syllabus

Module	Contents	No. of hrs
1	DNA structure, topology, Superhelical and relaxed molecules. Plasmids in nature, Fundamentals of Density gradient Centrifugation and Alkaline lysis for Plasmid preparation.	6
2	Palindromes and repeat structures. Restriction Endonucleases and their action. Vectors used for Gene-cloning: Plasmids (e.g pUC type, conjugative, Ti etc.), Phages (Lambda and M13 type), Cosmids and Phagemids.	8
3	**Cloning strategies:** Expression and Fusion vectors Stability of plasmids(PAR locus, High copy number etc) Library construction (Genomic and C-DNA type), and Screening for the clone.	7
4	**DNA transfer into cells:** Transformation and Transfection Membrane Fusion and Electroporation Gene-Gun and Micro-injection	7
5	**Enzymes for Recombinant Technology:** Restriction Endonucleases, DNA polymerases, Reverse Transcriptase, Polynucleotide Kinase, Terminal Transferase, Alkaline Phosphatase, S1-Nuclease, Bal-31, DNA Ligase.	8

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Module	Contents	No. of hrs
6	**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.	8
7	Antisense and RNA interference Technology and their Applications. r-DNA in medicine, e.g. Insulin and Blood clotting factor VIII. Use of cell-lines in bio-molecules production.	8

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 Name	Credits
BTC503	Biophysics	4.0

Prerequisites

Knowledge of Chemistry, Physics, Atomic physics, Biochemistry, Molecular Biology.

Course Objectives

The objectives of this course are 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.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction to Biophysics.** Physicochemical properties of biological macromolecules and their complexes, Structural studies of Nucleic Acids, Proteins, lipids and Carbohydrates. Approaches: Electron Microscopy, Atomic Force Microscopy, X ray Crystallography, NMR Spectroscopy.	8
2	**Nucleic Acid interactions:** Different nucleic acid carrier proteins, Carrier RNA, snRNA, Interactions between DNA & protein, Zinc finger proteins, various nucleic acid binding proteins, Nuclear transport.	8
3	**Membrane Structure & Properties** The principles governing the structures of biological membrane, Two-dimensional fluids, Assembly of membrane components.	7
4	**Protein Structural study.** Proteins - 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, phasing techniques and structure validation.	8
5	**Lipids & their Interaction.** Details of Lipid Structures, Lipoproteins and Glycolipids. High density (HDL) and low density (LDL) lipoprotein, energetics-structure-function relationship in exchangeable apolipoproteins and lipoproteins, Disorder caused by saturated fat and cholesterol. Artereochlerosis.	8

References

1. Cantor R, Samual P. R. (1985). Biophysical Chemistry. W. H. Freeman & Co.

2. Van Holde Johnson and Ho. (2006) Principles of Physical Biochemistry. Second Edition, Pearson Prentice Hall.

3. Igor N. Serdyuk, Nathan R. Zaccai, & Joseph Zac. Methods in Molecular Biophysics: Structure, dynamics and Function. Cambridge University Press.

4. Physical Biocheistry: Principles and applications by David Sheehan, Jon Wiley & Sons.

Course Code	Course Name	Credits
BTC504	Thermodynamics & Biochemical Engineering	4.0

Prerequisites

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.

Detail syllabus

Module	Contents	No. of hrs
1	**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.	04
2	**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.	5
3	**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.	5
4	**Biochemical Energetics:** Coupled reactions and energy rise 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 .	5

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Module	Contents	No. of hrs
5	**Properties of Pure Fluids:** Principles of corresponding states, Generalized compressibility charts. Reference properties,energy 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 Cp & Cv, Gibbs- Helmholtz equation.	6
6	**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 diagrams types of diagrams and construction of thermodynamic diagrams.	4
7	**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, Raoults law for ideal solutions, Henry's law and dilute solutions ideal behavior of real solutions and Henrys law, Activity in solutions, Activity coefficients effect of temperature and pressure, Gibbs - Duhem equation, Property changes of mixing, excess properties excess Gibbs free energy.	6
8	**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 co efficient equation, bubble point and dew point equilibria, Consistency test for VLE data using slope of ln ? curves, using partial pressure data, calculation of activity coefficients using Gibbs - Duhem equation, Liquid-Liquid Equilibrium diagrams binary liquid Equilibrium diagrams.	4

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).

Course Code	Course Name	Credits
BTC505	Bioreactor Analysis & Technology	4.0

Prerequisites

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.

Detail syllabus

Module	Contents	No. of hrs
1	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	7
2	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.	8
3	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 ,stepwise 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.	8
4	Heterogeneous Reactions: 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	7

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Module	Contents	No. of hrs
5	Deviations from ideal reactors: Concept of non ideality, reasons of non ideality, RTD studies, F curve, C curve, E curve, diagnosis of ills of flow reactors, modeling of non ideal behaviour-dispersion model, tanks in series model.	5
6	Working principle of unconventional reactors: Selection criterion for bioreactors, Bubble column, Air lift reactor, Fluidized bed reactor, perfusion reactors, membrane reactors	4

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 Name	Credits
BTC506	Business Communication & Ethics	2.0

Course Objectives

- To inculcate in students professional and ethical attitude, effective communication skills, teamwork, skills, 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 provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.

Course Outcomes

A learner will be able to

- Communicate effectively in both verbal and written form and demonstrate knowledge of professional and ethical responsibilities,
- participate and succeed in Campus placements and competitive examinations like GATE, CET,
- 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.

