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 2017-18

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

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 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

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 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 Files**: 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

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Name</th><th colspan="3">Teaching Scheme (Contact Hours)</th><th colspan="4">Credits Assigned</th></tr>
<tr><th>Theory</th><th>Pract.</th><th>Tut.</th><th>Theory</th><th>TW/Pract</th><th>Tut.</th><th>Total</th></tr>
<tr><td>FEL201</td><td>Basic Workshop Practice - II</td><td>--</td><td>04</td><td>--</td><td>--</td><td>02</td><td>--</td><td>02</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</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>Test1</th><th>Test2</th><th>Av of Test 1 & 2</th></tr>
<tr><td>FEL201</td><td>Basic Workshop Practice - II</td><td>--</td><td>--</td><td>--</td><td>--</td><td>50</td><td>--</td><td>--</td><td>50</td></tr>
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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	ITL301	Data Structure Lab	1
2	ITL302	SQL Lab	1
3	ITL303	Fundamentals, Computer programming Paradigms Lab	1
4	ITL304	Java Lab (SBL)	1
5	ITM301	Mini Project – 1 A Front end /backend Application using JAVA	1
6	ITL401	Network Lab	1
7	ITL402	Unix Lab	1
8	ITL403	Microprocessor Lab	1
9	ITL404	Python Lab (SBL)	1
10	ITM401	Mini Project – 1 B Python based automation projects	1
11	TEITL501	Computer Graphics and Virtual Reality	1
12	TEITL502	Operating Systems	1
13	TEITL503	Microcontroller and Embedded Systems	1
14	TEITL504	Advanced Database Management Systems	1
15	TEITL505	Open-Source Technologies	1
16	TEITL601	Software Engineering	1
17	TEITL602	Distributed Systems	1
18	TEITL603	System and Web Security	1
19	TEITL604	Data Mining and Business Intelligence	1
20	TEITL605	Advance Internet Technology	1
21	ITL701	Software Project 2 1 1 Management	1
22	ITL702	Cloud Computing	1
23	ITL703	Intelligent System	1
24	ITL704	Wireless Technology	1
25	ITT705	Elective -I	1
26	ITP706	Project-I	1
27	ITL801	Storage Network 2 1 1 Management and Retrieval	1
28	ITL802	Big Data Analytics	1
29	ITL803	Computer Simulation 2 1 1 and Modeling	1
30	ITL804	Elective -II	1
31	ITP805	Project - II	1
		Total	31

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

<table>
<tr><td rowspan="4">Course Code</td><td rowspan="4">Course Name</td><td colspan="8">Examination Scheme</td></tr>
<tr><td colspan="4">Theory Marks</td><td rowspan="3">Term Work</td><td rowspan="3">Oral & Practical</td><td rowspan="3">Oral</td><td rowspan="3">Total</td></tr>
<tr><td colspan="3">Internal assessment</td><td rowspan="2">End Sem. Exam</td></tr>
<tr><td>Test1</td><td>Test 2</td><td>Avg. of Two Tests</td></tr>
<tr><td>ITC301</td><td>Applied Mathematics III</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 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

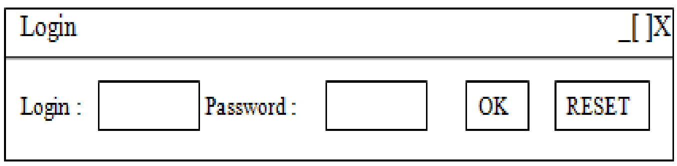
		read a number and should implement the following methods 1. factorial() 2. reverse() 3. testArmstrong() 4. testPalindrome() 5. testPrime() 6. fibonacciSeries() ix) Write a Java program to demonstrate Method overloading		
2)	Classes, Objects, Arrays and Recursion	**Theory** 2.1 Classes & Objects: Class 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

5)		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

<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">Oral & 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>Test1</th><th>Test2</th><th>Avg. of Two Tests</th></tr>
<tr><td>ITC401</td><td>Applied Mathematics IV</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 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	Applications of Automata	1.Power and Limitations of Regular and Context Free Grammars and Machines 2.Designing Functions: FA: Acceptor and Verifier. FSM: Translator PDA: Simple Parser for WF parenthesis, palindromes etc. TM: Basic bit wise calculator(+ /-/AND/OR) and Translator **(Note Added)**	04	CO2 CO4 CO5 CO6

Text books

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

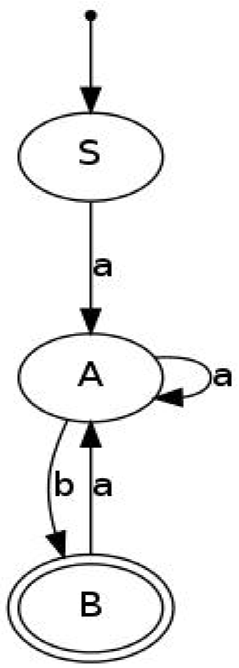
References

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

Sample Example for Tutorial: Applications of Automata

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

A simple example of DFA is:

	Functions
	**S(x)** **{ if(x == 'a') goto A(next);** **else print("Error"); }**
	A(x) { if(x == 'a') goto A(next); **else if(x == 'b') goto B(next);** **else print("Error"); \}**
	B(x) **{ if(x == 'a') goto A(next);** **else if(x == 'b') goto B(next);** **else if(end) print("Accept");** **else print("Error"); \}**

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

Bachelor of Engineering

Information Technology (Third 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. 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

Third Year Engineering (Semester V)
Revised course for Information Technology
Academic Year 2014-15 (REV- 2012)

Sub Code	Subject Name	Teaching Scheme (hrs/week)			Credits Assigned			
		Theory	Practical	Tut.	Theory	TW/ Practical	Tut.	Total
TEITC501	Computer Graphics and Virtual Reality	4			4			4
TEITC502	Operating Systems	4			4			4
TEITC503	Microcontroller and Embedded Systems	4			4			4
TEITC504	Advanced Database Management Systems	4			4			4
TEITC505	Open Source Technologies	3			3			3
TEITC506	Business Communication and Ethics*		2**+2			2		2
TEITL501	Computer Graphics and Virtual Reality		2			1		1
TEITL502	Operating Systems		2			1		1
TEITL503	Microcontroller and Embedded Systems		2			1		1
TEITL504	Advanced Database Management Systems		2			1		1
TEITL505	Open Source Technologies		2			1		1
	Total	19	12		19	07		26

***Common for all programs.**
****Theory class to be conducted for entire class.**

Note: During third year of engineering learners can be exposed to industrial environment by arranging an industrial visit.

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.					
TEITC501	Computer Graphics and Virtual Reality	20	20	20	80	3	25	25	150
TEITC502	Operating Systems	20	20	20	80	3	25	25	150
TEITC503	Microcontroller and Embedded Systems	20	20	20	80	3	25	25	150
TEITC504	Advanced Database Management Systems	20	20	20	80	3	25	25	150
TEITC505	Open Source Technologies	20	20	20	80	3	25	25	150
TEITC506	Business Communication and Ethics*	---	---	---	---	---	25	25	050
	Total	100	100	100	400	15	150	150	800

Third Year Engineering (Semester VI)
Revised course for Information Technology
Academic Year 2014 -15 (REV- 2012)

Subject Code	Subject Name	Teaching Scheme (hrs/week)			Credits Assigned			
		Theory	Practical	Tut.	Theory	TW/Pract.	Tut.	Total
TEITC601	Software Engineering	4			4			4
TEITC602	Distributed Systems	4			4			4
TEITC603	System and Web Security	4			4			4
TEITC604	Data Mining and Business Intelligence	4			4			4
TEITC605	Advance Internet Technology	4			4			4
TEITL601	Software Engineering		2			1		1
TEITL602	Distributed Systems		2			1		1
TEITL603	System and Web Security		2			1		1
TEITL604	Data Mining and Business Intelligence		2			1		1
TEITL605	Advance Internet Technology		2			1		1
	Total	20	10		20	05		25

Examination Scheme

Course Code	Course Name	Theory					Term work	Practical /Oral	Total
		Internal Assessment			End Sem exam	Exam duration (in Hrs)			
		TEST 1	TEST 2	AVG.					
TEITC601	Software Engineering	20	20	20	80	3	25	25	150
TEITC602	Distributed Systems	20	20	20	80	3	25	25	150
TEITC603	System & Web Security	20	20	20	80	3	25	25	150
TEITC604	Data Mining & Business Intelligence	20	20	20	80	3	25	25	150
TEITC605	Advance Internet Technology	20	20	20	80	3	25	25	150
	Total	100	100	100	400	15	125	125	750

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
TEITC501	Computer Graphics And Virtual Reality	04 Hrs./Week	02 Hrs./Week	---	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					
TEITC501	Computer Graphics And Virtual Reality	20	20	20	80	25	25	---	150

Course Objectives	
1	The objective of the course is to equip students with the fundamental knowledge and basic technical competence in the field of computer graphics.
2	Provide an understanding of how to scan convert the basic geometrical primitives, how to transform the shapes so as to fit them as per the picture definition.
3	Provide an understanding of mapping from a world coordinates to device coordinates, clipping, solid modeling, rendering, and projections.
4	To comprehend and analyze the fundamentals of animation, virtual reality, underlying technologies, principles, and applications.

Course Outcomes	
1	Students shall have understood basic concepts of computer graphics.
2	Students shall have understood algorithms to scan convert the basic geometrical primitives, transformations, Area filling, clipping.
3	Students shall have understood the fundamentals of animation, Virtual reality ,the related technologies, and shall be able to describe applications of Virtual Reality.

DETAILED SYLLABUS

Sr. No.	Module	Detailed Content	Hours
1.	**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.	**10**
2.	**Area Filling and Two Dimensional Transformations**	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.	**8**
3.	**Two Dimensional Viewing**	Introduction ,Viewing Pipeline , View Coordinate reference frame ,Window to viewport transformation, Point clipping, Line clipping**:** Cohen Sutherland Algorithm, Liang Barsky algorithms, Polygon clipping**:** Sutherland Hodgeman polygon clipping and Weiler Atherton. Text Clipping.	**6**
4.	**Three Dimensional Transformation,Viewing and Projection.**	Three Dimensional transformations**:** Translation, Scaling, Rotations, Composite. Three Dimensional object representation: Polygon Surfaces, Tables, Meshes. Three Dimensional Viewing Pipeline , Viewing transformation , Projections **:** Parallel(Oblique and orthographic), Perspective (one Point)	**6**
5.	**Introduction to Animation**	Key Frame Animation, Animation Sequence, Motion Control Methods, Morphing, Warping(only Mesh Warping).	**2**
6.	**Introduction to Virtual Reality**	Virtual Reality : Basic Concepts , Classical Components of VR System , Types of VR Systems, Three Dimensional Position Trackers, Navigation and Manipulation Interfaces, Gesture	**8**

		Interfaces, Graphical Display, Sound displays, and Haptic Feedback . Input Devices ,Graphical Rendering Pipeline , Haptic Rendering Pipeline, Open GL rendering pipeline.Applications of Virtual Reality.	
7	**Modeling**	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.	**4**
8	**Introduction to VR programming**	Introduction , Programming through VRML : Defining and Using Nodes and Shapes , VRML Browsers , Java 3D :Visual Object Definition by Shape 3D instances , Defining personal visual object class, ColorCube Class, Geometric – Utility Classes, Geometry Classes , Attributes.	**4**

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

Term work: Term Work shall consist of programs based on the given list. Journal must include at least 2 assignments.

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

Suggested Practical List:

1. Implementation of Line Drawing algorithms : DDA , Bresenham and using them generating line with different styles like dotted , dashed , centered and thick line.
2. Implementation of Circle generation algorithm : Midpoint and using it generating concentric circles.
3. Implementation of Area Filling Algorithm : Boundary Fill , Flood Fill and Scan line Polygon Fill.
4. Curve Generation : Bezier for n control points , B Spline (Uniform)
5. Fractal Generation (Koch Curve)
6. Program for performing Two Dimensional Transformations : Translation , Scaling , Rotation , Reflection , Shear by using a homogeneous Matrix representation ,use of a function for matrix multiplication is desirable , so as to perform composite transformation.
7. Implementation of Line Clipping Algorithm : Cohen Sutherland , Liang Barsky.
8. Implementation of Polygon Clipping Algorithm : Sutherland Hodgman.
9. Program to represent a 3D object using polygon surfaces and then perform 3D transformation.
10. Program to perform projection of a 3D object on Projection Plane : Parallel and Perspective.
11. Program for Animation.

It is desirable to implement some of the experiments by using Open GL.

In addition at least 3 programs using VRML and JAVA 3D APIs.

It is recommended to encourage the student to form a group for a mini project (a simple graphical utility) and for them submitting a theoretical Q. / A. type assignments can be kept optional.

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.

<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>TEITC502</td><td>Operating Systems</td><td>04 Hrs./Week</td><td>02 Hrs./Week</td><td>---</td><td>04</td><td>01</td><td>---</td><td>05</td></tr>
</table>

<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</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 2 Tests</th></tr>
<tr><td>TEITC502</td><td>Operating Systems</td><td>20</td><td>20</td><td>20</td><td>80</td><td>25</td><td>---</td><td>25</td><td>150</td></tr>
</table>

Pre-requisites: Data structures, Programming Language (C / JAVA), Computer Organization & Architecture.

Course Objectives:

- To understand the main components of an OS & their functions.
- 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.
- To understand the concepts and implementation of virtual memory.
- To understand various issues in Inter Process Communication (IPC) and the role of OS in IPC.
- To study different file systems of OS like Linux, Windows and overview of OS for mobile & hand held devices.

Course Outcomes:

- Student will learn important computer system resources and their management policies, algorithms used by operating systems.
- Student will understand what makes a computer system function and the primary PC components.
- Student will understand the working of an OS as a manager of various resources.
- Student will implement some of the functions of OS such as scheduling policies, page replacement algorithms, IPC.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**Overview of Operating System**	Operating system objectives and functions, Evolution of OS, Characteristics of modern OS, Basic concepts: Processes, Files, System calls, Shell, Kernel architectures: Monolithic, Micro-kernel, Layered, Kernel mode of operations.	**4**
2	**Process Management**	Process description: Process, Process States, Process Control Block (PCB), Threads, Thread management. Process Scheduling: Types, Comparison of different scheduling policies.	**10**
3	**Process Co-ordination**	Principles of Concurrency, Race condition and critical section, Mutual Exclusion- Hardware and Software approaches, Semaphores, Monitors, Message Passing, Producer Consumer Problem. Deadlock: Principles of Deadlock, Deadlock Detection, Deadlock Avoidance, Deadlock Prevention.	**10**
4	**Memory Management**	Memory Management Requirements, Memory Partitioning, Virtual memory: Paging; Segmentation; Page replacement policies, page faults.	**6**
5	**Input Output Management**	I/O Devices, Organization of the I/O Function, Operating System Design Issues, I/O Buffering, Disk Scheduling and disk scheduling algorithms, Disk cache.	**6**
6	**File Management**	Overview, File Organization, File Sharing; Record Blocking; Secondary Storage Management.	**6**
7	**Case Studies**	Producer Consumer Problem, Multithreading, RAID, File systems of Windows and Linux , Overview of Android OS.	**6**

Text Books:

1. Modern Operating Systems, Tanenbaum, IIIrd Edition, PHI
2. Operating System-Internal & Design Principles, VIth Edition, William Stallings, Pearson
3. Operating Systems Concepts, Silberschatz A., Galvin P., Gagne G, VIIIth Edition Wiley.
4. Principles of Operating Systems, Naresh Chauhan, First Edition , Oxford university press.

References:

1. Operating Systems in Depth, Thomas W. Doeppner, Wiley.
2. Operating System Programming and Operating Systems, D M Dhamdhere, IInd Revised Edition, Tata McGraw.
3. Operating Systems, *Achyut S. Godbole,* 2nd edition, Tata McGraw Hill.
4. Application development using Android, Hello, Android, mobile development platform, Ed Burnette, 3rd Edition.
5. Linux Command Line & Shell Scripting, Richard Blum and Christine Bresnahan, 2nd edition, Wiley.

Term work: Term Work shall consist of programs based on the given list. Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)
Oral Examination will be based on the above syllabus.
Suggested Practical List:

1. Implementation of System Calls (at least five).
2. Implementation of CPU Scheduling Policies (both pre-emptive and non pre-emptive).
3. Implementation of Page Replacement Algorithms.
4. Implementation of IPC (Producer Consumer problem) .
5. Implementation of Multithreading.
6. Implementation of Deadlock Avoidance algorithm (Bankers algorithm).

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			Credits Assigned			
		Theory	Practical	Tut.	Theory	TW/ Practical	Tut.	Total
TEITC503	Microcontroller and Embedded Systems	04 Hrs./Week	02 Hrs./Week	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				TW	Practical	Oral	Total
		Internal Assessment			End Semester Exam				
		Test1 (T1)	Test2 (T2)	Average of T1 & T2					
TEITC503	Microcontroller and Embedded Systems	20	20	20	80	25	-	25	150

Pre-requisites: Fundamentals of Computer, Digital Logic Circuits, Computer Organization and Architecture

Course Objectives:

CEO 1	To conceptualize the basics of embedded systems
CEO 2	To conceptualize the basics of organizational and architectural issues of a microcontroller.
CEO 3	To learn programming techniques used in microcontroller.
CEO 4	To understand basic concept of ARM processor
CEO 5	To understand fundamentals of real time operating system

Course Outcomes:

A	Ability to understand basic structure embedded systems
B	Ability to understand basic structure microcontroller.
C	Ability to understand basic concepts used in embedded system.
D	Ability to program microcontroller.
E	Ability to design conceptual embedded system.