Detail syllabus

Module	Contents	No. of hrs
1	Report Writing: Objectives of report writing Language and Style in a report Types of reports Formats of reports: Memo, letter, project and survey based	7
2	Technical Proposals Objective of technical proposals Parts of proposal	2
3	Introduction to Interpersonal Skills Emotional Intelligence Leadership Team Buliding Assertiveness Conflict Resolution Negotiation Skills Motivation Time Management	7
4	Meetings and Documentation Strategies for conducting effective meetings Notice Agenda Minutes of the meeting	2
5	Introduction to Corporate Ethics and etiquettes Business Meeting etiquettes, Interview etiquettes, Professional and work etiquettes, Social skills Greetings and Art of Conversation Dressing and Grooming Dinning etiquette Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions)	2
6	Employment Skills Cover letter Resume Group Discussion Presentation Skills Interview Skills	6

References

1. Fred Luthans, Organizational Behavior , Mc Graw Hill, edition
2. Lesiker and Petit, Report Writing for Business , Mc Graw 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. R.C Sharma and Krishna Mohan, Business Correspondence and Report Writing,
7. B N Ghosh, 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. K. Alex ,Soft Skills, S Chand and Company
11. Dr.KAlex,SoftSkills,S Chand and Company
12. R.Subramaniam, Professional Ethics Oxford University Press 2013.

Course Code	Course Name	Credits
BTL507	Lab I	1.5

Suggested experiments

- Physical method of microbial control.
- Chemical method of microbial control.
- Isolation of bioluminescent organisms.
- Diauxic growth curve of E.Coli.
- 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)
- Immunodiagnostics (demonstration using commercial kits)
- Determination of MIC of antibacterial drugs
- Identification of Ag Ab complex by Slide agglutination test

Course Code	Course Name	Credits
BTL508	Lab II	1.5

Suggested experiments

- Making the bacterial cells competent
- Transformation of E.coli.
- In vitro DNA ligation
- Bacterial conjugation
- Northern blotting technique
- Southern blotting
- RFLP technique
- PCR analysis of DNA fragments by agarose gel electrophoresis
- Protein Analysis by SDS-PAGE
- Isolation of Genomic DNA
- Bacterial survival against UV irradiation and mutagenesis
- Isolation, purification, quantification and separation of plasmid DNA by miniprep method (Boiling lysis)
- Isolation, purification, quantification and separation of plasmid DNA by maxiprep method (Alkaline lysis)
- separation of DNA by Agarose gel electrophoresis
- Isolation of mutants, e.g. auxotrophs, by chemical mutagenesis. (Acridine orange/ Ethydium bromide)
- β-galactosidase activity of lac+ & lac− mutant of E.coli
- Primary screening of antibiotic producers from soil

University of Mumbai

Scheme for TE: Semester-VI

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CHC601	Bioinformatics-II	03	–	–	3.0	–	–	3.0
CHC602	Cell & Tissue Culture	04	–	–	4.0	–	–	4.0
CHC603	Enzyme Engineering	03	–	–	3.0	–	–	3.0
CHC604	IPR,Bioethics & Biosafety	03	–	01	3.0	–	1.0	4.0
CHC605	Process Control & Instrumentation	03	–	01	3.0	–	1.0	4.0
CHE606	Elective – I	03	–	01	3.0	–	1.0	4.0
CHL607	Lab – III	–	03	–	–	1.5	–	1.5
CHL608	Lab – IV	–	03	–	–	1.5	–	1.5
CHL609	Lab – V	–	02	–	–	1.0	–	1.0
	Total	19	08	03	19.0	4.0	3.0	26.0

Examination Scheme

Subject Code	Subject Name	Examination Scheme							
		Theory marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
CHC601	Bioinformatics-II	20	20	20	80	–	–	–	100
CHC602	Cell & Tissue Culture	20	20	20	80	–	–	–	100
CHC603	Enzyme Engineering	20	20	20	80	–	–	–	100
CHC604	IPR,Bioethics & Biosafety	20	20	20	80	25	–	–	125
CHC605	Process Control & Instrumentation	20	20	20	80	25	–	–	125
CHE606	Elective – I	20	20	20	80	25	–	–	125
CHL607	Lab – III	–	–	–	–	–	25	–	25
CHL609	Lab – IV	–	–	–	–	–	25	–	25
CHL610	Lab – V	–	–	–	–	–	25	–	25
			Total	120	480	75	75	–	750

Elective Streams(CHE606)

a	Research Methodology and Scientific writing
b	Stem Cell Biology
c	Good Laboratory Practices (GLP) & Process Safety

Course Code	Course Name	Credits
BTC601	Bioinformatics II	3.0

Prerequisites

Bioinformatics I, Knowledge of protein structure.

Course Objectives

The objectives of this course are to

- 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 bioinformatical databases, perform text- and sequence-based searches, and analyse and discuss the results in light of molecular biological knowledge
- Explain the major steps in pairwise and multiple sequence alignment, explain the principle for, and execute pairwise 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.

Detail syllabus

Module	Contents	No. of hrs
1	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

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Module	Contents	No. of hrs
2	Interactions: Protein ligand interactions, Torsion angle, Ramchandran plot, Protein folding & Chaperones. Cartesian coordidates	10
3	Overview: Machine learning, Genetic algorithms, Simulated annealing. Interoperability: Introduction, Its role in bioinformatics. Interexchange Languages: XML, CORBA, And UMLS. Clustering algorithms.	08
4	Drug designing: Drug optimization, Identification of pharmacophore, Optimizing access to target, Prodrugs, Endogenous compounds as drugs, Quantitative structure- activity relationship (QSAR).	05
5	Docking: Introduction, Protein protein docking, Protein Ligand docking, Applications of docking.	06

References

1. Cynthia Gibas & Per Jambeck, Developing Bioinformatics computer skills, third edition.
2. S.C. Rastogi, Bioinformatics concepts, skills & applications, first edition.
3. DovStekel, 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.