Detailed Syllabus:

Module	Detailed Contents	Hours
1	**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.	**06**
2	**The Microcontroller Architecture:** Introduction to 8051 Microcontroller, Architecture, Pin configuration, Memory organization, Input /Output Ports, Counter and Timers, Serial communication, Interrupts.	**08**
3	**Assembly Language Programming of 8051:** Instruction set, Addressing modes, Development tools, Assembler Directives, Programming based on Arithmetic & Logical operations, I/O parallel and serial ports, Timers & Counters, and ISR.	**10**
4	**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**
5	**Embedded / Real Time Operating System:** Architecture of kernel, Task and Task scheduler, Interrupt service routines, Semaphores, Mutex, Mailboxes, Message queues, Event registers, Pipes, Signals, Timers, Memory management, Priority inversion problem. Off-the-Shelf Operating Systems, Embedded Operating Systems, Real Time Operating System (RTOS) and Handheld Operating Systems.	**8**
6	**Embedded System - Design case studies:** Digital clock, Battery operated smart card reader, Automated meter reading system, Digital camera.	**06**

Text Books:

1. The 8051 microcontroller & Embedded systems, M. A. Mazidi, J. G. Mazidi, R. D. McKinlay, Pearson
2. The 8051 microcontroller & Embedded systems, Kenneth J. Ayala, Dhananjay V. Gadre, Cengage Learning
3. Embedded / real – time systems: concepts, design & programming, Black Book, Dr. K. V. K. K. Prasad, Dreamtech press, Reprint edition 2013
4. Introduction to embedded systems, Shibu K. V., McGraw Hill
5. ARM System on chip Architecture, Steve Furber, Pearson, edition second

Reference Books:

1. Embedded systems an integrated approach, Laya B. Das, Pearson, Third impression, 2013
2. ARM system developer's guide, Andrew N. Sloss, Dominic Symes, Chris Wright, Morgan Kaufmann Publishers
3. Embedded system design A Unified hardware/software Introduction, Frank Vahid, Tony Givargis, Wiely
4. ARM Technical Reference manual

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

The faculty should conduct eight programming practicals/experiments based on the above syllabus and two case studies based on recent trends in embedded systems.

Oral examination will be 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.
- 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	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
TEITC504	Advanced Database Management Systems	04 Hr/week	02 Hr/week	---	04	01	---	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of 2 Tests					
TEITC504	Advanced Database Management Systems	20	20	20	80	25	---	25	150

Course Objectives:

1. To reinforce and strengthen the database concepts learned in the basic course in database technologies
2. To impart skills that can help design and implement advanced queries using Structured Query Language.
3. To equip students with knowledge to implement and integrate databases in actual applications.
4. To make students aware of how databases are actually stored and accessed.
5. To introduce advanced concepts of transaction management and recovery techniques.
6. To initiate awareness about the potential security threats that exist in database systems and how to tackle them

7. To introduce other database models like distributed and object based
8. To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse.

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

1. Construct complex queries using SQL to retrieve and manipulate information in a database.
2. Design and implement full-fledged real life applications integrated with database systems.
3. Clearly understand how databases are actually stored and accessed; How transaction ACID properties are maintained and how a database recovers from failures.
4. Apply security controls to avoid any type of security incidents on vital database systems.
5. Design advanced data systems using Object based systems or Distributing databases for better resource management.
6. Understand the importance of enterprise data and be able to organize data to perform analysis on the data and take strategic decisions.

DETAILED SYLLABUS

Sr. No.	Module	Detailed Content	Hours	Weightage
1	**Introduction**	Reviewing basic concepts of a relational database, Basic SQL	**01**	**0%**
2	**Advanced SQL**	Complex Retrieval Queries using Group By, Recursive Queries, nested Queries ; Specifying Constraints as Assertions; Event Condition Action (ECA) model (Triggers) in SQL; Creating and working with Views in SQL; Database Programming: Embedded SQL, Dynamic SQL and SQLJ, Database Programming with Function Calls: JDBC; Stored Procedures in SQL, Embedded SQL, Dynamic SQL.	**06**	**10%**

3	**Advanced Transaction Processing & Recovery**	Review of ACID properties and Serializability; Multiversion Concurrency Control Techniques; Granularity of Data Items and Multiple Granularity Locking ; Advanced Database Recovery techniques like Write Ahead Logging (WAL), ARIES, Checkpoints.	**06**	**10%**
4	**Data Security**	Introduction to Database Security Issues; Discretionary Access Control Based on Granting and Revoking Privileges; Mandatory Access Control and Role-Based Access Control for Multilevel Security; SQL Injection; Introduction to Statistical Database Security Introduction to Flow Control	**04**	**10%**
5	**Storage and Indexing**	Operation on Files; hashing Techniques; Types of Single-Level Ordered Indexes; Multilevel Indexes; Dynamic Multilevel Indexes Using B-Trees and B+-Trees; Indexes on Multiple Keys.	**04**	**10%**
6	**Distributed Databases**	Types of Distributed Database Systems; Distributed Database Architectures; Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design; Query Processing and Optimization in Distributed Databases; Overview of Transaction Management in Distributed Databases; Overview of Concurrency Control and Recovery in Distributed Databases.	**06**	**10%**
7	**Object Based Databases**	Overview of Object Database Concepts; Object-Relational Features; Object Database Extensions to SQL; The Object Definition Language ODL; Object Database Conceptual Design; The Object Query Language OQL.	**05**	**10%**
8	**Introduction to Data**	The Need for Data Warehousing; Increasing Demand for Strategic Information; Inability of Past Decision Support System; Operational Vs Decisional Support System; 1.3 Data	**02**	**5%**

	Warehousing	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.		
9	**Dimensional Modeling**	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:; he 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**	**15%**
10	**ETL Process**	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.	**04**	**10%**
11	**Online Analytical Processing (OLAP)**	Need for Online Analytical Processing; OLTP vs OLAP; OLAP and Multidimensional Analysis; Hypercubes; OLAP Operations in Multidimensional Data Model; OLAP Models: MOLAP, ROLAP, HOLAP, DOLAP;	**04**	**10%**

Text Books:

1. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
2. Korth, Slberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
3. Theraja Reema, "Data Warehousing", Oxford University Press, 2009

References:

1. Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals", Wiley India.
2. C. J. Date, A. Kannan, S. Swamynathan "An Introduction To Database Systems", 8th Edition Pearson Education.
3. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems" 3rd Edition - McGraw Hill
4. Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide To Dimensional Modeling", 3rd Edition. 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:

Suggested Practical List

1. Problem Definition and draw ER /EER diagram
2. Creation of the database: using constrains and triggers
3. Advanced SQL – must cover Views, nested and recursive queries.
4. Implementing an application and integrating with the database using JDBC, Dynamic and embedded SQL
5. Any one Database Hashing technique
6. Implementing and index using B or B+ trees.
7. Creating and querying an Object database. – Use ODL and OQL (Paper Exercise-Assignment)

8. Implementing a Distributed Database.
9. Demonstration of database security techniques – SQL injection, inference attacks etc.
10. Problem Definition for a Data Warehouse, Construction of Star Schema Model.
11. Creation of a DW and running OLAP operations on them (Roll up, Drill down, Slice, Dice, pivot)

Tools used:

1. Any Database software like Oracle, DB2, SQL Server, MY SQL or any other open source tools.
2. Programming to be done in JAVA.

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.
5. Weightage 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
TEITC505	Open Source Technologies	03 Hr/Week	02 Hr/Week	---	03	01	---	04

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					
TEITC505	Open Source Technologies	20	20	20	80	25	25	---	150

Course Objectives:

1. To introduce the concept of open Source Software.
2. To enable students to learn Linux Environment.
3. To make students well versed with Android and Shell Programming

Course Outcomes: On successful completion of this course students should be able:

1. To develop android applications.
2. To install and work on Linux.
3. To perform Shell Programming.

DETAILED SYLLABUS

Sr. No.	Module	Detailed Content	Hours
1.	Over View of Open Source Software	Need of Open Sources –Advantages of Open sources –Applications- FOSS – FOSS usage –Free Software Movement – Comercial Aspect of Open Source Movement – Licensing – Certification – Open Source Software Development Model – comparision with close source / Proprietary software – Free Software – Open source vs source –available –Widely used open source software license :Apache License, BSD license, GNU General Public License, GNU Lesser General Public License, MIT License, Eclipse Public License and Mozilla Public License.	04
2.	Open Source Operating System	Installation of Linux (Redhat-CentOS): Theory about Multiboot Enviroment, Hardisk Partitioning, Swap space, LVM, and Bootloader Command Line: Basic File System Manamgnet Task, Working with files, Piping and Redirection, Working with VI editor, use of sed and understanding FHS of Linux	04
3.	Open Source Operating System: system Administrator task	Job management, Process Mangment, Mounting Devices and filesystem working with Linux, Backup, working with user, group and permission, Managing Software. Understanding Boot process and related files, Common kernel Manamgnet Task	04
4.	Open source Operating System: Network and Security Administration	Basic networking commands, Configuration of Apache Web servers, DNS servers, DHCP servers, mail Servers, NFS, FTP servers. Securing servers with IPtables. Setting up cryptographic services, SSL, Managing Certificate with OpenSSL, working with the GNU Privacy guard.	06

5.	Open Source Operating System: Shell Programming	Bash Shell Scripting, Executing Script, Working with Variables and Input, Using Control Strutures, Script control, handling with signals, Creating functions, working sed and gawk -Working with web using shell script: Downloading web page as formatted text file and parsing for data, working cURL etc.	08
6.	Open source Tools Only in LAB	Version Control using RCS and CVS (hands on RCS in single Machine) Content management : Understanding working of Drupal (Basic Drupal components) Security assessment : OpenVAS IDE :Working of Eclipse	---
7.	Open Source Mobile Programming	Android programming: Setting up Android Enviroment (using Eclipse for android development), Activites and Intents, User Interface, Designing UI using views, Data Persistence, Conent Providers, messaging and networking, Location-based Services, Publishing Android Applications	10

Text Books:

1. Redhat Linux 6.0 Administration Wiley
2. Linux Shell scripting Cookbook: Sarath Lakshman PACKT
3. Linux Lab - Open source Technology : Ambavade -Dreamtech
4. Beginning Adnorid Development Wrox Press

References:

1. Drupal guide to Planning and Building Web Site: Wrox Press

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

Suggested Practical List :

1. Linux command line : File System, Process Managment User Administration

2. Setting Up Web server, DNS server, FTP Servers

3. Working with IPTABLES, OpenVAS

4. Version Control

5. Working with Drupal

6. Shell Script

7. Andorid Setup

8. Programning in Andorid

9. Programming in Android

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

Course Code	Course/Subject Name	Credits
TEITC506	**Business Communication &Ethics**	**2**

Pre-requisite

- FEC206 Communication Skills

Objective

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.

DETAILED SYLLABUS:

Module	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 Buliding	
	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**

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.

Reference Books:

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,3rdedition.Dr.K.Alex ,"Soft Skills",S Chand and Company
9. Dr.KAlex,"SoftSkills",S Chand and Company

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
TEITC601	Software Engineering	04 Hr/Week	02 Hr/Week	---	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					
TEITC601	Software Engineering	20	20	20	80	25	---	25	150

Course Objectives:

This course will study a collection of methods which embody an "engineering" approach to the development of software. It will discuss the nature of software and software projects, software development models, software process maturity, project planning, management, and estimations. Students are required to study and practice methods for analysis, design, testing, and implementation of large, complex software systems. We will inquire into the various perspectives on software quality -- what it means, how to measure it, how to improve it. The major work of the course should be a group project.

Course Outcomes:

1. Meet the Information Technology Program Objectives of identifying and solving engineering problems
2. To understand principles, concepts, methods, and techniques of the software engineering approach to producing quality software for large, complex systems.
3. To function effectively as a member of a team engaged in technical work.
4. To think critically about ethical and social issues in software engineering for different applications

DETAILED SYLLABUS

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Software Engineering	Professional Software Development, Layered Technology, Process framework, CMM, Process Patterns and Assessment	**03**
2	Process Models	Prescriptive Models : Waterfall Model, Incremental, RAD Models Evolutionary Process Models:Prototyping, Spiral and Concurrent Development Model Specialized Models: Component based, Aspect Oriented development	**06**
03	Agile Software Development	Agile Process and Process Models, Adaptive and Dynamic system Development, Scrum, Feature Driven Development and Agile Modeling	**03**
04	Engineering and Modeling Practices	Core Principles, Communication, Planning, Modeling, Construction and deployment. System Modeling and UML	**04**
05	Requirements Engineering and Analysis Model	Requirements Engineering Tasks, Elicitation, building analysis model, Data Modeling concepts, Object Oriented Analysis	**06**
06	Design Engineering	Design Concepts, Design Model – Data, Architecture, Interface, Component Level and Deployment Level design elements	**05**
07	Testing strategies and tactics	Testing strategies for conventional and Object Oriented architectures, Validation and system testing Software testing fundamentals, Black box and white box testing, Object Oriented testing methods	**06**
08	Metrics for Process and Projects	Process Metrics and Project Metrics, Software Measurement, Object Oriented Metrics, Software Project Estimation, Decomposition Techniques, LOC based, FP based and Use case based estimations, Empirical estimation Models	**06**

09	Risk Management	Risk strategies, Software risks, Risk Identification, Projection, RMMM	**03**
10	Quality Management	Quality Concepts, SQA activities, Software reviews, FTR, Software reliability and measures, SQA plan	**03**
11	Change Management	Software Configuration Management, elements of SCM, SCM Process, Change Control	**03**

Text Books:

1. "Software Engineering : APractitioner's Approach" by Roger Pressman Sixth Edition
2. "Software Engineering" by Ian Sommerville, Pearson
3. "Software Engineering : A Precise Approach" Pankaj Jalote , Wiley India

References: (for Practical)

1. "System Analysis and Design" Alan Dennis, Wixom, R M Roth – Wiley India
2. "Software Engineering : Principles and Practice" by Waman S Jawadekar

Term work: Should be based on the Project work done as a team.

Suggested Practical List:

The focus of the lab component of this course is to apply software engineering methods for carrying out a software development mini project. Students will be assigned to teams of 3-4 students. Each team will be assigned to produce a software development model, complete with specifications, prototyping, and design.

The deliverables required may be:

1. Application of agility principles/process model selection/system modeling tools for the given scenario
2. Requirements gathering, elicitation, elaboration, negotiation, specification, validation using appropriate tools
3. Use case development
4. Activity diagram, class diagrams, swimlane, data flow diagrams, State diagrams and sequence diagrams
5. Data design model, Architecture, UI, Collaboration diagrams
6. Component Level Design
7. Design unique test cases on different strategies
8. Prepare project Plan, predict resources and timeline(scheduling)
9. Prepare a risk identification and management plan

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.
5. Weightage 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
TEITC602	Distributed Systems	04 Hr/Week	02 Hr/Week	---	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					
TEITC602	Distributed Systems	20	20	20	80	25	25	---	150

Course Objectives:

Distributed Systems form a significant field in Information Technology. The course aims to provide solid foundation in the concepts of distributed systems along with its design and implementation. Synchronization, Message Passing, Remote Communication, Consistency Management and Application development using different Distributed Technologies form part of core concepts to be studied under this course.

Course Outcomes:

- The student gains clear understanding of fundamental principles of Distributed Systems along with design and implementation of key mechanisms, Clock Synchronization, Election Algorithms, Mutual Exclusion, Message Communication, Process and Resource Scheduling etc.
- The student understands the message communication, remote procedure call and Remote method invocation (RPC and RMI) along with group communication.
- Emphasis is on developing applications using current distributed computing technologies like EJB, CORBA and .NET.
- Student should be able to develop/design distributed system/applications for an enterprise using SOA

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours 48
1	Fundamentals	Introduction, Distributed Computing Models, Software Concepts, Issues in designing Distributed System, Client – Server Model	**4**
2	Communication	Message Passing , Introduction to Message Passing, Advantages and features of Message Passing, Message Format, Message Buffering, Multi Data gram Messaging , Group Communication Remote Procedure Call (RPC): Basic RPC Operations, Parameter Passing, Extended RPC Models Remote Object Invocation: Distributed Objects, Binding a Client to an Object, Static Vs Dynamic RMI, Parameter Passing, Java RMI Message Oriented Communication: Persistence and synchronicity in communication, Message Oriented Transient and Persistent Communications	**8**
3	Processes	Threads, Code Migration: Approaches to Code Migration, Migration and Local Resources, Migration in Heterogeneous Systems	**4**
4	Synchronization	Clock Synchronization, Physical and Logical Clocks, Global State, Election Algorithms, Mutual Exclusion, Distributed Transactions, Deadlocks	**8**
5	Consistency and Replication	Introduction, Data-Centric Consistency Models, Client Centric Consistency Models, Distributed Protocols	**8**
6	Distributed Technologies and Frameworks	Overview of EJB S/W Architecture, view of EJB Conversation, Building and Deploying EJB, Roles in EJB, Types of Enterprise Beans, Lifecycle of Beans , Developing Applications using EJB Framework.	**5**

		Introduction to CORBA, CORBA Components and architecture, Method Invocation, Static and Dynamic Invocation in CORBA, CORBA IDL, Developing Application using CORBA	**4**
		Introduction to .NET, .NET architecture, . NET Remoting	**3**
		Comparison of RMI, CORBA, EJB, .NET	**1**
7.	Service Oriented Architecture	Defining SOA, Business value of SOA, SOA characteristics, Concept of a service, SOA Architecture, Deploying SOA applications.	**3**

Text Books:

- Sunita Mahajan, Seema Shah, " Distributed Computing", Oxford, second edition.
- Andrew S. Tanenbaum & Maarten van Steen " Distributed Systems : Principles and paradigms" Prentice Hall of India Private Limited
- G. Sudha Sadasivam, Radha Shankarmani, "Middleware and Enterprise Integration Technologies " , Wiley Precise Textbook

References:

1. Pradeep K. Sinha "Distributed Operating Systems", Prentice Hall of India Private Limited
2. Thomas Erl "Service Oriented Architecture : Concepts, Technology and Design" Prentice Hall
3. G. Coulouris, J. Dollimore and T. Kindberg "Distributed Systems :

Term work: 25 marks

Term work should consist of at least 10 practical experiments with 1 mini project and assignments covering the topics of the syllabus

Distribution of marks for term work shall be as follows:

Laboratory work (10 Experiments)	10 Marks
Mini Project	05 Marks
Assignments	05 Marks
Attendance	05 Marks

Suggested Practical List :

1. Client Server based program using RPC
2. Client Server based program using RMI
3. Implementation of Clock Synchronization (logical/physical)
4. Implementation of Election algorithm.
5. Implementation of Mutual Exclusion algorithms
6. Program multithreaded client/server processes.
7. Program to demonstrate process/code migration.
8. Write a distributed application using EJB
9. Write a program using CORBA to demonstrate object brokering.
10. Use .Net framework to deploy a distributed application.
11. Mini Project : For Eg. using SOA

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.
5. Weightage 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
TEITC603	System And Web Security	04 Hr/Week	02 Hr/Week	---	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					
TEITC603	System And Web Security	20	20	20	80	25	---	25	150

Course Objectives

1. Understand the fundamental principles of access control models and techniques, authentication and secure system design
2. Apply methods for authentication, access control, intrusion detection and prevention
3. Identify and mitigate software security vulnerabilities in existing systems.
4. Understand the role of firewalls, IPSec, Virtual Private Networks and identity management, etc.
5. Understand Web Server vulnerabilities and their counter measures

Course Outcomes:

Upon successful completion of the course the student will be able to:

- Differentiate between authentication and authorization;
- Explain the basic idea behind access control and compare the various access control policies and models.

- Explain the need for security protocols in the context of use with Internet-based applications;
- Explain the basic idea behind firewalls and intrusion detection systems and how they work;
- Explain malicious software and typical software solutions used in dealing with viruses and worms;
- Understand and explain various issues related to program security and web security.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction to Computer Security**	Vulnerabilities, Threats and Attacks, Public Key Cryptography and Cryptanalysis, Knapsack cryptosystem	04
2	**Authentication**	Authentication Methods and Protocols, Password based authentication, Token Based Authentication, Biometric Authentication, Digital Certificates, X. 509 Directory Services, PKI, Needham Schroeder Authentication Protocol, Single sign on, Kerberos Authentication Protocol, Federated Identity Management.	08
3	**Access Control**	Access control Policies: DAC, MAC, RBAC, Access control Matrix, ACLs and Capability Lists, Multiple level security model: Biba and Bell La Padula Models, Multilateral security, Covert channel, CAPTCHA.	06
4	**Software security**	Software Flaws, Buffer Overflow, Incomplete Mediation, Race conditions, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits, Miscellaneous Software Attacks: Salami attack, Linearization Attacks, Trusted Computing: Software reverse engineering, Digital Rights management	08

5	**Operating System Security**	Linux Security Model, File System Security, Linux Vulnerabilities, Windows Security Architecture, Windows Vulnerabilities	04
6	**Network Security**	Network security basics, TCP/IP vulnerabilities Layer wise: Packet Sniffing, ARP spoofing, port scanning, IP spoofing, TCP syn flood, DNS Spoofing, Internet Security Protocols: SSL, TLS, IPSEC, Secure Email and S/MIME, 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. Firewalls, Intrusion Detection Systems: Host Based and Network Based IDS, Honey pots.	12
7	**Web Security**	User Authentication and session management, Cookies, Secure HTTP, SQL Injection Techniques, Cross Site Scripting, Cross-Site Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, Web Services Security.	06

Text Books

1) Computer Security Principles and Practice, by William Stallings, Pearson Education.

2) Security in Computing by Charles P. Pfleeger , Pearson Education

3) Computer Security by Dieter Gollman, **3rd Edition,** Wiley India.

4) Cryptography and Network Security by Behrouz A. Forouzan, TATA McGraw hill.

Reference Books

1) Information security Principles and Practice by Mark Stamp, Wiley publication

2) OWASP TOP 10: https://www.owasp.org/index.php/Top_10_2013

3) Network security bible 2nd edition, Eric Cole, Wiley India.

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

Suggested Practical List:

1. Design and implement the RSA cryptosystem.
2. Implement Digital signature scheme using RSA.
3. Simulate the Buffer overflow attack.
4. Simulate the Salami attack.
5. Design and implement a program for adding passwords to a file. The program should be able to filter out weak passwords (based on dictionary words or variants) and store the strong passwords by creating a hash of user ID and password.
6. Study of a packet sniffer like wireshark, or tcpdump. Use this tool to capture and analyze data in packets.
7. Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc
8. Detect ARP spoofing using open source tool ARPWATCH
9. Install an IDS (e.g. SNORT) and study the logs.
10. Use of iptables in linux to create firewalls.
11. Implement a simple SQL injection attack.

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.
5. Weightage 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
TEITC604	Data Mining and Business Intelligence	04 Hr/Week	02 Hr/Week	---	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					
TEITC604	Data Mining and Business Intelligence	20	20	20	80	25	---	25	150

Course Objectives:

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. Learning how to gather and analyse 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.

Course Outcomes: On successful completion of this course students should be able:

1. Demonstrate an understanding of the importance of data mining and the principles of business intelligence
2. Able to 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.
4. Define and apply metrics to measure the performance of various data mining algorithms.
5. 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.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction to Data Mining**	What is Data Mining; Kind of patterns to be mined; Technologies used; Major issues in Data Mining	**02**
2	**Data Exploration**	Types of Attributes; Statistical Description of Data; Data Visualization; Measuring similarity and dissimilarity.	**04**
3	**Data Preprocessing**	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**
4	**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. **Model Evaluation & Selection: A**ccuracy and Error measures, Holdout, Random Sampling, Cross Validation, Bootstrap; Comparing Classifier performance using ROC Curves. **Combining Classifiers**: Bagging, Boosting, Random	**08**

		Forests.	
5	**Clustering**	Cluster Analysis: Basic Concepts; **Partitioning Methods**: K-Means, K-Mediods; **Hierarchical Methods**: Agglomerative, Divisive, BIRCH; **Density-Based Methods:** DBSCAN, OPTICS	**08**
6	**Outlier Analysis**	What are outliers? Types, Challenges; **Outlier Detection Methods:** Supervised, Semi-Supervised, Unsupervised, Proximity based, Clustering Based.	**02**
7	**Frequent Pattern Mining**	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**
8	**Business Intelligence**	What is BI? Effective and timely decisions; Data, information and knowledge; The role of mathematical models; Business intelligence architectures; Enabling factors in business intelligence project; Development of a business intelligence system; Ethics and business intelligence	**03**
9	**Decision Support System**	Representation of the decision-making process; Evolution of information systems; Definition of decision support system; Development of a decision support system.	**03**
10	**BI Applications**	Data mining for business Applications like Fraud Detection, Clickstream Mining, Market Segmentation, retail industry, telecommunications industry, banking & finance CRM etc	**06**

Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3^{rd} 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", 1^{st} Edition, Wiley India.
3. Business Intelligence: Data Mining and Optimization for Decision Making by Carlo Vercellis ,Wiley India Publications

Reference Books:

1. P. N. Tan, M. Steinbach, Vipin Kumar, "Introduction to Data Mining", Pearson Education
2. Michael Berry and Gordon Linoff "Data Mining Techniques", 2nd Edition Wiley Publications.
3. Michael Berry and Gordon Linoff "Mastering Data Mining- Art & science of CRM", Wiley Student Edition
4. Vikram Pudi & Radha Krishna, "Data Mining", Oxford Higher Education.

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.

Suggested Practical List:

1) 2 tutorials

    a) Solving exercises in Data Exploration

    b) Solving exercises in Data preprocessing

2) Use WEKA to implement the following Classifiers - Decision tree, Naïve Bayes, Random Forest;
3) Implementation of any one classifier using languages like JAVA;
4) Use WEKA to implement the following Clustering Algorithms – K-means, Agglomerative, Divisive;
5) Implementation of any one clustering algorithm using languages like JAVA;

6) Use Weka to implement Association Mining using – Apriori, FPM;
7) Detailed study of any one BI tool like Oracle BI, SPSS, Clementine, and XLMiner etc. (paper Assignment)
8) 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

   d) Interpret and visualize the results

   e) Provide clearly the BI decision that is to be taken as a result of mining.

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.
5. Weightage 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
TEITT605	Advanced Internet Technology	04 Hr/Week	02 Hr/Week	---	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					
TEITT605	Advanced Internet Technology	20	20	20	80	25	25	---	150

Course Objectives:

1. To introduce the concept of Search Engine basics.
2. To enable students to determine SEO Objective and develop SEO plan prior to Site Development.
3. To make students well versed with HTML 5, CSS3 and Responsive Web Design.
4. Learning the characteristic of RIA – Web Mashup Eco System.

Course Outcomes: On successful completion of this course students should be able:

1. Develop Keyword Generation, Using Google Analytics etc.

2. To demonstrate Responsive Web Design.

3. To demonstrate Amazon/Google or yahoo mashup.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	Search Engine Optimization	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 Perior to Site Deveopment - SEO for Rawtraffic;E-commerce Sales;Mindsahre/Branding; Direct Marketing; Reputation Management; Ideological Influence 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 – Dtermining Top competitors, Benchmarking Current Indexing Status, Current Rankings, Benchmarking Current Traffic Source and Volumes, Conduct SEO/Website SWOT analysis. Keyword Genration – 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.	**20**
2.	Responsive web design with HTML5 and CSS3	Getting Started with HTML 5, CSS3 and Responsive Web Design.	**16**

		Media Queries: Supporting Differing Viewports Embracing Fluid Layout HTML 5 for Responsive Design CSS3: Selectors, Typography and color Modes Stunning Aesthetics with CSS3 CSS3 Transitions, Transformations and Animations Conquer Forms HTML5 and CSS3	
3.	RIA and Mashup	Characteristic of RIA – Web Mashup Eco Systems – Mashup Techniques :1) Mashing on the Web Server, Rich User Interface using Ajax, Mashing with JSON RIA: Ajax vs Traditional Approach Technical Background: 1) Javascript and AJAX 2) JSON Alternative to XML 3) Syndication 4) REST and WS * Web Services	**12**

Text Books:

1. Professional Web 2.0 Programming WROX press
2. Responsive Web Design with HTML5 and CSS3 PACKT
3. The Art of SEO O'Reilly Publication

References:

1. Rich Internet Application AJAX and Beyond WROX press
2. Web Technology, Srinivasan, Pearson

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

Suggested Practical List:

1) Practical on SEO (Keyword Generation, Using Google Analytics etc.)

2) Practical to demonstrate Responsive Web Design

3) Practical to demonstrate Amazon/Google or yahoo mashup

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

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			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC7052	Software Architecture	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,2nd 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	CSL301	Data Structure Lab	1
2	CSL302	Digital Logic & Computer Architecture Lab	1
3	CSL303	Computer Graphics Lab	1
4	CSL304	Skill base Lab course: Object Oriented Programming with Java	1
5	CSM301	Mini Project – 1 A	1
6	CSL401	Analysis of Algorithm Lab	1
7	CSL402	Database Management System Lab	1
8	CSL403	Operating System Lab	1
9	CSL404	Microprocessor Lab	1
10	CSL405	Skill Base Lab Course: Python Programming	1
11	CSM401	Mini Project 1-B	1
12	CPC501	Microprocessor	1
13	CPC502	Operating Systems	1
14	CPC503	Structured and Object Oriented Analysis and Design	1
15	CPC504	Computer Networks	1
16	CPL501	Web Technologies Laboratory	1
17	CPL502	Business Communication and Ethics*	1
18	CPC601	System Programming and Compiler Construction	1
19	CPC602	Software Engineering	1
20	CPC603	Distributed Databases	1
21	CPC604	Mobile Communication and Computing	1
22	CPE6011	Elective-I	1
23	CPL601	Network Programming Laboratory	1
24	CPC701	Digital Signal Processing	1
25	CPC702	Cryptography and System Security	1
26	CPC703	Artificial Intelligenc	1
27	CPE7042X	Elective-II	1
28	CPP701	Project I	1
29	CPL701	Network Threats and Attacks Laboratory	1
30	CPC801	Data Warehouse and Mining	1
31	CPC802	Human Machine Interaction	1
32	CPC803	Parallel and distributed Systems	1
33	CPE803X	Elective-III	1
34	CPP802	Project II	1
35	CPL801	Cloud Computing Laboratory	1
		Total	35

AC – 11.05.2017

Item No. 4.193

UNIVERSITY OF MUMBAI

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

Under

FACULTY OF TECHNOLOGY

Computer Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

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

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

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

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

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

Chairman's Preamble:

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Computer Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by more than 85 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Computer Engineering. The Program Educational Objectives finalized for the undergraduate program in Computer Engineering are listed below;

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

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

Dr. Subhash K. Shinde
Chairman, Board of Studies in Computer Engineering,
University of Mumbai, Mumbai.

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2017-18

S. E. Computer Engineering (Semester-III)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC301	Applied Mathematics -III	4+1@	-	-	5	-	-	5
CSC302	Digital Logic Design and Analysis	4	-	-	4	-	-	4
CSC303	Discrete Mathematics	3+1@	-	-	4	-	-	4
CSC304	Electronic Circuits and Communication Fundamentals	4	-	-	4	-	-	4
CSC305	Data Structures	4	-	-	4	-	-	4
CSL301	Digital System Lab	-	2	-	-	1	-	1
CSL302	Basic Electronics Lab	-	2	-	-	1	-	1
CSL303	Data structure Lab	-	2	-		1	-	1
CSL304	OOPM(Java) Lab	-	2+2*	-	-	2	-	2
	Total	**21**	**10**	-	**21**	**5**	-	**26**

@ 1 hour to be taken tutorial as class wise.

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

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC301	Applied Mathematics -III	20	20	20	80	3	-	-	-	100
CSC302	Digital Logic Design and Analysis	20	20	20	80	3	-	-	-	100
CSC303	Discrete Structures	20	20	20	80	3	-	-	-	100
CSC304	Electronic Circuits and Communication Fundamentals	20	20	20	80	3	-	-	-	100
CSC305	Data Structures	20	20	20	80	3	--	-	-	100
CSL301	Digital System Lab	-	-	-	-	-	25	--	25	50
CSL302	Basic Electronics Lab	-	-	-	-	-	25	25	---	50
CSL303	Data structure Lab	-	-	-	-	-	25	-	25	50
CSL304	OOPM(Java) Lab	-	-	-	-	-	50	--	50	100
Total		100	100	100	400	-	125	25	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2017-18

S. E. Computer Engineering (Semester-IV)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC401	Applied Mathematics- IV	4+1@	-	-	5	-	-	5
CSC402	Analysis of Algorithms	4	-	-	4	-	-	4
CSC403	Computer Organization and Architecture	4	-	-	4	-	-	4
CSC404	Computer Graphics	4	-	-	4	-	-	4
CSC405	Operating System	4	-	-	4	-	-	4
CSL401	Analysis of Algorithms Lab	-	2	-	-	1	-	1
CSL402	Computer Graphics Lab	-	2	-	-	1	-	1
CSL403	Processor Architecture Lab	-	2	-		1	-	1
CSL404	Operating System Lab	-	2	-	-	1	-	1
CSL405	Open Source Tech Lab	-	2+2*	-	-	2	-	2
	Total	**21**	**12**	-	**21**	**6**	-	**27**

@ 1 hour to be taken tutorial as class wise .

*2 hours shown as Practical's to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC401	Applied Mathematics- IV	20	20	20	80	3	-	-	-	100
CSC402	Analysis of Algorithms	20	20	20	80	3	-	-	-	100
CSC403	Computer Organization and Architecture	20	20	20	80	3	-	-	-	100
CSC404	Computer Graphics	20	20	20	80	3	-	-	-	100
CSC405	Operating System	20	20	20	80	3	--	-	-	100
CSL401	Analysis of Algorithms Lab	-	-	-	-	-	25	--	25	50
CSL402	Computer Graphics Lab	-	-	-	-	-	25	--	25	50
CSL403	Processor Architecture Lab	-	-	-	-	-	25	25	-	50
CSL404	Operating System Lab	-	-	-	-	-	25	-	25	50
CSL405	Open Source Tech Lab	-	-	-	-	-	25	---	25	50
Total		100	100	100	400	-	125	25	100	750

T. E. Computer Engineering (Semester-V)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC501	Microprocessor	4	-	-	4	-	-	4
CSC502	Database Management System	4	-	-	4	-	-	4
CSC503	Computer Network	4	-	-	4	-	-	4
CSC504	Theory of Computer Science	3+1@	-	-	4	-	-	4
CSDLO 501X	Department Level Optional Course -I	4	-	-	4	-	-	4
CSL501	Microprocessor Lab	-	2	-	-	1		1
CSL502	Computer Network Lab	-	2	-	-	1	-	1
CSL503	Database & Info. System Lab	-	2	-	-	1	-	1
CSL504	Web Design Lab	-	2+2*	-	-	2	-	2
CSL505	Business Comm. & Ethics	-	2+2*	-	-	2	-	2
	Total	**20**	**14**	-	**20**	**7**	-	**27**

@ 1 hour to be taken tutorial as class wise.
*2 hours shown as Practical's to be taken class wise and other 2 hours to be taken as batch wise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC501	Microprocessor	20	20	20	80	3	-	-	100
CSC502	Database Management System	20	20	20	80	3	-	-	100
CSC503	Computer Network	20	20	20	80	3	-	-	100
CSC504	Theory of Computer Science	20	20	20	80	3	-	-	100
CSDLO 501X	Department Level Optional Course -I	20	20	20	80	3	--	-	100
CSL501	Microprocessor Lab	-	-	-	-	-	25	25	50
CSL502	Computer Network Lab	-	-	-	-	-	25	25	50
CSL503	Database & Info. System Lab	-	-	-	-	-	25	25	50
CSL504	Web Design Lab	-	-	-	-	-	25	25	50
CSL505	Business Comm. & Ethics	-	-	-	-	-	50	-	50
Total		100	100	100	400	-	150	100	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2018-19