Course Code	Course Name	Credits
BTC602	Cell and Tissue Culture	4.0

Prerequisites

Basic knowledge of Cell Biology, Microbiology and Plant and Animal Physiology

Course Objectives

The objectives of this course are to :

- 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

Detail syllabus

Module	Contents	No. of hrs
1	**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	7
2	**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	8
3	**Transformation of Plants:** Agrobacterium mediated Gene transfer, Direct Methods of Gene Transfer, Chemical Methods, Electroporation, Microinjection, Particle Bombardment, Virus Mediated Gene Transfer, Transgenic Plants, Applications of Plant Biotechnology for Production of Quality Oil, Industrial Enzymes and Plantibodies	8
4	Introduction to Animal Cell Culture: Historical Background, Advantages of Tissue Culture, Limitations, Major Types of Tissue Culture	5

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Module	Contents	No. of hrs
5	Laboratory Design & Layout of ATC laboratory, Equipments and Materials Of a Tissue Culture Laboratory, Media Preparation and Sterilization techniques, The Culture Environment, Cell Adhesion, Cell Proliferation, Differentiation, Cell Signaling, Energy Metabolism.	10
6	**Primary Culture:** Initiation of a Primary Cell Culture, Isolation of the Tissue, Types of Primary Culture, Subculture and Cell Lines.	7
7	Cloning and Selection of Animal Cells, Cell Separation, Characterization, Differentiation, Cryopreservation, Scale-up & Automation, Antibody Engineering and Large scale Production of Pharmaceutical Products, Stem cell Cultures, Embryonic Stem Cell Cultures and their Applications	7

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; Volume 11 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

Course Code	Course Name	Credits
BTC603	Enzyme Engineering	3.0

Prerequisites

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 a 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.

Detail syllabus

Module	Contents	No. of hrs
1	Enzyme as a Biological Catalysts. Chemical nature, polypeptide structures Models of Enzyme-substrate interactions, Catalytic and Allosteric sites. Activation Energy and catalysis.	4
2	Structures of Enzymes (Primary, Secondary, Tertiary etc.), Effect of pH, Temperature and Salts on Enzyme efficiency and Inhibition. Enzyme Kinetics, models and degree of efficiencies/Inhibition, their types and analysis.	8
3	Enzyme activity Analysis: pH-change, Viscometry, Manometry, Colorimetry, Spectrophotometry, etc. Fundamentals of each method, constants and variables involved. Criteria for the Degree of accuracy.	6
4	Working with Enzyme: Detection, Isolation and Purification of Enzyme under study. Stability of Enzyme. Genetic Modification of Enzyme. Immobilization of Enzyme for repeat use.	8
5	Criteria of Enzyme Purity, Specific Activity, Subunit Analysis, Western Blotting.	4

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Module	Contents	No. of hrs
6	Process design and Operation strategies for Enzyme based reactors. Operational problems, Decline and loss of Enzyme efficiency, Remedies!	5
7	Application of Enzyme in Industries: Food, Leather, Beverage, Detergents, Pharmaceuticals and Medicines, Analytical/ Diagnostics and Biosensors, Therapeutics.	4

References

1. Enzymes-Palmer;T,(Affiliated East West Press Pvt.Ltd.), 2004.
2. Biochemistry- Stryer,Berg, 6thEdition, (W.H.Freeman and Co.), 2007.
3. Biochemistry-Metzler;DE, 2ndEdn., (Academic press) 2001.
4. Lehninger Principles of biochemistry-Nesson,Cox, 4thEdn., (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, 5thEdn. (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 Name	Credits
BTC604	IPR, Bioethics and Biosafety	4.0

Prerequisites

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 biohazardous material

Detail syllabus

Module	Contents	No. of hrs
1	**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
2	**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	6
3	**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	7

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Module	Contents	No. of hrs
4	**IPR and Biotechnology:** Biopiracy and Bioprospecting Farmers Rights and Plant breeders rights Biodiversity	5
5	**Biosafety:** Good Lab Practices Introduction to Biological Safety Cabinets Primary Containment for Biohazards Biosafety Levels GMOs and LMOs and their environmental impact Roles of Institutional Biosafety Committee, RCGM, GEAC etc. For GMO applications in food and agriculture Risk analysis, assessment and management	7
6	**Bioethics:** Bioethical issues related to Healthcare & medicine Food & agriculture Genetic engineering The Human Genome Project and Genetic Testing Environmental problems	4

References

1. IPR, Biosafety and Bioethics by Deepa Goel and Shomini Parasha

2. Intellectual property rights by Dr. Reddy

Course Code	Course Name	Credits
BTC605	Process Control & Instrumentation	4.0

Prerequisites

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.

Detail syllabus

Module	Contents	No. of hrs
1	**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.	5
2	**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.	6
3	**First order systems in series** Interacting and non-interacting systems and their dynamic response to step, pulse and impulse inputs; conceptual numericals.	4
4	**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.	5

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Module	Contents	No. of hrs
5	**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.	5
6	**Closed loop control systems** Block diagrams for servo and regulatory problems. Transient response of first and second order processes for set point changes and load changes with proportional and PI controllers, conceptual numericals.	4
7	**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.	6
8	**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, multi variable controls and their application for optimum controls.	4

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 Name	Credits
BTE606	Research Methodology	4.0

Prerequisites

Knowledge of Biochemistry, Microbiology, Molecular Biolog, Genetics.

Course Objectives

- To learn to express a scientific idea, or observation, logically and scientifically.
- To learn how to gather data, analyse them, and express them.
- To understand how an expression can cause an error or confusion, and how to avoid it.

Course Outcomes

- One learns to collect data and analyse it, express scientific finding in a logical and an understandable form.
- One also learns to cite references.

Detail syllabus

Module	Contents	No. of hrs
1	**Methodology and Literature collection:** Introduction to Research Methodology - Meaning of Research, Type of Research: Basic, Applied, Researches, Criterions of good Research, Problems Defining the Research Problem. Literature collection - Review process. Discriminative Reading, Consulting Source material. Literature citation - Different Systems of citing Reference:- Name Year System citation in the text, Name Year System List of Reference.	11
2	**Research, Data collection and Analysis.** Research Design - Sample Collection - Criteria of Selecting a Sampling Procedure, Observation/Interview/Collection through Questionnaires/Schedules, Case study method. Processing and Analysis of data. Reporting of results. Interpretations and Discussion.	14
3	**Scientific Writing:** Report Writing: Steps in Report Writing. Title, Authors, Abstract, (Summary/Synopsis), Key Words, Introduction, Materials and Methods, Results, Discussion, Acknowledgements, Appendix, references. Use of Table / Figures in Report Writing . (Placement of Table / figure, Numbering, Box Heading, Caption photographs. Formatting and Typing Introduction, Margins, Spacing, Alignment, Fonts, etc., Format of Thesis.)	14