T. E. Computer Engineering (Semester-VI)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC601	Software Engineering	4	-	-	4	-	-	4
CSC602	System Programming & Complier Construction	4	-	-	4	-	-	4
CSC603	Data Warehousing & Mining	4	-	-	4	-	-	4
CSC604	Cryptography & System Security	4	-	-	4	-	-	4
CSDLO 601X	Department Level Optional Course -II	4	-	-	4	-	-	4
CSL601	Software Engineering Lab	-	2	-	-	1	-	1
CSL602	System software Lab	-	2	-	-	1	-	1
CSL603	Data Warehousing & Mining Lab	-	2	-	-	1	-	1
CSL604	System Security Lab	-	2	-	-	1	-	1
CSP605	Mini-Project	-	4	-	-	2	-	2
	Total	**20**	**12**	-	**20**	**6**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC601	Software Engineering	20	20	20	80	3	-	-	-	100
CSC602	System Programming & Complier Construction	20	20	20	80	3	-	-	-	100
CSC603	Data Warehousing & Mining	20	20	20	80	3	-	-	-	100
CSC604	Cryptography & System Security	20	20	20	80	3	-	-	-	100
CSDLO 601X	Department Level Optional Course -II	20	20	20	80	3	-	-	-	100
CSL601	Software Engineering Lab	-	-	-	-	-	25	25	--	50
CSL602	System Software Lab	-	-	-	-	-	25	--	25	50
CSL603	Data Warehousing & Mining Lab	-	-	-	-	-	25	--	25	50
CSL604	System Security Lab	-	-	-	-	-	25	---	25	50
CSP605	Mini-Project	-	-	-	-	-	25	---	25	50
Total		100	100	100	400	-	150	25	100	750

B. E. Computer Engineering (Semester-VII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC701	Digital Signal & Image Processing	4	-	-	4	-	-	4
CSC702	Mobile Communication & Computing	4	-	-	4	-	-	4
CSC703	Artificial Intelligence & Soft Computing	4	-	-	4	-	-	4
CSDLO 701X	Department Level Optional Course -III	4	-	-	4	-	-	4
ILO701X	Institute Level Optional Course-I	3	-	-	3	-	-	3
CSL701	Digital Signal & Image Processing Lab	-	2	-	-	1	-	1
CSL702	Mobile App. Development. Tech. Lab	-	2	-	-	1	-	1
CSL703	Artificial Intelligence & Soft Computing Lab	-	2	-		1	-	1
CSL704	Computational Lab-I	-	2			1	-	1
CSP705	Major Project-I	-	6			3	-	3
	Total	**19**	**14**	-	**19**	**7**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)				
		Test 1	Test 2	Avg.						
CSC701	Digital Signal & Image Processing	20	20	20	80	3	-	--	-	100
CSC702	Mobile Communication & Computing	20	20	20	80	3	-	--	-	100
CSC703	Artificial Intelligence & Soft Computing	20	20	20	80	3	-	--	-	100
CSDLO 701X	Department Level Optional Course -III	20	20	20	80	3	-	--	-	100
ILO701X	Institute Level Optional Course-I	20	20	20	80	3	--	--	-	100
CSL701	Digital Signal & Image Processing Lab	-	-	-	-	-	25	--	--	25
CSL702	Mobile App. Development. Tech. Lab	-	-	-	-	-	25	--	25	50
CSL703	Artificial Intelligence & Soft Computing Lab	--	-	-	-	--	25	25	--	50
CSL704	Computational Lab-I						25	--	25	50
CSP705	Major Project-I	-	-	-	-	-	50	-	25	75
Total		100	100	100	400		150	25	75	750

Program Structure B.E. Computer Engineering, (Rev. 2016) w.e.f. AY 2019-20

B. E. Computer Engineering (Semester-VIII)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	TW/ Pract	Tut	Total
CSC801	Human Machine Interaction	4	-	-	4	-	-	4
CSC802	Distributed Computing	4	-	-	4	-	-	4
CSDLO 801X	Department Level Optional Course -IV	4	-	-	4	-	-	4
ILO801X	Institute Level Optional Course-II	3	-	-	3	-	-	3
CSL801	Human Machine Interaction Lab	-	2	-	-	1		1
CSL802	Distributed Computing Lab		2			1		1
CSL803	Cloud Computing Lab	-	4	-	-	2		2
CSL804	Computational Lab-II	-	2	-		1		1
CSP805	Major Project-II	-	12			6	-	6
	Total	**15**	**22**	-	**15**	**11**	-	**26**

Course Code	Course Name	Examination Scheme								
		Theory					TW	Oral	Oral & Pract	Total
		Internal Assessment			End Sem. Exam	Exam Duratio n (in				
		Test 1	Test 2	Avg.						
CSC801	Human Machine Interaction	20	20	20	80	3	-	-	-	100
CSC802	Distributed Computing	20	20	20	80	3	-	-	-	100
CSDLO 801X	Department Level Optional Course -IV	20	20	20	80	3	-	-	-	100
ILO801X	Institute Level Optional Course-II	20	20	20	80	3	-	-	-	100
CSC801	Human Machine Interaction Lab						25	25	-	50
CSL802	Distributed Computing Lab	-	-	-	-	-	25	25		50
CSL803	Cloud Computing Lab	-	-	-	-	-	50	--	25	75
CSL804	Computational Lab-II	-	-	-	-	-	50	--	25	75
CSP805	Major Project-II						50		50	100
Total		100	100	100	400	--	150		100	750

Sem.	Department Level Optional Course (DLOC)	Institute Level Optional Course (ILOC)
V	CSDLO5011: Multimedia System CSDLO5012: Advance Operating System CSDLO5013: Advance Algorithm	--------------------
VI	CSDLO6021: Machine Learning CSDLO6022: Advance Database System CSDLO6023: Enterprise Resource Planning CSDLO6024: Advance Computer Network	-------------------
VII	CSDLO7031: Advance System Security & Digital Forensics CSDLO7032: Big Data & Analytics CSDLO7033: Robotics	ILO7011. Product Lifecycle Management ILO7012. Reliability Engineering ILO7013. Management Information System ILO7014. Design of Experiments ILO7015. Operation Research ILO7016. Cyber Security and Laws ILO7017. Disaster Management & Mitigation Measures ILO7018. Energy Audit and Management ILO7019. Development Engineering
VIII	DLO8011: High Performance Computing DLO8012: Natural Language Processing DLO8013: Adhoc Wireless Network	ILO8021. Project Management ILO8022. Finance Management ILO8023. Entrepreneurship Development and Management ILO8024. Human Resource Management ILO8025. Professional Ethics and CSR ILO8026. Research Methodology ILO8027. IPR and Patenting ILO8028. Digital Business Management ILO8029. Environmental Management

Course Code	Course Name	Credits
CSC301	**Applied Mathematics-III**	**5**

Course objectives:

1. To understand the concept of complex variables, C-R equations, harmonic functions and its conjugate and mapping in complex plane.
2. To learn the complex mapping, standard mappings, cross ratios and fixed point.
3. To learn the Laplace Transform, Inverse Laplace Transform of various functions, its application and Z-transform.
4. To understand the concept of Fourier Series, its complex form and enhance the problem solving skill.

Course outcomes: On successful completion of course learner will be able to:

1. Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic function.
2. Plot the image of the curve by a complex transformation from z-plane to w-plane.
3. Expand the periodic function by using Fourier series and complex form of Fourier series.
4. Understand the concept of Laplace transform and inverse Laplace transform of various functions and its application to solve ordinary differential equations.
5. Apply the concept of Z- transformation and its inverse of the given sequence.
6. Apply the concept of Correlation and Regression to the engineering problems.

Module No.	Unit No.	Topics	Hrs.
1.0		**Laplace Transform**	**09**
	1.1	**Laplace Transform of Standard Functions:** Introduction, Definition of Laplace transform, Laplace transform of $1, e^{at} \sin(at), \cos(at), \sinh(at), \cosh(at), t^n\ erf\,(t)$, Heavi-side unit step, dirac-delta function, LT of periodic function.	
	1.2	**Properties of Laplace Transform:** Linearity, first shifting property, second shifting property, multiplication by t^n, division by t, Laplace Transform of derivatives and integrals, change of scale property. (without proof)	
2.0		**Inverse Laplace Transform**	**08**
	2.1	Inverse Laplace Transform by Partial fraction method, Convolution theorem	
	2.2	Application to solve initial and boundary value problem involving	

		ordinary differential equations with one dependent variable and constant coefficients.	
3.0		**Fourier Series**	**10**
	3.1	Dirichlet's conditions, Fourier series of periodic functions with period 2π and $2L$, Fourier series for even and odd functions.	
	3.2	Half range sine and cosine Fourier series, Parsevel's identities (without proof)	
	3.3	Complex form of Fourier series, Orthogonal and Orthonormal set of functions.	
4.0		**Complex Variable & mapping**	**09**
	4.1	Functions of a complex variable, Analytic functions, Cauchy-Riemann equations in Cartesian co-ordinates & Polar co-ordinates.	
	4.2	Harmonic functions, Analytic method and Milne Thomson methods to find f(z), Orthogonal trajectories.	
	4.3	**Mapping:** Conformal mapping, bilinear transformations, cross ratio, fixed points, bilinear transformation of straight lines and circles.	
5.0		**Z-transform**	**06**
	5.1	Z-transform of standard functions such as $Z(a^n)$, $Z(n^p)$.	
	5.2	Properties of Z-transform :Linearity, Change of scale, Shifting property, Multiplication of K, Initial and final value, Convolution theorem (without proof)	
	5.3	**Inverse Z transform:** Binomial Expansion and Method of Partial fraction	
6.0		**Correlation & regression, Curve Fitting**	**10**
	6.1	Scattered diagrams, Karl Pearson's coefficient of correlation, covariance, Spearman's Rank correlation(non-repeated and repeated ranks)	
	6.2	Regression coefficient & Lines of Regression.	
	6.3	Fitting of curves: Least square method. Fitting of the straight line $y = a + bx$,parabolic curve $y = a + bx + cx^2$,& exponential curve $y = ab^x$	
		Total	**52**

Text Books:

1. Higher Engineering Mathematics by Grewal B. S. 38th edition, Khanna Publication 2005.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
3. A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar &
4. J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.

Reference Books:

1. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
2. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
3. Integral Transforms and their Engineering Applications by Dr. B. B. Singh, Synergy Knowledgewar.
4. Laplace Transforms by Murry R. Spieget, Schaun's out line series-McGraw Hill Publication.

Assessment:

Internal Assessment:

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

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC302	**Digital Logic Design and Analysis**	**4**

Course Objectives:

1. To introduce the fundamental concepts and methods for design of digital circuits and a pre-requisite for computer organization and architecture, microprocessor systems.
2. To provide the concept of designing Combinational and sequential circuits.
3. To provide basic knowledge of how digital building blocks are described in VHDL.

Course Outcomes: At the end of the course student should be able-

1. To understand different number systems and their conversions.
2. To analyze and minimize Boolean expressions.
3. To design and analyze combinational circuits.
4. To design and analyze sequential circuits
5. To understand the basic concepts of VHDL.
6. To study basics of TTL and CMOS Logic families.

Module	Detailed Content	Hours
1	**Number Systems and Codes** Introduction to number system and conversions: Binary, Octal, Decimal and Hexadecimal number Systems, Binary arithmetic: addition, subtraction (1's and 2's complement), multiplication and division. Octal and Hexadecimal arithmetic: Addition and Subtraction (7's and 8's complement method for octal) and (15's and 16's complement method for Hexadecimal). Codes: Gray Code, BCD Code, Excess-3 code, ASCII Code. Error Detection and Correction: Hamming codes.	8
2	**Boolean Algebra and Logic Gates**: Theorems and Properties of Boolean Algebra, Boolean functions, Boolean function reduction using Boolean laws, Canonical forms, Standard SOP and POS form. Basic Digital gates: NOT , AND , OR , NAND , NOR , EXOR , EX-NOR, positive and negative logic, K-map method 2 variable, 3 variable, 4 variable, Don't care condition, Quine-McClusky Method, NAND-NOR Realization.	8
3	**Combinational Logic Design:** Introduction, Half and Full Adder, Half subtractor Full Subtractor, Four Bit Ripple adder, look ahead carry adder, 4 bit adder subtractor, one digit BCD Adder, Multiplexer, Multiplexer tree, Demultiplexer, Demultiplexer tree, Encoders Priority encoder, Decoders, One bit, Two bit , 4-bit Magnitude Comparator, ALU IC 74181.	8

4	**Sequential Logic Design**: Introduction: SR latch, Concepts of Flip Flops: SR, D, J-K, T, Truth Tables and Excitation Tables of all types, Race around condition, Master Slave J-K Flip Flops, Timing Diagram, Flip-flop conversion, State machines, state diagrams, State table, concept of Moore and Mealy machine. Counters : Design of Asynchronous and Synchronous Counters,Modulus of the Counters, UP- DOWN counter, Shift Registers: SISO, SIPO, PIPO, PISO Bidirectional Shift Register, Universal Shift Register, Ring and twisted ring/Johnson Counter, sequence generator.	15
5	**Introduction to VHDL:** Introduction: Fundamental building blocks Library, Entity, Architecture, Modeling Styles, Concurrent and sequential statements, simple design examples for combinational circuits and sequential circuits.	6
6	**Digital Logic Families**: Introduction: Terminologies like Propagation Delay, Power Consumption, Fan in and Fan out , current and voltage parameters, noise margin, with respect to TTL and CMOS Logic and their comparison	3

Text Books:

1. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill.
2. M. Morris Mano, "Digital Logic and computer Design", PHI.
3. Norman Balabanian, "Digital Logic Design Principles", Wiley.
4. J. Bhasker." VHDL Primer", Pearson Education.

Reference Books:

1. Donald p Leach, Albert Paul Malvino,"Digital principles and Applications",Tata McGraw
2. Yarbrough John M. , "Digital Logic Applications and Design ", Cengage Learning.
3. Douglas L. Perry, "VHDL Programming by Example", Tata McGraw Hill.

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

Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC303	**Discrete Mathematics**	**4**

Course Objectives:

1. Cultivate clear thinking and creative problem solving.
2. Thoroughly train in the construction and understanding of mathematical proofs. Exercise common mathematical arguments and proof strategies.
3. Thoroughly prepare for the mathematical aspects of other Computer Engineering courses

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

1. Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
2. Ability to reason logically.
3. Ability to understand relations, Diagraph and lattice..
4. Ability to understand use of functions, graphs and their use in programming applications.
5. Understand use of groups and codes in Encoding-Decoding
6. Apply discrete structures into other computing problems such as formal specification, verification, artificial intelligence, cryptography, Data Analysis and Data Mining etc.

Prerequisite: Basic Mathematics

Sr. No.	Module	Detailed Content	Hours
1	Set Theory	• Sets, Venn diagrams, Operations on Sets • Laws of set theory, Power set and Products • Partitions of sets, The Principle of Inclusion and Exclusion	4
2	Logic	• Propositions and logical operations, Truth tables • Equivalence, Implications • Laws of logic, Normal Forms • Predicates and Quantifiers • Mathematical Induction	8
3	Relations and Functions	• Relations, Paths and Digraphs • Properties and types of binary relations • Operations on relations, Closures, Warshall's algorithm • Equivalence and partial ordered relations, • Poset, Hasse diagram and Lattice • Functions: Types of functions - Injective, Surjective and Bijective	12

		• Composition of functions , Identity and Inverse function • Pigeon-hole principle	
4	Counting	• Permutations , Combinations • Elements of Probability, Discrete Probability and Conditional Probability • Generating Functions and Recurrence Relations • Recursive Functions • Introduction to Functional Programming	6
5	Graphs	• Definitions, Paths and circuits: Eulerian and Hamiltonian • Types of graphs, Sub Graphs • Isomorphism of graphs	6
6	Algebraic Structures and Coding Theory	• Algebraic structures with one binary operation: semigroup, monoid and group, Abelian group • Isomorphism, Homomorphism and Automorphism • Cyclic groups, Normal subgroups, • Codes and group codes	8

Text Books:

1. BernadKolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, "Discrete Mathematical Structures", Pearson Education.
2. C.L.Liu, Elements of Discrete Mathematics, second edition 1985, McGraw-Hill BookCompany. Reprinted 2000.
3. K.H.Rosen, Discrete Mathematics and applications, fifth edition 2003, TataMcGraw Hill publishing Company.
4. D.E. Rydeheard University of Manchester , R.M. Burstall, University of Edinburgh "Computational Category Theory".

Reference Books:

1. Y N Singh, "Discrete Mathematical Structures", Wiley-India.
2. J .L.Mott, A.Kandel, T.P .Baker, Discrete Mathematics for Computer Scientists and Mathematicians, second edition 1986, Prentice Hall of India.
3. J. P. Trembley, R. Manohar "Discrete Mathematical Structures with Applications to Computer Science", TataMcgraw-Hill.
4. Seymour Lipschutz , Marc Lars Lipson," Discrete Mathematics" Schaum'sOutline, McGraw Hill Education.

Internal Assessment:

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

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

**** Tutorial lecture can be conducted for each unit and min 10 problems on the covered unit can be given to the students for practice.**

Course Code	Course Name	Credits
CSC304	**Electronic Circuits and Communication Fundamentals**	**4**

Course Objectives:

1. To develop the knowledge of semiconductor devices and circuits, and explain their use in communication applications.
2. To inculcate circuit analysis capabilities in students.
3. To gain knowledge in electronic devices and circuits that is useful in real life applications.
4. To understand the fundamental concepts of electronic communication and their use in computer applications.

Course Outcomes: At the end of the course student should be able

1. To understand the use of semiconductor devices in circuits and analyze them.
2. To understand importance of oscillators and power amplifiers in communication system.
3. To understand basic concepts of operational amplifier and their applications.
4. To understand the fundamental concepts of electronic communication
5. To apply knowledge of electronic devices and circuits to communication applications.
6. To study basic concepts of information theory.