References

1. Research Methodology for Biological Sciences (2006), N. Gurumani MJP Publishers
2. Research Methodology : Methods and Techniques. 2nd Edition C.R.Kothari, New age international Publishers 2004
3. Research methods for the bioscience: 2006 International Student Edition. Oxford University Press, Edition, D. Holmes, P. MP. Moody, D. Dine. ISBN 13 : 978-0-19-568631-9

Course Code	Course Name	Credits
BTE606	Stem Cell Biology	4.0

Prerequisites

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

- Students will be well-versed with the new technology of Stem-cell.
- They will have understood Developmental biology at a cellular level, possibility of use of Stem cells for therapeutic purposes.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction:** Universal mechanism of development: Cell proliferation, Specialization, Interaction and Movement. Case study of. C. Elegans.	6
2	**Cell proliferation and development:** Morphogens and their gradients, Intrinsic programming, Sequential induction.	6
3	**Plant Development:** Root, Shoot, Flower, Seed & Meristem. Plant part generation, Plant growth regulators. Maintaining of the Meristem cells.	6
4	**Stem cells:** Epidermis renewal by stem cells, Maintaining population of stem cells, Transit amplifying cells, Multipotent stem cells and Blood cell formation.	7
5	**Types of stem cell:** Embryonic, Bone marrow (Hematopoietic), Pluripotent stem cells and methods of generating them.	7
6	**Application of stem cells:** Repairing Nervous system, Liver cell proliferation and repair, Cardiac repair, Diabetes treatment, GM stem cells and Gene therapy	7

References

1. Molecular biology of Cell: Alberts et al. 2014. (Chapter on Stem Cells.)

2. Please refer to on-line information for various sub topics, available an peered review research articles.

Course Code	Course Name	Credits
BTE606	Good Laboratory Practices (GLP) & Process Safety	4.0

Prerequisites

Knowledge of various pharmaceutical and biotechnological products and techniques invovled in such industries.

Course Objectives

- To learn the regulations and various guidelines, and how these regulations apply to the manufacturing nad distribution of pharmaceitical and biological products.
- To impart knowledge of the principles of GLP/GMP and their practical applications
- To attain knowledge of the safety procedures carried out in Bioprocess and chemical plants.
- To familiarize the basic concepts of safety and biosafety guideline.

Course Outcomes

- Gain the skills and knowledge necessary to understand and work in GLP/GMP compliant environment.
- Understand the purpose and reasoning of GLP/GMP regulations and their practical applications through key quality systems.
- Understand QA-GMP-QC relationship.
- Gain knowledge of the various safety procedures to be followed in laboratory and production units.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction to GLP:** Good laboratory practices-Introduction, WHO guidlines on GLP and GMP History of Good Laboratory Practices Quality assurances in Good Laboratory Practices	06
2	**Quality standards and Quality Assurances:** Quality Standards- Advantages and Disadvantages, Concept of Quality Control Quality Assurance- Their functions and advantages Quality assurance and quality management in industry Customer requirement of quality Government and trade standards of quality Federal Food and Drug Law FDA Action BSTI Laws, BSTI action and activities Other food laws (Legalization), Trade and Company Standards Control by National, International, Social Organizations (example:FAO, WHO, UNICEF, CAB), Society (example: NSB, Professional societies)	06

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Module	Contents	No. of hrs
3	**Good Manufacturing Practices in Pharmaceutical and Food Industries:** Types of validation in Pharma industry Scope and importance of Validation, Limitations, Organization and Elements of validation (Q, OQ, PQ and DQ) Cleaning Validation, Validation of Analytical Procedures as per ICH Guidelines Implications of cGMP and Food plant sanitation The regulationsof cGMPs Planning of Plant Sanitation Programs and Construction factors Hygeinic design of food plants and equipments Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials Control of rats, rodents, birds, insects and microbes. Cleaning and Disinfection: Physical and Microbiological Approach	09
4	**Quality Control:** Introdution to Quality control and Total Quality Control in the food industry Various Quality Attributes of food such as size, shape, texture, color, viscosity and flavor Instrumental chemical and microbial quality control Sensory evaluation of food and statistical analysis Food Regulation and Compliance Food Inspection and Food Law Critical Control Points in Food Industries: Critical Quality control point in different stages of production including raw materials and processing materials Food Quality and Quality control including the HACCP system (Critical quality control points in different stages of production including raw materials and proccessing materials)	06
5	**Biosafety:** Introduction: Historical Background, Biosafety in Laboratory/ institution. Laboratory associated infections and other hazards, assessment of Biological Hazards and levels of biosafety, prudent biosafety practices in the laboratory/institution Introduction to Biological safety cabinets, Primary Containment of Biohazards, Biosafety Levels, Recommended Biosafety Levels for Infectious Agents and Infected Animals Biosafet guidelines, Government of India Guidelines Definition of Genetically Modified Organisms (GMOs)	06
6	**Safety and Hazard Analysis Hazards:** Chemical Hazards Classification, Radiation hazards and control of exposure to radiation Fire triangle, fire prevention methods Industrial hygiene: Introduction, evaluation and control Toxicology: Routes of entry of toxic substances, Toxic studies Safe Housekeeping instrumentation for safe operation, personal protective equipments	09

References

1. Quality Control of Herbal Drugs- Dr. Pulok a. Mukherjee (Bussiness Horizons Pharmaceutical Publishers)

2. cGMP for Pharmaceuticals- Manohar A. Potdar (Pharma Med Press)

3. Validation of Active Pharmaceuticals-Ira R. Berry (CRC Press)
4. Guidelines on cGMP and Quality of Pharmaceutical Products-S Iyer (DK Publications)
5. Quality Assurance and Quality Management in Pharmaceutical Industry-Y. Anjaneyulu (Pharma Book Syndicate)
6. Quality Assurance in Analytical Chemistry, B.W.Wenclawiak, M.Koch E. Hadjicostas
7. WHO Library Cataloguing in Publication Data
8. Handbook: Good Laboratory Practices (GLP): quality practices for regulated non-clinical research and development-2nd ed.