Prerequisite: Basic electrical engineering

Module	Detailed Content	Hours
1	**Electronic Circuits:Bipolar junction transistor**. Input and Output characteristics, Types of Biasing - Fixed bias, self-bias, voltage divider bias, DC load line and significance, CE amplifier using re model, (Analysis based Numericals)	08
2	**Power Amplifiers:** Introduction, Class A and Class C power amplifier. Oscillators: Introduction, Barkhausen criteria, Colpitts oscillator and Crystal oscillator	04
3	**Electronic Circuits** : **Operational Amplifier and its applications** Op-amp – block diagram, parameters and characteristics, applications-Inverting and Non inverting amplifier, Summing Amplifier(Numerical), Difference amplifier, Basic Integrator and Differentiator, Comparator, Zero Crossing Detector (only theory)	10

4	**Communication Fundamentals: Analog Communication** Block diagram and elements of analog communication systems, Theory of amplitude modulation and types of AM (Numerical) Generation of DSB SC using diode based balanced modulator, Generation of SSB using phase shift method, Introduction of FM,and its mathematical representation, Statement of Carson's Rule Comparison of AM, FM, Block diagram of AM transmitter (HLM and LLM) Block diagram of AM Superheterodyne receiver.	10
5	**Pulse Modulation and Multiplexing.** Statement of Sampling Theorem, Generation and detection of PAM, PWM, PPM, PCM, DM and ADM. Principle of TDM using PCM and FDM	10
6	**Communication Fundamentals**: **Information theory.** Amount of information, average information, information rate, Statement of Shannon's theorem, channel capacity (Numericals)	06

Text Books:

1. Robert Boylestad, 'Electronic Devices and circuit Theory', Prentice Hall.
2. D Roy Choudhury, ' Linear integrated Circuits' New Age International Ltd
3. G. Kennedy, B. Davis, S R M Prasanna, 'Electronic Communication Systems', McGraw Hill, 5th Edition.
4. Wayne Tomasi, 'Electronic Communication Systems (fundamentals through advanced)', Pearson Education, 4th Edition.
5. K. Sam Shanmugam,' Digital and analog communication systems', Wiley.

Reference Books:

1. Donald Neamen, 'Electronic Circuit Analysis and Design', Tata McGraw Hill,2nd Edition.
2. K. R. Botkar, 'Integrated Circuits', Khanna Publishers, 9th Edition
3. Simon Haykin, 'Digital Communication systems', Wiley.
4. David Bell, 'Electronic Devices and Circuits', Oxford, 5th Edition.
5. Ramakant A. Gayakwad, 'Op-amp and linear integrated circuits', PHI, 3rd edition.

Internal Assessment

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

Theory Examination:

2 Question paper will comprise of 6 questions, each carrying 20 marks.
5. The students need to solve total 4 questions.
6. Question No.1 will be compulsory and based on entire syllabus.
7. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC305	**Data Structures**	**4**

Course Objectives:

1. To teach various storage mechanisms of data.
2. To design and implement various data structures.
3. To introduce various techniques for representation of the data in the real world.
4. To teach different sorting techniques.
5. To teach different searching techniques.

Course Outcomes:

1. Students will be able to implement various linear and nonlinear data structures.
2. Students will be able to handle operations like insertion, deletion, searching and traversing on various data structures.
3. Students will be able to select appropriate sorting technique for given problem.
4. Students will be able to select appropriate searching technique for given problem.
5. Students will be able to apply the learned concepts in various domains like DBMS and Compiler Construction.
6. Students will be able to choose appropriate data structure for specified problem domain.

Prerequisite: C Programming

Module	Detailed Content	Hours
01	**Introduction to Data Structures**	03
	Introduction, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of ADT, Arrays.	
02	**Stack and Queues**	10
	Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack – Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation, Recursion. ADT of Queue, Operations on Queue, Array Implementation of Queue, Circular Queue, Priority Queue, Double Ended Queue, Applications of Queue.	
03	**Linked List**	10
	Introduction, Representation of Linked List, Linked List v/s Array, Implementation of Linked List, Linked Implementation of Stack and Queue, Circular Linked List, Doubly Linked List, Application – Polynomial Representation and Addition.	
04	**Trees**	12
	Introduction, Tree Terminologies, Binary Tree, Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Implementation of Binary Search Tree, Applications – Expression Tree, Huffman Encoding. Search Trees – AVL, B Tree, B+ Tree, Splay Tree and Trie.	

05	**Graphs**	06
	Introduction, Graph Terminologies, Representation, Graph Traversals – Depth First Search (DFS) and Breadth First Search (BFS), Application – Topological Sorting	
06	**Sorting and Searching**	07
	Introduction, Bubble Sort, Insertion Sort, Merge Sort, Quick Sort. Linear Search, Binary Search, Hashing – Concept, Hash Functions, Collision Handling Techniques.	

Text Books:

1. Data Structures using C, Reema Thareja, Oxford
2. Data Structures using C and C++, Rajesh K Shukla, Wiley - India
3. Data Structures Using C, Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, Pearson
4. Data Structures: A Pseudocode Approach with C, Richard F. Gilberg & Behrouz A., Forouzan, Second Edition, CENGAGE Learning
5. Introduction to Data Structure and Its Applications, JeanPaul Tremblay, P. G. Sorenson

Reference Books:

1. C & Data Structures, Prof. P.S. Deshpande, Prof. O.G. Kakde, DreamTech press.
2. Data Structure Using C, Balagurusamy.
3. Data Structures Using C, ISRD Group, Second Edition, Tata McGraw-Hill.
4. Data Structures, Adapted by: GAV PAI, Schaum's Outlines.

Internal Assessment:

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

End Semester Theory Examination:

1 Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules

Lab Code	Lab Name	Credits
CSL301	**Digital System Lab**	**1**

Lab Outcome:

1. Understand the basics of various digital components.
2. Understand the principles of design of combinational logic and sequential logic circuits using basic components.
3. Recognize the importance of digital systems in computer architecture.
4. Design and simulate the basic digital circuit.

Description

Experiments with Logic Building Blocks using SSI/MSI, Experiments on Design and/or use Minimization tools. Use of VHDL and simulation in Logic Design. Experiment on design using MSI and/or PLDs tools.

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	To study and verify the truth table of various logic gates using ICs and realize Boolean expressions using gates
2	To realize basic gates using universal gates
4	To realize binary to gray code and gray code to binary converter.
5	To realize parity generator and detector.
6	To realize arithmetic circuits i) Half adder ii) Full adder iii) Half subtractor iv) Full subtractor
7	To realize 2 bit magnitude comparator.
8	To Study multiplexer IC and realization of full adder using multiplexer IC
9	To Study decoder IC and realization of combinational logic using decoder IC
10	Study of flip-flops using IC's
11	To realize asynchronous 3 bit up counter.
12	To realize shift registers using flip flops
13	To realize basic gates using VHDL

14	To realize 4:1 multiplexer using VHDL
15	To realize 4 bit counter using VHDL

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Oral & Practical exam will be based on the above and CSC302: Digital Logic Design and Analysis syllabus.

Lab Code	Lab Name	Credits
CSL302	**Basic Electronics Lab**	**1**

Lab Outcome:

1. Understand the basics of various semiconductor devices, electronic components and instruments.
2. Understand the working of electronic circuits using components
3. Recognize the importance of electronic circuits in electronic communications.
4. Study the fundamental concepts of various modulation methods.

Description

Experiments with semiconductor devices, ICs, electronic component and various measuring instruments. Study experiments on various modulation methods.

Suggested List of Experiments:

Sr. No.	List Experiments
1	Study of electronic components and measuring instruments.
2	Implementation of single stage BJTamplifier.
3	Implementation of oscillators.
4	Implementation of inverting, non inverting amplifier using IC741.
5	Implementation of adder and subtractor using IC 741.
6	Implementation of differentiator using IC741.
7	Implementation of integrator using IC741.
8	Modulation and Demodulation of AM.
9	Study of super heterodyne receiver
10	Modulation and Demodulation PAM.
11	Modulation and Demodulation PWM.
12	Modulation and Demodulation PPM.
13	Modulation and Demodulation PCM.
14	Study of TDM.

15	Study of FDM.
16	SPICE based simulation.

Term Work:

Laboratory work will be based on above syllabus with minimum 10 experiments to be incorporated.

Oral exam will be based on the above mentioned experiment list and CSC304: Electronic circuits and communication fundamentals syllabus.

Lab Code	Lab Name	Credits
CSL303	**Data Structures Lab**	**1**

Lab outcomes:

1. Students will be able to implement various linear and nonlinear data structures.
2. Students will be able to handle operations like insertion, deletion, searching and traversing on various data structures.

Description: Experiments based on creating and manipulating various data structures.

Suggested Experiments:

Students are required to complete at least 12 experiments.
Star (*) marked experiments are compulsory.

*1) Array Implementation of Stack.

*2) Conversion of Infix to Postfix.

3) Evaluation of Postfix Expression.

4) Check continuity of different types of parenthesis using stack.

5) Array Implementation of Queue.

*6) Array Implementation of Circular Queue.

7) Array Implementation of Priority Queue

*8) Implementation of Singly Linked List

9) Linked Implementation of Stack

10) Linked Implementation of Queue.

11) Implementation of Circular Linked List.

12) Implementation of Doubly Linked List.

*13) Implement Binary Search Tree.

14) Implementation of Bubble Sort.

15) Implementation of Insertion Sort.

16) Implementation of Merge Sort.

*17) Implementation of Quick Sort.

*18) Implementation of Binary Search.

19) Implementation of Hashing.

20) Implementation of Depth First Search and Breadth First Search.

Term Work:

1. Term work should consist of at least 10 experiments.
2. Journal must include at least 2 assignments.
3. A case study should be conducted using a Mini Project by taking a good problem definition and complete the following phases.
   a. Decomposing the problem into modules
   b. Identifying the best suited data structure for solving the sub problems with justification
   c. Define algorithms for various identified functions
   d. Implement the modules
4. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5. Term Work:

Total 25 Marks = (Experiments: 10 mark + Mini Project: 05 mark + Assignments: 05 mark)

Practical and oral examination will be based on the above syllabus.

Lab Code	Lab Name	Credits
CSL304	**OOPM (JAVA) Lab**	**2**

Course Objective:

1. To learn the object oriented programming concepts.
2. To study various java programming concept like multithreading, exception handling, packages etc.
3. To explain components of GUI based programming.

Course Outcomes: At the end of the course Student should be able:

1. To apply fundamental programming constructs.
2. To illustrate the concept of packages, classes and objects.
3. To elaborate the concept of strings, arrays and vectors.
4. To implement the concept of inheritance and interfaces.
5. To implement the notion of exception handling and multithreading.
6. To develop GUI based application.

Prerequisite: Structured Programming Approach

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Object Oriented Programming	1.1 OOP Concepts: Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism. 1.2 Features of Java, JVM 1.3 Basic Constructs/Notions: Constants, variables and data types, Operators and Expressions, Revision of Branching and looping	02
2	Classes, Object and Packages	2.1Class, Object, Method. 2.2 Constructor, Static members and methods 2.3 Passing and returning Objects 2.4Method Overloading 2.5 Packages in java, creating user defined packages, access specifiers.	05
3	Array, String and Vector	3.1 Arrays, Strings, String Buffer 3.2 Wrapper classes, Vector	04
4	Inheritance and Interface	4.1Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword, 4.2 Implementing interfaces, extending interfaces	03
5	Exception Handling and Multithreading	5.1 Error vs Exception, try, catch, finally, throw, throws, creating own exception 5.2 Thread lifecycle, Thread class methods, creating threads, Synchronization	04
6	GUI programming in JAVA	6.1 Applet: Applet life cycle, Creating applets, Graphics class methods, Font and Color class, parameter passing.	08

		6.2 Event Handling: Event classes and event listener 6.3 Introduction to AWT: Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Check Box, and Radio Buttons. 6.4 Programming using JDBC: Introduction to JDBC, JDBC Drivers & Architecture.	

Text books:

1. Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.

2. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University Press, 2010

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.

2. DietalandDietal, 'Java: How to Program', 8/e,PHI

3. 'JAVA Programming', Black Book, Dreamtech Press.

4. 'Learn to Master Java programming', Staredusolutions

Digital Material:

1. www.nptelvideos.in
2. www.w3schools.com
3. http://spoken-tutorial.org
4. www.staredusolutions.org

Suggested List of Programming Assignments/Laboratory Work:

1.	Program on various ways to accept data through keyboard and unsigned right shift operator.
2.	Program on branching, looping, labelled break and labelled continue.
3.	Program to create class with members and methods, accept and display details for single object.
4.	Program on constructor and constructor overloading
5.	Program on method overloading
6.	Program on passing object as argument and returning object
7.	Program on creating user defined package
8.	Program on 1D array
9.	Program on 2D array

10.	Program on String
11.	Program on StringBuffer
12.	Program on Vector
13.	Program on single and multilevel inheritance (Use super keyword)
14.	Program on abstract class
15.	Program on interface demonstrating concept of multiple inheritance
16.	Program on dynamic method dispatch using base class and interface reference.
17.	Program to demonstrate try, catch, throw, throws and finally.
18.	Program to demonstrate user defined exception
19.	Program on multithreading
20.	Program on concept of synchronization
21.	Program on Applet to demonstrate Graphics, Font and Color class.
22.	Program on passing parameters to applets
23.	Program to create GUI application without event handling using AWT controls
24.	Program to create GUI application with event handling using AWT controls
25.	Mini Project based on content of the syllabus. (Group of 2-3 students)

Term Work:
Students will submit term work in the form of journal that will include:
1. At least 16-18 programs and mini project
2. Two assignments covering whole syllabus

Term Work: 50 Marks (Total Marks) = 20 marks (Experiments) +
20 marks (Mini Project) +
05 marks (Assignments) +
05 marks (Attendance)

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Credits
CSC401	**Applied Mathematics-IV**	**5**

Course Objectives: The objectives of this course are to teach the students:

1. Matrix theory, and it's application to find the matrix function. Present methods of computing and using Eigen values and Eigen vectors.
2. Set up and directly evaluate contour integrals Cauchy's integral theorem and formula in basic and extended form. Present Taylor and Laurent's series to find singularities zero's and poles also presents residues theory
3. Theory of probability, Baye's Theorem, Expectation and Moments and it's application.
4. Probability distribution such as Binomial, Poisson and Normal distribution with their properties.
5. Sampling theory and it's application for small and large sample and Optimization techniques.

Course Outcomes:

1. Students in this course will be able to apply the method of solving complex integration, computing residues & evaluate various contour integrals.
2. Demonstrate ability to manipulate matrices and compute Eigen values and Eigen vectors.
3. Apply the concept of probability distribution to the engineering problems.
4. Apply the concept of sampling theory to the engineering problems.
5. Use matrix algebra with its specific rules to solve the system of linear equation, using concept of Eigen value and Eigen vector to the engineering problems.
6. Apply the concept of Linear & Non-Linear Programming Problem to the engineering problems.

Module No.	Unit No.	Topics	Hrs.
1.0		**Complex Integration**	**10**
	1.1	Complex Integration – Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula(without proof)	
	1.2	Taylor's and Laurent's series (without proof)	
	1.3	Zeros, poles of f(z), Residues, Cauchy's Residue theorem.	
	1.4	Applications of Residue theorem to evaluate Integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)\,d\theta$, $\int_{-\infty}^{\infty} f(x)\,dx$	
2.0		**Matrices**	**10**
	2.1	Eigen values and Eigen vectors.	
	2.2	Cayley-Hamilton theorem(without proof)	
	2.3	Similar matrices, diagonalisable matrix.	
	2.4	Derogatory and non-derogatory matrices, Functions of square matrix.	

3.0		**Probability**	**10**
	3.1	Baye's Theorem	
	3.2	**Random Variables:** Discrete & continuous random variables, expectation, Variance, Probability Density Function & Cumulative Density Function.	
	3.3	Moments & Moment generating function.	
	3.4	**Probability distribution:** Binomial distribution, Poisson & Normal distribution. (For detail study)	
4.0		**Sampling Theory (Large Sample test)**	**06**
	4.1	Sampling Distribution, Test of Hypothesis, Level of significance, Critical region, One Tailed and Two Tailed test,	
	4.2	Test of significant for Large Samples:-Means of the samples and test of significant of means of two large samples.	
5.0		**Sampling Theory (Small Sample test)**	**06**
	5.1	Test of significant for small samples:- Students t- distribution for dependent and independent samples	
	5.2	Chi square test:- Test of goodness of fit and independence of attributes,Contingency table.	
6.0		**Mathematical Programming**	**10**
	6.1	Types of solution, Standard and Canonical form of LPP, Basic and feasible solutions, simplex method.	
	6.2	Artificial variables, Big –M method (method of penalty).	
	6.3	Duality and Dual simplex method.	
	6.4	Non Linear Programming Problems with equality constrains and inequality Constrains (two or three variables with one constrains) (No formulation, No Graphical method).	
		Total	**52**

Text Books:

1. Higher Engineering Mathematics by Grewal B. S. 38^{th} 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. 9^{th} edition, John Wiley.
5. Operations Research by S.D. Sharma Kedar Nath, Ram Nath & Co. Meerat.
6. Engineering optimization (Theory and Practice) by Singiresu S.Rao, New Age International publication.

Assessment:

Internal Assessment:

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

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

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

Course Code	Course Name	Credits
CSC402	**Analysis of Algorithms**	**4**

Course Objectives:

4. To provide mathematical approach for Analysis of Algorithms
5. To solve problems using various strategies
6. To analyse strategies for solving problems not solvable in polynomial time.

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

1. Analyze the running time and space complexity of algorithms.
2. Describe, apply and analyze the complexity of divide and conquer strategy.
3. Describe, apply and analyze the complexity of greedy strategy.
4. Describe, apply and analyze the complexity of dynamic programming strategy.
5. Explain and apply backtracking, branch and bound and string matching techniques to deal with some hard problems.
6. Describe the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP-Complete.

Prerequisites: Students should be familiar with concepts of Data structure and discrete structures.