Course Code	Course Name	Credits
BTL607	Lab III	1.5

Suggested experiments

- 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

Course Code	Course Name	Credits
BTL608	Lab IV	1.5

Suggested experiments

- 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
- Enzyme Inhibition studies
- Characterization of enzymes/ Determination of molecular weight of enzyme.
- 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 is 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

Course Code	Course Name	Credits
BTL609	Lab V	1.0

Suggested experiments

- 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 Chemsketch & Marvinsketch.
- 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.

AC 26/02/2015 Item no. 4.64

UNIVERSITY OF MUMBAI

Revised Syllabus
Program – **Bachelor of Engineering**
Course – **Biotechnology Engineering**
(Final Year – Sem VII and VIII)

under
Faculty of Technology
(As per Credit Based Semester and Grading System from 2015-16)

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 work done over the entire semester.
- It is suggested that each tutorial be graded immediately and an average be taken at the end.
- A minimum of ten tutorials will form the basis for final evaluation.
- Term work assessment has to be done based on the following:
- Assignments: 20 Marks
- Attendance: 05 Marks
- For giving weightage to attendance, the following guidelines should be followed:
- 75% - 80%: 3 Marks, 81% - 90%: 4 Marks, Abobe 91%: 5 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 as much of the syllabus possible.

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

- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Project & Seminar Guidelines

- Project Groups: Students can form groups with not more than 3(Three).
- The load for projects may be calculated as below,

  Sem VII: $\frac{1}{2}$ hr for teacher per group.

  Sem VIII: 1 hr for teacher per group.
- Maximum of four groups can be allotted to a 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, six hours are allotted in Project A, 8 hours in Project-B and three hours for Seminar.

University of Mumbai

Scheme for BE: Semester-VII

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BTC701	Bioseparation & Downstream Processing Technology-I	04	–	01	04	–	01	05
BTC702	Bioprocess Modeling & Simulation	04	–	01	04	–	01	05
BTC703	Seminar	–	–	03	–	–	03	03
BTE704	Elective-II	04	–	01	04	–	01	05
BTP705	Project-A	–	–	06	–	–	03	03
BTL706	LAB VI	–	04	–	–	02	–	02
BTL707	LAB VII	–	04	–	–	02	–	02
	Total	12	08	12	12	04	09	25

Examination Scheme

Subject Code	Subject Name	Examination Scheme							
		Theory marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1 (A)	Test 2 (B)	Avg.of (A) & (B)					
BTC701	Bioseparation & Downstream Processing Technology-I	20	20	20	80	25	–	–	125
BTC702	Bioprocess Modeling & Simulation	20	20	20	80	25	–	–	125
BTC703	Seminar	–	–	–	–	50	–	–	50
BTE704	Elective – II	20	20	20	80	25	–	25	150
BTP705	Project-A	–	–	–	–	50	–	50	100
BTL706	LAB VI	–	–	–	–	–	25	–	25
BTL707	LAB VII	–	–	–	–	–	25	–	25
			Total	60	240	175	50	75	600

Elective Streams(BTE704)

Sem.VII	**Elective II**	• Food Biotechnology • Pharmaceutical Technology • Nanotechnology

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
BTC701	Bioseparation & Downstream Processing I	4.0	1.0	5.0

Prerequisites

- Basics of Bioprocesses and Unit Operations
- Basic knowledge of mass balace.
- Concepts of molecular diffusion and diffusion coefficients

Course Objectives

- To cover the fundamentals, and design concepts of various down stream 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

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction to Bioproducts and Bioseparation:** Range and characteristics of bioproducts Characteristics of Fermentation Broths Selection of unit operation with due consideration of physical, chemical and biochemical aspect of biomolecules Stages of Downstream Processing	06
2	**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, Sonication	07
3	**Primary Separation:** Removal of insolubles and Biomass (and particulate debris) separation techniques Flocculation and sedimentation Centrifugation-Ultracentrifugation, Gradient centrifugation FiltrationTheory of Filtration, Pretreatment of Fermentation Broths, Filter Media and Equipment, Conventional and Cross-flow Filtration, Continuous Filtration, Filter cake resistance, specific cake resistance, Washing and dewatering of filter cakes	12

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Module	Contents	No. of hrs
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, 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
5	**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 and without reflux] Equipments for liquid-liquid extraction. Kinetics and modeling of extraction cycles, Types of extraction processes: Reactive extraction, Aqueous two phase systems, Reverse micellar extraction, Liquid-liquid and solid-liquid extraction, Super critical fluid Extraction. Design of extraction equipment. Different types of extractors and designing of extractors. **Leaching:** Representation of equilibria, single stage leaching, multistage cross current leaching,multistage counter current leaching, equipments for leaching.	12
6	**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	05

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 New York 1993.
3. Geankoplis C.J., Transport processed 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: Priniples 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, WileyInterscience 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		
		Theory	Tut.	Total
BTC702	Bioprocess Modelling and Simulation	4.0	1.0	5.0

Prerequisites

- 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 apects 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

Detail syllabus

Module	Contents	No. of hrs
1	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	10
2	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	10
3	Numerical Methods: Solution of linear algebraic equations by cramer's rule, Gauss elimination, Gauss siedel 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, Runga Kutta method Basic data analysis-curve fitting	12

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Module	Contents	No. of hrs
4	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
5	Modelling for activated sludge process,Model for anaerobic digestion, Model for lactic acid fermentation,antibiotic production,Ethanol fermentation	10

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. FinlaysonWiley- International, 2005.

Course Code	Course/ Subject Name	Credits
BTS703	Seminar	3.0

Details

- Seminar topics will be the consensus of the project guide and the students. Each student will work on a unique topic.
- Representation of seminar work can be in the form of presentation
- Students shall present research articles which may or may not be related to the topic of their project.