Module	Detailed Content	Hours
1	**Introduction to analysis of algorithm** Performance analysis , space and time complexity Growth of function – Big –Oh ,Omega , Theta notation Mathematical background for algorithm analysis, Analysis of selection sort , insertion sort. **Recurrences:** -The substitution method -Recursion tree method -Master method **Divide and Conquer Approach:** General method Analysis of Merge sort, Analysis of Quick sort, Analysis of Binary search, Finding minimum and maximum algorithm and analysis, Strassen's matrix multiplication	12
2	**Dynamic Programming Approach:** General Method Multistage graphs single source shortest path all pair shortest path Assembly-line scheduling 0/1 knapsack Travelling salesman problem Longest common subsequence	08
3	**Greedy Method Approach:**	06

	General Method Single source shortest path Knapsack problem Job sequencing with deadlines Minimum cost spanning trees-Kruskal and prim's algorithm Optimal storage on tapes	
4	**Backtracking and Branch-and-bound:** General Method 8 queen problem(N-queen problem) Sum of subsets Graph coloring 15 puzzle problem, Travelling salesman problem.	08
5	**String Matching Algorithms:** The naïve string matching Algorithms The Rabin Karp algorithm String matching with finite automata The knuth-Morris-Pratt algorithm	06
6	**Non-deterministic polynomial algorithms:** Polynomial time, Polynomial time verification NP Completeness and reducibility NP Completeness proofs Vertex Cover Problems Clique Problems	08

Text Books:

1. T.H.coreman , C.E. Leiserson,R.L. Rivest, and C. Stein, "Introduction to algorithms", 2nd edition , PHI publication 2005.
2. Ellis horowitz , Sartaj Sahni , S. Rajsekaran. "Fundamentals of computer algorithms" University Press

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw- Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.
3. John Kleinberg, Eva Tardos, "Algorithm Design", Pearson.
4. Michael T. Goodrich, Roberto Tamassia, "Algorithm Design", Wiley Publication.

Assessment:

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

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules**..**

Course Code	Course Name	Credit
CSC403	**Computer Organization and Architecture**	**4**

Course Objectives:

1. To have a thorough understanding of the basic structure and operation of a digital computer.
2. To discuss in detail the operation of the arithmetic unit including the algorithms & implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
3. To study the different ways of communicating with I/O devices and standard I/O interfaces.
4. To study the hierarchical memory system including cache memories and virtual memory.

Course Outcomes: At the end of the course student should be able-

1. To describe basic structure of the computer system.
2. To demonstrate the arithmetic algorithms for solving ALU operations.
3. To describe instruction level parallelism and hazards in typical processor pipelines.
4. To describe superscalar architectures, multi-core architecture and their advantages
5. To demonstrate the memory mapping techniques.
6. To Identify various types of buses, interrupts and I/O operations in a computer system

Prerequisite: Digital Logic Design and Application

Sr. No.	**Module**	**Detailed Content**	**Hours**
1	<u>Introduction</u>	<u>Overview of Computer Architecture & Organization</u> • Introduction • Basic organization of computer • Block level description of the functional units. <u>Data Representation and Arithmetic Algorithms:</u> • Integer Data computation: Addition, Subtraction. Multiplication: unsigned multiplication, Booth's algorithm. • Division of integers: Restoring and non restoring division • Floating point representation. IEEE 754 floating point number representation. • Floating point arithmetic: Addition, Subtraction, Multiplication, Division	08
2	<u>Processor Organization and Architecture</u>	• Von Neumann model, Harvard Architecture • Register Organization, Instruction formats, addressing modes, instruction cycle. Instruction interpretation and sequencing. • ALU and Shifters • Basic pipelined datapath and control, Data dependences, data hazards, Branch hazards, delayed branches, branch prediction • Performance measures – CPI, speedup, efficiency, throughput and Amdahl's law	10

3	<u>Control Unit Design</u>	• Hardwired control unit design methods: State table, delay element, sequence counter with examples like control unit for multiplication and division • Microprogrammed control Unit: Microinstruction sequencing and execution. Micro operations, Wilkie's microprogrammed Control Unit, Examples on microprograms	08
4	<u>Memory Organization</u>	• Classifications of primary and secondary memories. Types of RAM (SRAM, DRAM, SDRAM, DDR, SSD) and ROM, Characteristics of memory, Memory hierarchy: cost and performance measurement. • Virtual Memory: Concept, Segmentation and Paging, Address translation mechanism. • Interleaved and Associative memory. • Cache memory Concepts, Locality of reference, design problems based on mapping techniques. Cache Coherency, Write Policies	12
5	<u>I/O Organization and Peripherals</u>	• Common I/O device types and characteristics • Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA. • Introduction to buses, Bus arbitration and multiple bus hierarchy • Interrupt types, Interrupts handling	06
6	<u>Advanced Processor Principles</u>	• Introduction to parallel processing, Flynn's Classification • Concepts of superscalar architecture, out-of-order execution, speculative execution, multithreaded processor, VLIW, data flow computing. • Introduction to Multi-core processor architecture	08

Text Books:

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", Pearson Publication, 10th Edition, 2013
2. John P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1988
3. B. Govindarajulu, "Computer Architecture and Organization: Design Principles and Applications", Second Edition, McGraw-Hill (India),

Reference Books:

1. Andrew S. Tanenbaum "Structured Computer Organization", Pearson, Sixth Edition
2. Morris Mano. "Computer System Architecture" Pearson Publication, 3rd Edition, 2007
3. Kai Hwang, Fayé Alayé Briggs. "Computer architecture and parallel processing", McGraw-Hill
4. P. Pal Chaudhuri. "Computer Organization and Design" Prentice Hall India, 2004
5. Dr. M. Usha, T.S. Shrikant. "Computer System Architecture and Organization" Wiley India, 2014.

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

End Semester Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC404	**Computer Graphics**	**4**

Course Objectives

1. To equip students with the fundamental knowledge and basic technical competence in the field of computer graphics.
2. To emphasize on implementation aspect of Computer Graphics Algorithms.
3. To prepare the student for advance areas like Image Processing or Computer Vision or Virtual Reality and professional avenues in the field of Computer Graphics.

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

1. Understand the basic concepts of Computer Graphics.
2. Demonstrate various algorithms for scan conversion and filling of basic objects and their comparative analysis.
3. Apply geometric transformations, viewing and clipping on graphical objects.
4. Explore solid model representation techniques and projections.
5. Understand visible surface detection techniques and illumination models.

Prerequisite: Knowledge of C Programming, Basic Data Structures and Mathematics**.**

Module No	Detail Syllabus	Hours
1	**Introduction and Overview of Graphics System**: • Definition and Representative uses of computer graphics, classification of application areas, Overview of coordinate systems ,definition of scan conversion, rasterization and rendering. • Raster scan & random scan displays, Flat Panel displays like LCD and LED , architecture of raster graphics system with display processor, architecture of random scan systems.	03
2	**Output Primitives** : • Scan conversions of point,line, circle and ellipse : DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle, midpoint algorithm for ellipse drawing (Mathematical derivation for above algorithms is expected) • Aliasing , Antialiasing techniques like Pre and post filtering , super sampling , and pixel phasing). • Filled Area Primitive: Scan line Polygon Fill algorithm, Inside outside tests, Boundary Fill and Flood fill algorithm.	12
3	**Two Dimensional Geometric Transformations** • Basic transformations : Translation , Scaling , Rotation • Matrix representation and Homogeneous Coordinates • Composite transformation • Other transformations : Reflection and Shear • Raster method for transformation.	06

4	**Two Dimensional Viewing and Clipping** • Viewing transformation pipeline and Window to Viewport coordinate transformation • Clipping operations – Point clipping , Line clipping algorithms : Cohen – Sutherland , Midpoint subdivision , Liang – Barsky , Polygon Clipping Algorithms : Sutherland – Hodgeman, Weiler – Atherton.	08
5	**Three Dimensional Object Representations , Geometric Transformations and 3D Viewing** • Boundary Representation and Space partitioning representation: Polygon Surfaces , Bezier Curve , Bezier Surface , B-Spline Curve , Sweep Representation, Constructive Solid Geometry ,Octree, Fractal-Geometry : Fractal Dimension, Koch Curve. • 3D Transformations :Translation, Rotation , Scaling and Reflection. • Composite transformations :Rotation about an arbitrary axis • 3D transformation pipeline • Projections – Parallel , Perspective.(Matrix Representation) • 3D clipping.	12
6	**Visible Surface Detection** • Classification of Visible Surface Detection algorithm • Back Surface detection method • Depth Buffer method • Depth Sorting method • Scan line method • Area Subdivision method	04
7	**Illumination Models and Surface Rendering** • Basic Illumination Models : Diffused reflection, Phong Specular reflection Model • Halftone and Dithering techniques • Polygon Rendering :Constant shading , Gouraud Shading , Phong Shading.	03

Text Books:

1. "Computer Graphics" C version by Hearn & Baker, 2^{nd} Edition, Pearson
2. "Computer Graphics Principles and Practice in C , 2nd Edition ,James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, Pearson .
3. "Computer Graphics", by Rajesh K. Maurya, Wiley India Publication.
4. "Computer Graphics " , by Samit Bhattacharya , Oxford Publication.

Reference Books:

1. “Procedural Elements for Computer Graphics “ by D. Rogers , Tata McGraw-Hill Publications.
2. “Computer Graphics” , by Zhigang Xiang , Roy Plastock , Schaum’s Outlines McGraw-Hill Education
3. “Computer Graphics using OpenGL” , by F.S.Hill , Jr. ,Third edition, Pearson Publications.

Assessment:

Internal Assessment:

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

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
CSC405	**Operating System**	**4**

Course Objectives:

1. To introduce basic concepts and functions of operating systems.
2. To understand the concept of process, thread and resource management.
3. To understand the concepts of process synchronization and deadlock.
4. To understand various Memory, I/O and File management techniques.

Course Outcomes: At the end of the course student should be able to

1. Understand role of Operating System in terms of process, memory, file and I/O management.
2. Apply and analyse the concept of a process, thread, mutual exclusion and deadlock.
3. Evaluate performance of process scheduling algorithms and IPC.
4. Apply and analyse the concepts of memory management techniques.
5. Evaluate the performance of memory allocation and replacement techniques.
6. Apply and analyze different techniques of file and I/O management.

Prerequisite: Computer Organization & Architecture

Sr No	Module	Detailed Content	Hours
1	**Operating System Overview**	Operating System Objectives and Functions, The Evolution of Operating Systems, OS Design Considerations for Multiprocessor and Multicore architectures, Operating system structures, System Calls, Linux Kernel and Shell.	8 hrs
2	**Process Concept and Scheduling**	**Process:** Concept of a Process, Process States, Process Description, Process Control Block, Operations on Processes. **Threads**: Definition and Types, Concept of Multithreading, Multicore processors and threads. **Scheduling:** Uniprocessor Scheduling - Types of Scheduling: Preemptive and, Non-preemptive, Scheduling Algorithms: FCFS, SJF, SRTN, Priority based, Round Robin, Multilevel Queue scheduling. Introduction to Thread Scheduling, Multiprocessor Scheduling and Linux Scheduling.	8 hrs

3	**Synchronization and Deadlocks**	**Concurrency**: Principles of Concurrency, Inter-Process Communication, Process/Thread Synchronization. **Mutual Exclusion**: Requirements, Hardware Support, Operating System Support (Semaphores and Mutex), Programming Language Support (Monitors), Classical synchronization problems: Readers/Writers Problem, Producer and Consumer problem. **Principles of Deadlock**: Conditions and Resource Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker's Algorithm for Single & Multiple Resources, Deadlock Detection and Recovery. Dining Philosophers Problem.	12 hrs
4	**Memory Management**	**Memory Management**: Memory Management Requirements, Memory Partitioning: Fixed Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit, Next Fit, Buddy System, Relocation. Paging, Segmentation. **Virtual Memory**: Hardware and Control Structures, Demand Paging, Structure of Page Tables, Copy on Write, Page Replacement Strategies: FIFO, Optimal, LRU, LFU, Approximation, Counting Based. Allocation of frames, Thrashing.	8 hrs
5	**File Management**	**File Management**: Overview, File Organization and Access, File Directories, File Sharing, Secondary Storage Management, Linux Virtual File System.	6 hrs
6	**Input /Output Management**	**I/O Management and Disk Scheduling**: I/O Devices, Organization of the I/O Function, Operating System Design Issues, I/O Buffering, Disk Scheduling algorithm: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK. Disk Management, Disk Cache, Linux I/O.	6 hrs

Text Books:

1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8th Edition, 2014, ISBN-10: 0133805913 • ISBN-13: 9780133805918 .
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley & Sons , Inc., 9th Edition, 2016, ISBN 978-81-265-5427-0
3. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rd Edition.
4. D.M Dhamdhere, Operating Systems: A Concept Based Approach, Mc-Graw Hill

Reference Books:

1. Maurice J. Bach, "Design of UNIX Operating System", PHI
2. Achyut Godbole and Atul Kahate, Operating Systems, Mc Graw Hill Education, 3rd Edition
3. The Linux Kernel Book, Remy Card, Eric Dumas, Frank Mevel, Wiley Publications.

Assessment:

Internal Assessment:

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

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Lab Code	Lab Name	Credit
CSL401	**Analysis of Algorithms Lab**	**1**

Lab outcomes: At the end of the course student will be able to

1. Analyze the complexities of various problems in different domains.
2. Prove the correctness and analyze the running time of the basic algorithms for those classic problems in various domains.
3. Develop the efficient algorithms for the new problem with suitable designing techniques.
4. Implement the algorithms using different strategies.

Prerequisites: Students should be familiar with concepts of Data structure and Discrete structures.

Description:

Minimum 2 experiments should be implemented using any language on each algorithm design strategy (Divide and conquer, dynamic programming, Greedy method, backtracking and branch & bound, string matching).

Suggested Laboratory Experiments:

Sr. No.	Module Name	Suggested Experiment List
1	Introduction to analysis of algorithm Divide and Conquer Approach	Selection sort , insertion sort. Merge sort, Quick sort, Binary search.
2	Dynamic Programming Approach	Multistage graphs, single source shortest path, all pair shortest path, 0/1 knapsack, Travelling salesman problem, Longest common subsequence.
3	Greedy Method Approach	Single source shortest path, Knapsack problem, Job sequencing with deadlines, Minimum cost spanning trees-Kruskal and prim’s algorithm, Optimal storage on tapes.
4	Backtracking and Branch-and-bound	8 queen problem (N-queen problem), Sum of subsets, Graph coloring, 15 puzzle problem, Travelling salesman problem.

5	String Matching Algorithms	The naïve string matching Algorithms, The Rabin Karp algorithm, String matching with finite automata, The knuth-Morris-Pratt algorithm.
6	Any two Experiments	This will involve implementation of two algorithms for problems beyond the scope of syllabus. The exact set of algorithms to implement is to be decided by the course instructor.

Text Books:

1. T.H.Coreman , C.E. Leiserson,R.L. Rivest, and C. Stein, "Introduction to algorithms", 2nd edition , PHI publication 2005.
2. Ellis horowitz , sartaj Sahni , s. Rajsekaran. "Fundamentals of computer algorithms" University Press

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw- Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.
3. Dana Vrajittoru and William Knight, "Practical Analysis of Algorithms", Springer 2014th Edition.

Term Work:

Laboratory work must contain implementation of minimum 10 experiments. The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing marks in term work. The 25 marks of the term work should be divided as below:
25 Marks (total marks) = 15 Marks Lab. Experiments + 05 Marks Assignments (based on theory syllabus) + 05 (Attendance: theory + practical)

Oral & Practical Exam will be based on the experiments implemented in the Laboratory.

Lab Code	Lab Title	Credit
CSL402	**Computer Graphics Lab**	**1**

Lab Objectives

1 To emphasize on implementation aspect of Computer Graphics Algorithm.
2 To prepare students for advanced areas like Animation, image processing ,virtual reality etc

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

1 Explore the working principle, utility of various input/ output devices and graphical tools.
2 Implement various output and filled area primitive algorithms using C/ OpenGL
3 Apply transformation and clipping algorithms on graphical objects.
4 Implementation of curve and fractal generation.
5 Develop a Graphical application based on learned concept.

Content:

Scan conversions: lines, circles, ellipses. Filling algorithms, clipping algorithms. 2D and 3D transformation. Curves. Visible surface determination. Simple animations Application of these through exercises in C/C++/ Open GL

List of Desirable Experiments:

1. Study and apply basic opengl functions to draw basic primitives. (*)
2. Implement sierpinsky gasket using openGL.
3. Implement DDA Line Drawing algorithms and Bresenham algorithm(*)
4. Implement midpoint Circle algorithm(*)
5. Implement midpoint Ellipse algorithm
6. Implemen tArea Filling Algorithm: Boundary Fill, Flood Fill ,Scan line Polygon Fill (*)
7. Implement Curve : Bezier for n control points , B Spline (Uniform) (atleast one)(*)
8. Implement Fractal (Koch Curve)
9. Character Generation : Bit Map method and Stroke Method
10. Implement 2D Transformations: Translation, Scaling, Rotation, Reflection, Shear.(*)
11. Implement Line Clipping Algorithm: Cohen Sutherland / Liang Barsky.(*)
12. Implement polygon clipping algorithm(atleast one)
13. Program to represent a 3D object using polygon surfaces and then perform 3D transformation.
14. Program to perform projection of a 3D object on Projection Plane : Parallel and Perspective.(*)

Term Work

1. Term work should consist of at least 12 experiments. (*)→ Practical to be covered necessarily
2. Journal must include at least 2 assignments.
3. Mini Project to perform using C / OpenGL.

   Possible Ideas:

   a. Animation using multiple object
   b. Graphics editor with following features :

      *Draw basic geometrical entities; apply geometrical transformations, Area filling, Clipping against Clip window, displaying the text, displaying bar / line graphs , pie charts etc.

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

Term Work: 25 Marks (Total) = 10 Marks (Experiments)
+ 5 Marks (Mini Project)
+ 5 Marks (Assignments)
+ 5 Marks (Theory + Practical Attendance).

Oral & Practical exam will be based on the above content and CSC404: Computer Graphics.