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
BTE704	Elective – II : Food Biotechnology	4.0	1.0	5.0

Prerequisites

- 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 physicochemical, 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

Detail syllabus

Module	Contents	No. of hrs
1	Introduction to food technology, Constituent 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	08
2	Sources and activity of microorganisms associated with food; Factors affecting the growth and survival of micro-organisms in foods- intrinsic and extrincis; Food borne diseases infections and intoxications, food spoilage causes. Microbial food- yeasts, bacteria and production of new protein foods - SCP, mushroom, algal proteins	10
3	Microbial fermentation and production of food and beverages using microorganisms. Pickling, Sauerkraut, vinegar, bread. Dairy product- Yogurt, cheese production by microbial and enzymatic(proteases) method. Alcholholic beverages- Beer(deoxygenating and desugaring by glucose oxidase of beer, beer mashing and chill proofing), Wine (red, white, sparkling), whiskey (Single Malt, Multi Malt), Vodka, Rum and Gin	10
4	Fermentation methods for preserving foods, Preparation of various food additives like coloring agents, emulsifiers, vitamins, flavours and organic acids	08

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Module	Contents	No. of hrs
5	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	08
6	Food Packaging methods Materials used for food packaging of various food products like cheese, eggs, bread, alcoholic beverages, milk and juices	08

References

1. Frazier, Food Microbiology, Tl-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		
		Theory	Tut.	Total
BTE704	Elective – II: Pharmaceutical Biotechnology	4.0	1.0	5.0

Prerequisites

- Knowledge about biochemistry and biochemical pathways in biological systems
- Knowledge about cell biology and metabolism

Course Objectives

- Student shall know about bioavailability, bioequivalence and factor affecting bioavailability.
- Students shall know the pharmacokinetic and pharmacodynamic on the basis of CADD. They also know the design evaluation and application related to oral, parenteral, transdermal, implants, bioadhesives and targeted drug delivery systems.

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.

Detail syllabus

Module	Contents	No. of hrs
1	**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	06
2	**Pharmacodynamics and Pharmacokinetics:** Molecules acting as drug targets Enzymes, Receptors, Nucleic acid, Miscellaneous (Transport proteins, lipids, carbohydrates) Three Phases of drug action Drug Absorption, Distribution, Metabolism and Excretion (ADME) Modes of drug administration Drug dosing (half-life, steady state concentration, drug tolerance, Bioavailibility)	08
3	***In vivo* and *In vitro* approach of Drug discovery, design and development:** Drug discovery: finding a lead molecule Drug design: Optimizing target interaction	07

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Module	Contents	No. of hrs
4	**Final stages of drug development trials:** Preclinical and clinical trials Patenting and regulatory affairs	07
5	**Medicinal Chemistry:** Antibacterial, Anticancer, Antiviral drugs, Opioid anelgesics	06
6	**Biopharmaceuticals:** Production of Therapeutic Proteins, Hormones, Cytokines - Interferons, Interleukins I & II, Tumor Necrosis Factor (TNF); Nucleic acids Role of Biopharmaceuticals in treatment of various health disorders	10
7	**Drug Delivery Systems, Biomaterials And Their Applications:** Controlled and sustained delivery of drugs. Biomaterial for the sustained drug delivery. Liposome mediated drug delivery. Drug delivery methods for therapeutic proteins.	08

References

1. Biopharmaceuticals: Biochemistry & Biotechnology, Gary Walsh (1998), John Wiley & Sons Ltd.
2. Medicinal Chemistry by Graham L. Patrick, Oxford University Press
3. Remingtons Pharmaceutical sciences, (Mark Publications & Company eston PA) year 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		
		Theory	Tut.	Total
BTE704	Elective – II: Nanotechnology	4.0	1.0	5.0

Prerequisites

- 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.
- To motivate and facilitate student to undertake the project and research work in Nanotechnology.

Course Outcomes

At the end the student would have learned:

- 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.

Detail syllabus

Module	Contents	No. of hrs
1	**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, surface defects, Properties at nanoscale (optical, mechanical,electronic,and magnetic)	09
2	**Different Classes of Nanomaterials:** Classification based on dimensionality, Quantum Dots, Wells and Wires, Carbon-based nano materials (buckyballs, nanotubes, graphene), Metalbased nanomaterials (nanogold, nanosilver and metal oxides), Nanocomposites, Nanopolymers, Nanoglasses, Nano ceramics, Biological nanomaterials	10
3	**DNA and Protein based Nanostructures:** DNA-gold particle conjugates, Polymer nanocontainers, Nanopores and nanomembranes for biochemical sensing, Micro and nanofluidic devices in biologica studies, Peptide nanotubes and their applications electronics, antibacterial agents; protein self assembly, nanochips, nanopolymers	10

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Module	Contents	No. of hrs
4	**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	09
5	**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	14

References

1. Pradeep T., A textbook of nanoscience and nanotechnology , Tata Mcgrew 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/ Subject Name	Credits
BTP705	Project-A	3.0

Details

- 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, six hours are allotted in Project A to the students.
- Students are advised to take up industrial/ experimental oriented/ simulation and/or optimization based topics for their projects.
- Students are expected to do research and literature survey for their topics and submit a synopsis at the end of the semester, specifying their hypothised methodology and expected outcome of their work to be conducted in Project-B.
- Students are also expected to present their synopsis at the end of the semester.

Course Code	Course/Subject Name	Credits
BTL706	LAB-VI	2.0

Concepts for experiments:

A minimum of 10 experiments must be performed based on the following concepts:

- Viscometer
- Cell disruption
- Conventional filtration
- Centrifugation
- Distribution coefficient in Liq - liq extraction
- Binodal curve in liq - liq extraction
- Solid-liquid extraction of natural product and subsequent purification
- Leaching
- Protein precipitation and its recovery
- Gas Chromatography
- Ion Exchange Chromatography
- Separation of Plant Pigments using Column Chromatography

Course Code	Course/Subject Name	Credits
BTL707	LAB-VII	2.0

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 algebric equations
- Parameter Estimation in kinetics
- Modelling of Batch, Fed Batch and Continuous
- Simulation of Batch Reactor
- Simulation of Continuous Reactor
- Solving Numerical integrations
- Solving Algebric equations
- Solving Differential Equations

Scheme for BE: Semester-VIII

Subject Code	Subject Name	Teaching Scheme			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BTC801	Environmental Biotechnology	04	–	–	04	–	–	04
BTC802	Bioseparation & Downstream Processing Technology-II	04	–	–	04	–	–	04
BTC803	Bioprocess Plant & Equipment Design	03	–	01	03	–	01	04
BTE804	Elective-III	03	–	01	03	–	01	04
BTP805	Project-B	–	–	08	–	–	06	06
BTL806	LAB VIII	–	03	–	–	1.5	–	1.5
BTL807	LAB IX	–	03	–	–	1.5	–	1.5
	Total	14	06	10	14	03	08	25

Examination Scheme

Subject Code	Subject Name	Examination Scheme							
		Theory marks				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem. Exam				
		Test 1 (A)	Test 2 (B)	Avg.of (A) & (B)					
BTC801	Environmental Biotechnology	20	20	20	80	–	–	–	100
BTC802	Bioseparation & Downstream Processing Technology-II	20	20	20	80	–	–	–	100
BTC803	Bioprocess Plant & Equipment Design	20	20	20	80	25	–	–	125
BTE804	Elective-III	20	20	20	80	25	–	–	125
BTP805	Project-B	–	–	–	–	50	–	100	150
BTL806	LAB VIII	–	–	–	–	–	25	–	25
BTL807	LAB IX	–	–	–	–	–	25	–	25
			Total	80	320	100	50	100	650

Elective Streams(BTE804)

Sem.VIII	**Elective III**	• Non Conventional Sources of Energy • Biosensor & Diagnostics • Protein Engineering • Agriculture Biotechnology

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
BTC801	Environmental Biotechnology	4.0	–	4.0

Prerequisites

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

- By studying this subject the students can be able to: 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.

Detail syllabus

Module	Contents	No. of hrs
1	**Introduction:** Environmental Degradation, types of environmental degradation, factors affecting environmental degradation,biogeochemical cycles (Nitrogen, Carbon, Oxygen, Phosphorus, Sulfur, Hydrological), pollution, pollutants and their types (general idea), Man induced impact on environment (Global warming, Green house effect, ozone depletion, acid rain, Photochemical smog), Environmental monitoring- sampling (land, air, water), analysis- physical, chemical, biological, pollution monitoring- bio indicators, biosensors, biomarkers, pollution control aspects	07
2	**Pollution control:** Pollutants, types, sources, effects, atmospheric stability, atmospheric dispersion- (Gausian plume model), problems, 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

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Module	Contents	No. of hrs
3	**Water Pollution Control:** Pollutants, types, sources, effects, 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.	08
4	**Soil Pollution Control:** Pollutants, types, sources, effects, bioremediation of contaminated soil, types of bioremediation, factors affecting bioremediation, phytoremediation, role of genetic engineering	06
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 biosurfactnts	04
7	**Downstream Processing:** Downstream processing in biological treatment process, effluent disposal and reuse, biofiltration 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 Waste Rules, Environmental Clearance, Environmental Legislation and Pollution Control Acts in India, Central Pollution Control Board, its functions and powers, Procedure to operate an industry	03

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Module	Contents	No. of hrs
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

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	Credits		
		Theory	Tut.	Total
BTC802	Bioseparation & Downstream Processing II	4.0	–	4.0

Prerequisites

- Basics of Bioprocesses and Unit Operations
- Basic knowledge of mass balace.
- Concepts of molecular diffusion and diffusion coefficients

Course Objectives

- To cover the fundamentals, and design concepts of various down stream 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

Detail syllabus

Module	Contents	No. of hrs
1	**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
2	**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	10

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Module	Contents	No. of hrs
3	**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
4	**Crystallization:** Solubility curve, Super saturation, Method of obtaining super saturation 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
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, types of driers Lyophilization Formulation	06
6	**Case Studies of downstream processing:** Baker's yeast, Ethanol, Citric acid, Penicillin, Insulin, Casein, interferon, cephalosporin, Recombinant Streptokinase, Monoclonal antibodies, Tissue plasminogen activator, Taq polymerase	12

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 New York 1993.
3. Geankoplis C.J., Transport processed 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: Priniples 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, WileyInterscience 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		
		Theory	Tut.	Total
BTC803	Bioprocess plant and Equipment Design	3.0	1.0	4.0

Prerequisites

- 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 design.

Course Outcomes

- This course makes the students to learn the methods and practice 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

Detail syllabus

Module	Contents	No. of hrs
1	**Module 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.	07
2	**Module 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.	07

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Module	Contents	No. of hrs
3	**Module 3:** Development of flowsheet, piping and instrumentation diagram and its description. General design consideration, optimum design	07
4	**Module 4:** Detailed design and drawing of perforated plate distillation column.Absorption columns: Detailed design and drawing of perforated plate and packed towers.	06
5	**Module 5:** Design considerations for maintaining sterility of process streams and process equipments. Design of mechanically agitated fermenters and non-mechanically agitated (bubble column and air lift) fermenters.	06
6	**Module 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

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', 7 th Edn., McGraw Hill, NewYork, 1997.
3. Joshi, M.V., and Mahajani, V.V., 'Process Equipment Design', 3 rd 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		
		Theory	Tut.	Total
BTE804	Elective – III : Non Conventional Sources of Energy	3.0	1.0	4.0

Prerequisites

- 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 effecient 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.