Lab Code	Lab Name	Credit
CSL403	**Processor Architecture Lab**	**1**

Lab Objectives:

1. To implement the operation of the arithmetic unit including the algorithms & implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
2. To study the different ways of communicating with I/O devices and standard I/O interfaces.
3. To design memory subsystem including cache memory
4. To have through understanding of various computer buses

Lab Outcomes: At the end of the course student should be

1. Assemble personal computer
2. Design the basic building blocks of a computer: arithmetic-logic unit, registers, central processing unit, and memory.
3. Implement various algorithms like Booth's algorithm for arithmetic operations
4. Describe various I/O buses with merits and demerits.

Prerequisite: Digital Logic Design and Applications

Content:

Sr. No.	Module	Detailed Content
1	Overview of Computer Architecture & Organization	• Computer Anatomy- Memory, Ports, Motherboard and add-on cards • Dismantling and assembling PC
2	Programs on Data Representation and Arithmetic	• Ripple carry adder, Carry look-ahead adder, registers, Multiplication • Booths Algorithm, Restoring and Non restoring Division
3	Processor Organization and Architecture	• ALU Design, CPU Design • Case Study on multi-core Processors
4	Memory Organization	• Memory design, Cache Memory design
5	I/O Organization and Interrupts	• Case study on buses like ISA, PCI, USB etc • Interrupt handling using C/Java Programming

Digital Material:

- **Manual to use the simulator for computer organization and architecture.** Developed by the Department of CSE, IIT kharagpur (http://cse10-iitkgp.virtual-labs.ac.in/)

Books:

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", Pearson Publication, 10th Edition, 2013
2. B. Govindarajulu, "Computer Architecture and Organization: Design Principles and Applications", Second Edition, McGraw-Hill (India),
6. Andrew S. Tanenbaum "Structured Computer Organization", Pearson, Sixth Edition
7. Morris Mano. "Computer System Architecture" Pearson Publication, 3rd Edition, 2007
8. Kai Hwang, Fayé Alayé Briggs. "Computer architecture and parallel processing", McGraw-Hill
9. P. Pal Chaudhuri. "Computer Organization and Design" Prentice Hall India, 2004
10. Dr. M. Usha, T.S. Shrikant. "Computer System Architecture and Organization" Wiley India, 2014.

Term Work

Term work should consist of at least 10-12 experiments and 3-4 assignments based on above content and CSC403: Computer Organization and Architecture

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

Term Work: 25 Marks (Total) = 10 Marks (Experiments)
+ 5 Marks (Mini Project)
+ 5 Marks (Assignments)
+ 5 Marks (Theory + Practical Attendance).

Oral exam will be based on the above content and CSC403: Computer Organization and Architecture.

Lab Code	Lab Name	Credit
CSL404	**Operating System Lab**	**1**

Lab Outcome:

1. Understand basic operating system commands.
2. Understand and explore various system calls.
3. Write shell scripts and shell commands using kernel APIs.
4. Implement and analyze different process scheduling algorithms
5. Implement and analyze different memory management algorithms.
6. Evaluate process management techniques and deadlock handling using simulator.

Descriptions:

Sr. No	**Contents**
1	Explore the internal commands of linux like ls,chdir,mkdir,chown,chmod,chgrp,ps etc
2	Write shell scripts to do the following: ➢ Display top 10 processes in descending order ➢ Display processes with highest memory usage. ➢ Display current logged in user and logname. ➢ Display current shell, home directory, operating system type, current path setting, current working directory. ➢ Display OS version, release number, kernel version. ➢ Illustrate the use of sort, grep, awk, etc.
3	a) Create a child process in Linux using the fork system call. From the child process obtain the process ID of both child and parent by using getpid and getppid system call. Explore wait and waitpid before termination of process. b) Explore the following system calls: open, read, write, close, getpid, setpid, getuid, getgid, getegid, geteuid.
4	Implement basic commands of linux like ls, cp, mv and others using kernel APIs.
5	Write a program to implement any two CPU scheduling algorithms like FCFS, SJF, Round Robin etc.
6	Write a program to implement dynamic partitioning placement algorithms i.e Best Fit, First-Fit, Worst-Fit etc
7	Write a program to implement various page replacement policies.
8	Using the **CPU-OS simulator** analyze and synthesize the following: a. Process Scheduling algorithms. b. Thread creation and synchronization. c. Deadlock prevention and avoidance.

Digital Materials:

1. Download the CPU-OS simulator along with related tutorials from http://www.teach-sim.com
2. http://www.teach-sim.com

Books:

1. Linux Kernel Book, by Remy Card, Eric Dumas, Frank Mevel, Wiley India
2. Unix Concepts and Applications, Sumitabha Das, McGraw Hill.

Term Work:

- Term work should consist of at least 12 experiments and 2-3 assignments on above content.
- The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

- Term Work**:** 25 Marks (Total) = 10 Marks (Experiments)
  + 5 Marks (Mini Project)
  + 5 Marks (Assignments)
  + 5 Marks (Theory + Practical Attendance).

Oral & Practical exam will be based on the above content and CSC405: Operating system syllabus.

Lab Code	Lab Name	Credit
CSL405	**Open Source Technology Lab**	**2**

Course Outcomes:

1. To understand basic concepts in python and perl.
2. To explore contents of files, directories and text processing with python
3. To develop program for data structure using built in functions in python.
4. To explore django web framework for developing python based web application.
5. To understand file handling and database handling using perl.
6. To explore basics of two way communication between client and server using python and perl

Prerequisites: Knowledge of some programming language like C, Java

Content:

Sr. No	Module Name	Detailed Content
1	Python basics	Data types in python ,Operators in python, Input and Output, Control statement, Arrays in python, String and Character in python, Functions, List and Tuples, Dictionaries Exception, Introduction to OOP, Classes , Objects , Interfaces, Inheritance
2	Advanced Python	Files in Python, Directories, Building Modules, Packages, Text Processing, Regular expression in python.
3	Data Structure in Python	Link List, Stack, Queues, Dequeues
4	Python Integration Primer	Graphical User interface ,Networking in Python , Python database connectivity, Introduction to Django
5	Basics of Perl	Perl Overview, Variables, Control Statements, Subroutines, Objects, Packages and Modules
6	Perl advanced	Working with Files, Data manipulation, Database Systems, Networking

Text Books

1. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
2. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
3. Perl: The Complete Reference. Second Edition. Martin C. Brown, McGraw-Hill
4. Introduction to computing and problem solving using python , E Balagurusamy,McGraw Hill Education

Reference Book

1. Perl Black Book, 2nd Edition: Steven Holzner,Dreamtech Press
2. Learn Python the Hard Way: (3rd Edition) (Zed Shaw's Hard Way Series)
3. Python Projects , Laura Cassell,Alan Gauld,wrox publication

Digital Material:

1. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
2. Beginning Perl, https://www.perl.org/books/beginning-perl/
3. http://spoken-tutorial.org
4. www.staredusolutions.org

Suggested experiments using Python:

1. Exploring basics of python like data types (strings,list,array,dictionaries,set,tuples) and control
2. statements.
3. Creating functions, classes and objects using python. Demonstrate exception handling and inheritance.
4. Exploring Files and directories
   a. Python program to append data to existing file and then display the entire fille
   b. Python program to count number of lines, words and characters in a file.
   c. Python program to display file available in current directory
5. Creating GUI with python containing widgets such as labels, textbox,radio,checkboxes and custom dialog boxes.
6. Menu driven program for data structure using built in function for link list, stack and queues.
7. Program to demonstrate CRUD(**create, read, update and delete)** operations on database (SQLite/ MySQL) using python.
8. Creation of simple socket for basic information exchange between server and client.
9. Creating web application using Django web framework to demonstrate functionality of user login and registration (also validating user detail using regular expression).

Suggested experiments using Perl:

10. Exploring various data type , loops and conditional statement in perl. And Creating functions, packages and modules in perl.
11. Program to demonstrate use of objects and classes in perl.
12. Program to demonstrate file handling, data manipulation and use of regular expression for text processing in perl
13. Program to send email and read content of URL.

Term Work:

Students will submit term work in the form of journal that will include:

1. At least 12-14 programs.
2. One mini-project in a group 2-3 student.
3. Two assignments covering whole syllabus.

Term Work (25) = 15 marks (Experiments & Assignments)
+ 10 marks (Mini Project)
+ 05 marks (Attendance)

Practical and oral examination will be based on suggested practical list and entire syllabus.

AC 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, 8th 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”, 6th 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.

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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	ELL301	Electronics Devices and Circuits - I Lab	1
2	ELL302	Digital Logic Circuits Lab	1
3	ELL303	Electronic Instruments and Measurements Lab	1
4	ELC304	Electrical Networks Analysis and Synthesis	1
5	ELL304	Skill base Lab OOPM: (C++ and Java)	1
6	ELM301	Mini Project – 1A	1
7	ELL401	Electronics Devices and Circuits - II Lab	1
8	ELL402	Microcontroller Applications Lab	1
9	ELL403	Analog Communication Lab	1
10	ELL404	Skill Base Lab : Python Programming	1
11	ELM401	Mini Project - 1B	1
12	ETS506	Business Communication and Ethics	1
13	ETL501	Microcontrollers and Applications Laboratory	1
14	ETL502	Communication Engineering Laboratory I	1
15	ETL503	Communication Engineering Laboratory II	1
16	ETL504	Mini Project I	1
17	ETL601	Discrete Time Signal Processing Laboratory	1
18	ETL602	Communication Engineering Laboratory III	1
19	ETL603	Communication Engineering Laboratory IV	1
20	ETL604	Mini Project II	1
21	ETL701	Image and Video Processing Laboratory	1
22	ETL702	Advanced communication Engineering. Laboratory I	1
23	ETL703	Advanced communication Engineering. Laboratory II	1
24	ETEL70X	Elective	1
25	ETP701	Project (Stage I)	1
26	ETL801	Wireless Networks Laboratory	1
27	ETL802	Satellite communication and Networks Laboratory	1
28	ETL803	Internet and Voice Communication Laboratory	1
29	ETEL80X	Elective Laboratory	1
30	ETP801	Project (Stage II)	1
		Total	30

AC-11.05.2017
Item No. 4.307

UNIVERSITY OF MUMBAI

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

FACULTY OF TECHNOLOGY

Electronics and Telecommunication Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

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

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

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

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

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

Chairman’s Preamble:

The curriculum in higher education is a living entity. It evolves with time; it reflects the ever changing needs of the society and keeps pace with the growing talent of the students and the faculty. The engineering education in India is expanding in manifolds and the main challenge is the quality of education. All stakeholders are very much concerned about it. The curriculum of Electronics & Telecommunication in Mumbai University is no exception. In keeping with the demands of the changing times, it contains innovative features. The exposure to the latest technology and tools used all over the world is given by properly selecting the subjects. It is designed in such a way to incorporate the requirements of various industries. The major emphasis of this process is to measure the outcomes of the program. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of post-graduation. So the curriculum must be refined and updated to ensure that the defined objectives and outcomes are achieved.

I, as Chairman Ad-hoc Board of Studies in Electronics and Telecommunication Engineering, University of Mumbai, happy to state here that, the heads of the department and senior faculty from various institutes took timely and valuable initiative to frame the Program Educational objectives as listed below.

Objectives:

1. To produce Electronics & Telecommunication engineers, having strong theoretical foundation, good design experience and exposure to research and development.

2. To produce researcher who have clear thinking, articulation and interest to carry out theoretical and/or applied research resulting in significant advancement in the field of specialization.

3. To develop an ability to identify, formulate and solve electronics and telecommunication engineering problems in the latest technology.

4. To develop the ability among students to synthesize data and technical concepts from applications to product design.

These are the suggested and expected main objectives, individual affiliated institutes may add further in the list. I believe that the small step taken in the right direction will definitely help in providing quality education to the stake holders.

This book of curricula is the culmination of large number of faculty members and supporting staff. It also reflects the creative contribution of hundreds of teachers – both serving and retired. I sincerely hope that the faculty and students of Electronics and Telecommunication in Mumbai University will take full advantage of dynamic features of curriculum and make teaching-learning process a truly sublime experience for all.

At the end I must extend my gratitude to all experts and colleagues who contributed to make curriculum competent at par with latest technological development in the field of Electronics & Telecommunication Engineering.

Dr. Uttam D. Kolekar
Chairman, Ad-hoc Board of Studies in Electronics and Telecommunication Engineering

Program Structure for
B.E. Electronics & Telecommunication Engineering (Rev. 2016)
University of Mumbai
(With Effect from 2017-2018)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC301	Applied Mathematics- III	4	-	2@	4	1	5
ECC302	Electronic Devices and Circuits I	4	-	-	4	-	4
ECC303	Digital System Design	4	-	-	4	-	4
ECC304	Circuit Theory and Networks	4	-	2@	4	1	5
ECC305	Electronic Instrumentation and Control	4	-	2@	4	1	5
ECL301	Electronic Devices and Circuits I Laboratory	-	2	-	-	1	1
ECL302	Digital System Design Laboratory	-	2	-	-	1	1
ECL303	OOP using JAVA Laboratory	-	2	-	-	1	1
Total		**20**	**6**	**6**	**20**	**6**	**26**

@ 2 hour to be taken as tutorial classwise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC301	Applied Mathematics-III	20	20	20	80	03	25	--	125
ECC302	Electronic Devices and Circuits I	20	20	20	80	03	--	--	100
ECC303	Digital System Design	20	20	20	80	03	--	--	100
ECC304	Circuit Theory and Networks	20	20	20	80	03	25	--	125
ECC305	Electronic Instrumentation and Control	20	20	20	80	03	25	--	125
ECL301	Electronic Devices and Circuits I Laboratory	--	--	--	--	--	25	25	50
ECL302	Digital System Design Laboratory	--	--	--	--	--	25	25	50
ECL303	OOP using JAVA Laboratory	--	--	--	--	--	25	25	50
Total				**100**	**400**		**150**	**75**	**725**

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC401	Applied Mathematics- IV	4	-	2@	4	1	5
ECC402	Electronic Devices and Circuits II	4	-	-	4	-	4
ECC403	Linear Integrated Circuits	4	-	-	4	-	4
ECC404	Signals & Systems	4	-	2@	4	1	5
ECC405	Principles of Communication Engineering	4	-	-	4	-	4
ECL401	Electronic Devices and Circuits II Laboratory	-	2	-	-	1	1
ECL402	Linear Integrated Circuits Laboratory	-	2	-	-	1	1
ECL403	Principles of Communication Engineering Laboratory	-	2	-	-	1	1
Total		**20**	**6**	**4**	**20**	**5**	**25**

@ 2 hour to be taken as tutorial classwise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC401	Applied Mathematics- IV	20	20	20	80	03	25	--	125
ECC402	Electronic Devices and Circuits II	20	20	20	80	03	--	--	100
ECC403	Linear Integrated Circuits	20	20	20	80	03	--	--	100
ECC404	Signals & Systems	20	20	20	80	03	25	--	125
ECC405	Principles of Communication Engineering	20	20	20	80	03	--	--	100
ECL401	Electronic Devices and Circuits II Laboratory	--	--	--	--	--	25	25	50
ECL402	Linear Integrated Circuits Laboratory	--	--	--	--	--	25	25	50
ECL403	Principles of Communication Engineering Laboratory	--	--	--	--	--	25	25	50
Total				**100**	**400**		**125**	**75**	**700**

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC501	Microprocessor & Peripherals Interfacing	4	-	-	4	-	4
ECC502	Digital Communication	4	-	-	4	-	4
ECC503	Electromagnetic Engineering	4	-	1@	4	1	5
ECC504	Discrete Time Signal Processing	4	-	-	4	-	4
ECCDLO 501X	Department Level Optional Course I	4	-	-	4	-	4
ECL501	Microprocessor & Peripherals Interfacing Lab	-	2	-	-	1	1
ECL502	Digital Communication Lab	-	2	-	-	1	1
ECL503	Business Communication & Ethics Lab	-	2+2*	-	-	2	2
ECL504	Open Source Technology for Communication Lab	-	2	-	-	1	1
ECLDLO 501X	Department Level Optional Lab I	-	-	2#	-	1	1
Total		**20**	**10**	**3**	**20**	**7**	**27**

@ 1 hour to be taken as tutorial classwise #2 hours to be taken as either lab or tutorial based on subject requirement
*2 hours to be taken as tutorial batchwise

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral/ Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC501	Microprocessor & Peripherals Interfacing	20	20	20	80	03	--	--	100
ECC502	Digital Communication	20	20	20	80	03	--	--	100
ECC503	Electromagnetic Engineering	20	20	20	80	03	25	--	125
ECC504	Discrete Time Signal Processing	20	20	20	80	03	--	--	100
ECCDLO 501X	Department Level Optional Course I	20	20	20	80	03	--	--	100
ECL501	Microprocessor & Peripherals Interfacing Lab	--	--	--	--	--	25	25	50
ECL502	Digital Communication Lab	--	--	--	--	--	25	25	50
ECL503	Business Communication & Ethics Lab	--	--	--	--	--	50	--	50
ECL504	Open Source Technology for Communication Lab	--	--	--	--	--	25	25	50
ECLDLO 501X	Department Level Optional Lab I	--	--	--	--	--	25	--	25
Total				**100**	**400**		**175**	**75**	**750**

Course Code	Department Level Optional Course I
ECCDLO 5011	Microelectronics
ECCDLO 5012	TV & Video Engineering
ECCDLO 5013	Finite Automata Theory
ECCDLO 5014	Data Compression and Encryption