Detail syllabus

Module	Contents	No. of hrs
1	**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
2	**Solar energy:** 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, photo voltaics - solar cells & its applications	08
3	**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

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Module	Contents	No. of hrs
4	**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
5	**Energy from the Ocean:** Ocean Thermal Electric Conversion (OTEC) systems: open cycle, closed cycle, Hybrid cycle, prospects of OTEC in 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.	05
6	**Energy from Biomass:** Biomass conversion principle: combution 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. Biodisel: principle, production, efficiency, scope in India.	05
7	**Fuel cells:** Introduction, Design principle, operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells. Microbial Fuel cells: Principle, construction, working, efficiency and scope in India.	03
8	**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.	03
9	**Magneto Hydrodynamic (MDH) Power Generation:** Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials for MHD generators and future prospects.	03
10	**Energy Management:** Energy economics, energy conservation, energy audit, general concept of total energy system, scope of alternative energy system in India.	03

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 Duffic and Beckman, John Wiley
4. Solar Energy: Principles of Thermal Collection and Storage by S,P Sukhatme,Tata McGraw Hill
5. Alternative Energy Sources by B.L. Singhal Tech Max Publication
6. Non Conventional Energy Resources by S.Hasan Saeed and D.K.Sharma
7. Fuel Cells by Bockris and Srinivasan; McGraw Hill
8. Magneto Hydrodynamics by Kuliovsky and Lyubimov, Addison

Course Code	Course/ Subject Name	Credits		
		Theory	Tut.	Total
BTE804	Elective – III: Biosensors and Diagnostics	3.0	1.0	4.0

Prerequisites

Biochemistry , Analytical Methods In Biotechnology, Principles of Basic Instruments Used In A Biotechnology Lab.

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 challenged 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 .

Detail syllabus

Module	Contents	No. of hrs
1	Biosensors: Principles, Characteristics of Ideal Biosensors, Basic measuring procedure, Components of biosensors, Advantages & Limitations	09
2	Biocatalysis based biosensors, Bioaffinity based biosensors & Microorganisms based biosensors, Biologically active material and analyte. Types of membranes used in biosensor constructions.	10

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Module	Contents	No. of hrs
3	Various types of transducers, Principles and applications - Calorimetric, Optical, Potentiometric/ Amperometric, Conductrometric/ resistormetric.	05
4	Piezoelectric, Semiconductor, Impedimetric, Mechanical and molecular electronics based transducers, Chemiluminiscene-based biosensors.	05
5	Biosensors in clinical chemistry, Medicine and health care, Biosensors for veterinary, Agriculture and food, Low cost-biosensor for industrial processes for online monitoring , Biosensors for environmental monitoring.	10

References

1. Roger, K.R. and Gerlach, C.L. 1 99. Update on environmental for biosensors.Env. Sci. Techno! 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		
		Theory	Tut.	Total
BTE804	Elective – III: Protein Engineering	3.0	1.0	4.0

Prerequisites

- Principles of Biochemistry
- Principles of Recombinant DNA Technology
- Basics of Enzyme Activity

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.

Detail syllabus

Module	Contents	No. of hrs
1	**Structure of Proteins:** Post translational Modifications of proteins. Primary Structure and its determination Ramchandran Plot Secondary, Tertiary and Quaternary Structure of Proteins Bonds that stabilize a protein molecule Protein folding pathways and Energy Status of a Protein Molecule Protein Degradation in the cell	10
2	**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

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Module	Contents	No. of hrs
3	**Structure Function Relationships in Proteins:** Helix-turn-Helix motif in DNA binding and homeodomain protein. Zinc fingers. Leucine zippers. Membrane proteins: General characteristics, Transmembrane segments, bacteriorhodopsin and Photosynthetic reaction center	06
4	**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
5	**Applications of Protein Engineering:** Protein Engineering to enhance the solubility and assist 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-tRNA synthase. Engineering therapuetic hormones: insulin. Engineering humanized antibodies	10

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		
		Theory	Tut.	Total
BTE804	Elective – III: Agriculture Biotechnology	3.0	1.0	4.0

Prerequisites

- 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 imroved quality biomaterials

Detail syllabus

Module	Contents	No. of hrs
1	**Agricultural Microbiology:** Microbial groups in soil, Plant and Microbe interactions. Plant pathogens. Biological nitrogen fixation. Microflora of Rhizosphere and Phyllosphere microflora, microbes in composting Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), microbial insecticides, Microbial agents for control of Plant diseases	05

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Module	Contents	No. of hrs
2	**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	07
3	**Transgenic Plants:** Transgenic Plant Analysis: screening on selection media, PCR, Intact Transgene Integration characterization, Real time PCR, Transgene expression, western blot analysis 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 .	05
4	**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
5	**Biotic and Abiotic stress:** Abiotic stress: Acclimation 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	08

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Module	Contents	No. of hrs
6	**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
7	**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
8	**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

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
BTP805	Project-B	6.0

Details

- 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 are allotted in Project B to the students.
- Students are advised to take up industrial/ experimental oriented/ simulation and/or optimization based topics for their projects.
- Students have to submit a comprehensive thesis based on the research work conducted throughout the year.
- Students are expected to present their work and defend their thesis.

Course Code	Course/Subject Name	Credits
BTL806	LAB-VIII	1.5

Concepts for experiments:

A minimum of 10 experiments must be performed from the following list of experiments:

- Physical property like pH, turbidity, conductivity, alkalinity determination of waste water
- Determination of total phosphorus content of waste water
- Determination of total Kjeldahl Nitrogen of waste water
- Determination of BOD of waste water
- Determination of COD of waste water
- Determination of Oil and grease content of waste water
- Determination of total solids, total suspended solids and total dissolved solids
- Determination of MLSS and MLVSS
- Determination of Sludge Volume Index
- Estimation of metals like iron, copper in waste water
- Determination of chloride content of waste water
- Estimation of coliform bacteria in waste water
- Determination of phytoplankton in waste water
- Determination of Most Probable Number of waste water
- Removal of heavy metals by chemical methods from waste water Adsorption

Course Code	Course/Subject Name	Credits
BTL807	LAB-IX	1.5

Concepts for experiments:

A minimum of 10 experiments must be performed on the following concepts:

- Adsorption
- Membrane based filtration
- Dialysis
- Reverse Osmosis
- Storage techniques for bioactive compounds- Freeze drying, Spray drying
- Crystallization
- Isolation and purification of biomolecules (protein/s or enzyme) from crude source/fermentation broth
- Assessment of recovery and purity of the isolated product