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC601	Microcontrollers & Applications	4	-	--	4	--	4
ECC602	Computer Communication Networks	4	-	-	4	-	4
ECC603	Antenna & Radio Wave Propagation	4	-	-	4	-	4
ECC604	Image Processing and Machine Vision	4	-	--	4	--	4
ECCDLO 602X	Department Level Optional Course II	4	-	-	4	-	4
ECL601	Microcontroller & Applications Lab	-	2	-	-	1	1
ECL602	Computer Communication Network Lab	-	2	-	-	1	1
ECL603	Antenna & Radio Wave Propagation Lab	-	2	-	-	1	1
ECL604	Image Processing and Machine Vision Lab	-	2	-	-	1	1
ECLDLO 602X	Department Level Optional Lab II	-	2	-	-	1	1
Total		**20**	**10**	-	**20**	**5**	**25**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC601	Microcontroller& Applications	20	20	20	80	03	--	--	100
ECC602	Computer Communication Network	20	20	20	80	03	--	--	100
ECC603	Antenna & Radio Wave Propagation	20	20	20	80	03	--	--	100
ECC604	Image Processing and Machine Vision Lab	20	20	20	80	03	--	--	100
ECCDLO 602X	Department Level Optional Course II	20	20	20	80	03	--	--	100
ECL601	Microcontroller & Applications Lab	--	--	--	--	--	25	25	50
ECL602	Computer Communication Network Lab	--	--	--	--	--	25	25	50
ECL603	Antenna & Radio Wave Propagation Lab	--	--	--	--	--	25	25	50
ECL604	Image Processing and Machine Vision Lab	--	--	--	--	--	25	25	50
ECLDLO 602X	Department Level Optional Lab II	--	--	--	--	--	25	--	25
Total				**100**	**400**		**125**	**100**	**725**

Course Code	Department Level Optional Course II
ECCDLO 6021	Digital VLSI Design
ECCDLO 6022	Radar Engineering
ECCDLO 6023	Database Management System
ECCDLO 6024	Audio Processing

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC701	Microwave Engineering	4	-	-	4	-	4
ECC702	Mobile Communication System	4	-	-	4	-	4
ECC703	Optical Communication	4	-	--	4	-	4
ECCDLO 703X	Department Level Optional Course III	4	-	-	4	-	4
ILO701X	Institute Level Optional Course I	3	-	-	3	-	3
ECL701	Microwave Engineering Lab	-	2	-	-	1	1
ECL702	Mobile Communication System Lab	-	2	-	-	1	1
ECL703	Optical Communication Lab	-	2	-	-	1	1
ECLDLO 703X	Department Level Optional Lab III	-	2	-	-	1	1
ECL704	Project-I	-	6	-	-	3	3
Total		**19**	**14**	-	**19**	**7**	**26**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC701	Microwave Engineering	20	20	20	80	03	--	--	100
ECC702	Mobile Communication System	20	20	20	80	03	--	--	100
ECC703	Optical Communication	20	20	20	80	03	--	--	100
ECCDLO 703X	Department Level Optional Course III	20	20	20	80	03	--	--	100
ILO701X	Institute Level Optional Course I	20	20	20	80	03	--	--	100
ECL701	Microwave Engineering Lab	--	--	--	--	--	25	25	50
ECL702	Mobile Communication System Lab	--	--	--	--	--	25	25	50
ECL703	Optical Communication Lab	--	--	--	--	--	25	25	50
ECLDLO 703X	Department Level Optional Lab III	--	--	--	--	--	25	25	50
ECL704	Project-I	--	--	--	--	--	50	50	100
Total				**100**	**400**		**150**	**150**	**800**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I#
ECCDLO7031	Neural Networks and Fuzzy Logic	ILO7011	Product Lifecycle Management
ECCDLO7032	Big Data Analytics	ILO7012	Reliability Engineering
ECCDLO7033	Internet Communication Engineering	ILO7013	Management Information System
ECCDLO7034	CMOS Mixed Signal VLSI	ILO7014	Design of Experiments
ECCDLO7034	Embedded System	ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

 # Common with all branches

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pracs	Tut	Theory	TW/ Pracs	Total
ECC801	RF Design	4	-	--	4	--	4
ECC802	Wireless Networks	4	-	-	4	-	4
ECCDLO 804X	Department Level Optional Course IV	4	-	-	4	-	4
ILO802X	Institute Level Optional Course II	3	-	-	3	-	3
ECL801	RF Design Lab	-	2	-	-	1	1
ECL802	Wireless Networks Lab	-	2	-	-	1	1
ECLDLO 804X	Department Level Optional Lab IV	-	2	-	-	1	1
ECL803	Project-II	-	12	-	-	6	6
Total		**15**	**18**	**-**	**15**	**9**	**24**

Course Code	Course Name	Examination Scheme							
		Theory					TW	Oral & Prac	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ECC801	RF Design	20	20	20	80	03	--	--	100
ECC802	Wireless Networks	20	20	20	80	03	--	--	100
ECCDLO 804X	Department Level Optional Course IV	20	20	20	80	03	--	--	100
ILO802X	Institute Level Optional Course II	20	20	20	80	03	--	--	100
ECL801	RF Design Lab	--	--	--	--	--	25	25	50
ECL802	Wireless Networks Lab	--	--	--	--	--	25	25	50
ECLDLO 804X	Department Level Optional Lab IV	--	--	--	--	--	25	25	50
ECL803	Project-II	--	--	--	--	--	100	50	150
Total				**80**	**320**		**175**	**125**	**700**

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II#
ECCDLO8041	Optical Networks	ILO8021	Project Management
ECCDLO8042	Advanced Digital Signal Processing	ILO8022	Finance Management
ECCDLO8043	Satellite Communication	ILO8023	Entrepreneurship Development and Management
ECCDLO8044	Network management in Telecommunication	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

 # Common with all branches

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC301	Applied Mathematics-III	04	--	@2	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC301	Applied Mathematics-III	20	20	20	80	25	--	--	125

@ 2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Applied Mathematics I
- Applied Mathematics II

Course Objectives:

1. To build the strong foundation in Mathematics of students needed for the field of electronics and Telecommunication Engineering
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice.
4. To prepare students to work as part of teams on multi-disciplinary projects.

Course Outcome:

After successful completion of the course student will be able to

1. Students will demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable.
2. Students will demonstrate an ability to identify and Model the problems of the field of Electronics and Telecommunication and solve it.
3. Students will be able to apply the application of Mathematics in Telecommunication Engineering

Module No.	Unit No.	Detailed Content	Hours
1		**Laplace Transform**	**07**
	1.1	Laplace Transform (LT) of Standard Functions: Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace transform of $e^{at}, Sin(at), cos(at), sinh(at), cosh(at), t^{n}$ Heaviside unit step function, Dirac-delta function, Laplace transform of Periodic function	
	1.2	Properties of Laplace Transform: Linearity, first shifting theorem, second shifting theorem, multiplication by t^{n}, Division by *t*, Laplace Transform of derivatives and integrals, change of scale, convolution theorem, Evaluation of integrals using Laplace transform.	
2		**Inverse Laplace Transform & its Applications**	**06**
	2.1	Partial fraction method, Method of convolution, Laplace inverse by derivative	
	2.2	Applications of Laplace Transform: Solution of ordinary differential equations, Solving RLC circuit differential equation of first order and second order with boundary condition using Laplace transform (framing of differential equation is not included)	
3		**Fourier Series**	**11**
	3.1	Introduction: Orthogonal and orthonormal set of functions, Introduction of Dirchlet's conditions, Euler's formulae.	
	3.2	Fourier Series of Functions: Exponential, trigonometric functions of any period =2L, even and odd functions, half range sine and cosine series	
	3.3	Complex form of Fourier series, Fourier integral representation, Fourier Transform and Inverse Fourier transform of constant and exponential function.	
4		**Vector Algebra & Vector Differentiation**	**07**
	4.1	Review of Scalar and Vector Product: Scalar and vector product of three and four vectors, Vector differentiation, Gradient of scalar point function, Divergence and Curl of vector point function	
	4.2	Properties: Solenoidal and irrotational vector fields, conservative vector field	

5		**Vector Integral**	**06**
	5.1	Line integral	
	5.2	Green's theorem in a plane, Gauss' divergence theorem and Stokes' theorem	
6		**Complex Variable & Bessel Functions**	**11**
	6.1	Analytic Function: Necessary and sufficient conditions (No Proof), Cauchy Reiman equation Cartesian form (No Proof) Cauchy Reiman Equation in polar form (with Proof), Milne Thomson Method and it application, Harmonic function, orthogonal trajectories	
	6.2	Mapping: Conformal mapping, Bilinear transformations, cross ratio, fixed points	
	6.3	Bessel Functions: Bessel's differential equation, Properties of Bessel function of order +1/2 and -1/2, Generating function, expression of cos(xsinθ), sin (x sinθ) in term of Bessel functions	

Note: Term Work should be based on Tutorials.

Textbooks :

1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Murry R. Spieget, *"Vector Analysis",* Schaum's outline series, Mc-Graw Hill Publication

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC302	Electronic Devices & Circuits-I	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC302	Electronic Devices & Circuits-I	20	20	20	80	--	--	--	100

Course Pre-requisite:
- Basic Electrical Engineering
- Applied Physics

Course Objectives:
1. To understand operation of semiconductor devices.
2. To understand DC analysis and AC models of semiconductor devices.
3. To apply concepts for the design of Regulators and Amplifiers
4. To verify the theoretical concepts through laboratory and simulation experiments.
5. To implement mini projects based on concept of electronics circuit concepts.

Course Outcome:
After successful completion of the course student will be able to
1. Understand the current voltage characteristics of semiconductor devices,
2. Analyze dc circuits and relate ac models of semiconductor devices with their physical Operation,
3. Design and analyze of electronic circuits,
4. Evaluate frequency response to understand behaviour of Electronics circuits.

Module No.	Unit No.	Detailed Content	Hours
1		**Diode and material science**	**06**
	1.1	Study of various types of resistor, capacitor and inductors	
	1.2	Basic fabrication steps of passive elements.	
	1.3	PN junction Diode characteristics, small signal model	
2		**Rectifier, Filters and Regulator**	**08**
	2.1	Analysis and design of rectifier circuit with Filters (L, LC, C,CLC,CRC)	
	2.2	Concept of load and line regulation in power supply circuits.	
	2.3	Analysis and design of zener voltage regulator	
3		**Transistor biasing and design**	**08**
	3.1	Operation of BJT, FET (N-CHANNEL, P-CHANNEL) with characteristics and equation.	
	3.2	Bipolar Junction Transistor: BJT characteristics, DC/AC load line, DC analysis and design of fixed bias, collector to base bias and voltage divider bias, stability factor analysis	
	3.3	Junction Field Effect Transistor: Analysis and design of self-bias and voltage divider bias, zero temp drift biasing.	
4		**Transistor modeling and Small signal analysis of amplifier**	**12**
	4.1	Hybrid and hybrid-pi model of BJT with graphical representation.	
	4.2	Small signal model of FET with graphical representation.	
	4.3	Small signal analysis (Zi, Zo, Av and Ai) of CE, CB, and CC configurations using hybrid-pi model of BJT	
	4.4	small signal (mid-frequency) analysis of CS, CD and CG amplifiers using FET	
5		**High frequency response of BJT and FET amplifiers**	**08**
	5.1	High frequency hybrid-pi equivalent Circuits of BJT and FET, Miller effect and Miller capacitance, gain bandwidth product	
	5.2	Effects of capacitors on frequency response of single stage amplifier using BJT and FET	
	5.3	Analysis of single stage amplifiers at HF and gain bandwidth product.	

6		**Design of small signal amplifiers**	**06**
	6.1	Design of single stage RC Coupled CE amplifier.	
	6.2	Design of single stage RC Coupled CS amplifier. (USE of parameters from data sheet compulsory)	

Textbooks :

1. D. A. Neamen, *"Electronic Circuit Analysis and Design,"* Tata McGraw Hill, 2ndEdition.
2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, *"Microelectronic Circuits Theory and Applications,"* International Version, OXFORD International Students, 6thEdition
3. R. S. Dudhe and M. Farhan, "*Electronic Devices and Circuits*," Synergy Knowledgeware, 1st Edition, 2013.

Reference Books:

1. Boylestad and Nashelesky, "*Electronic Devices and Circuits Theory*," Pearson Education, 11th Edition.
2. A. K. Maini , "*Electronic Devices and Circuits*," Wiley.
3. T. L. Floyd, "*Electronic Devices,"*Prentice Hall, 9th Edition, 2012.
4. A. Rockett, "*Material Science of Semiconductors*,", Springer, 1stEdition, 2009
5. A. Mottershead, "*Electronic Devices and Circuits; An Introduction,*"

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC303	Digital System Design	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC303	Digital System Design	20	20	20	80	--	--	--	100

Course Objectives:

1. To understand number representation and conversion between different representation in digital electronic circuits.
2. To analyze logic processes and implement logical operations using combinational logic circuits.
3. To understand characteristics of memory and their classification.
4. To understand concepts of sequential circuits and to analyze sequential systems in terms of state machines.
5. To understand concept of Programmable Devices, PLA, PAL, CPLD and FPGA and implement digital system using VHDL.
6. To implement combinational and sequential circuits using VHDL.

Course Outcome:

After successful completion of the course student will be able to

1. Develop a digital logic and apply it to solve real life problems.
2. Analyze, design and implement combinational logic circuits.
3. Classify different semiconductor memories.
4. Analyze, design and implement sequential logic circuits.
5. Analyze digital system design using PLD.
6. Simulate and implement combinational and sequential circuits using VHDL systems.

Module No.	Unit No.	Detailed Content	Hours
1		**Number Systems and Codes**	**04**
	1.1	Review of Number System, Binary Code, Binary Coded Decimal, Octal Code, Hexadecimal Code and their conversions, Binary Arithmetics, Gray Code	
2		**Logic Gates and Combinational Logic Circuits**	**18**
	2.1	Analog and Digital signals and systems, Logic levels, TTL and CMOS Logic families and their characteristics	
	2.2	Digital logic gates, Realization using NAND, NOR gates, Boolean Algebra, De Morgan's Theorem, SOP and POS representation, K Map up to four variables and Quine-McClusky method	
	2.3	Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Serial and Parallel Addition, Carry Look ahead adder and BCD adder. Binary Multiplier, Magnitude Comparator,	
	2.4	Multiplexer and De-multiplexer: Multiplexer operations, cascading of Multiplexer, Boolean Function implementation using multiplexer and basic gates, de-multiplexer, encoder and decoder	
3		**Different Types of Memory**	**02**
		Classification and Characteristics of memory, SRAM, DRAM, ROM, PROM, EPROM and Flash memories	
4		**Sequential Logic Circuits:**	**12**
	4.1	Flip flops: RS, JK, Master slave flip flops; T & D flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO, Universal shift registers.	
	4.2	Counters: Asynchronous and Synchronous, Up/Down, MOD N, BCD	
	4.3	Applications of Sequential Circuits: Frequency division, Ring Counter, Johnson Counter. models, State transition diagram, Design of Moore and Mealy circuits-Design of Serial Adder and vending Machine	
	4.4	State Reduction Techniques: Row elimination and Implication table methods	
5		**Programmable Logic Devices:**	**09**
		Introduction : Programmable Logic Devices (PLD),	

		Programmable Logic Array (PLA), Programmable Array Logic(PAL), CPLD and FPGA, Keyboard Encoder system design using PLD	
6		**VHSIC Hardware Description Language (VHDL)**	**03**
	6.1	Data types, Structural modeling using VHDL, Attributes, Data Flow behavioral, Implementation of Priority Encoder-combinational circuit and Fibonacci Series Generator-sequential circuits using VHDL	

Textbooks :

1. John F. Warkerly, "*Digital Design Principles and Practices*", Pearson Education, Fourth Edition (2008).
2. R. P. Jain, "*Modern Digital Electronics*", Tata McGraw Hill Education, Third Edition (2003).
3. J. Bhaskar, "*VHDL Primer"*, PHI, Third Edition (2009).
4. Volnei A. Pedroni, "*Digital Electronics and Design with VHDL*" Morgan Kaufmann Publisher (2008)

Reference Books:

1. Morris Mano / Michael D. Ciletti, "*Digital Design"*, Pearson Education, Fourth Edition (2008).
2. Thomas L. Floyd, "*Digital Fundamentals*", Pearson Prentice Hall, Eleventh Global Edition (2015).
3. Mandal, "*Digital Electronics Principles and Applications*", McGraw Hill Education, First Edition (2010).
4. Stephen Brown & Zvonko Vranesic, "*Fundamentals of Digital Logic Design with VHDL*", Second Edition, TMH (2009).
5. Ronald J. Tocci, Neal S. Widmer, "*Digital Systems Principles and Applications*", Eighth Edition, PHI (2003)
6. Donald P. Leach / Albert Paul Malvino/Gautam Saha, "*Digital Principles and Applications"*, The McGraw Hill, Seventh Edition (2011).

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC304	Circuit Theory and Networks	04	--	@2	04	--	1	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC304	Circuit Theory and Networks	20	20	20	80	25	--	--	125

@ 2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Basic Electrical Engineering
- Solution to Differential Educations and Laplace Transform

Course Objectives:

1. To analyze the Circuits in time and frequency domain
2. To study network Topology, network Functions, two port network
3. To synthesize passive network by various methods

Course Outcome:

After successful completion of the course student will be able to

1. Apply their knowledge in analysing Circuits by using network theorems.
2. Apply the time and frequency method of analysis.
3. Find the various parameters of two port network.
4. Apply network topology for analyzing the circuit
5. Synthesize the network using passive elements.

Module No.	Unit No.	Detailed Content	Hours
1		**Electrical circuit analysis**	**08**
	1.1	Analysis of DC & AC Circuits: Analysis of Circuits with and without controlled sources using generalized loop and node matrix methods Circuit Theorems: Superposition, Thevenin's, Norton's, maximum power transfer and reciprocity theorems	
	1.2	Magnetic circuits: Concept of Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit Coupled circuit- solution using mesh analysis	
2		**Graph Theory**	**08**
	2.1	Objectives of graph theory, Linear Oriented Graphs, graph terminologies Matrix representation of a graph: Incidence matrix, Circuit matrix, Cut-set matrix, reduced incident matrix, tieset matrix, f-cutset matrix.	
	2.2	Relationship between sub matrices A, B & Q.	
	2.3	KVL & KCL using matrix	
3		**Time and frequency domain analysis**	**08**
	3.1	Time domain analysis of R-L and R-C Circuits: Forced and natural response, initial and final values Solution using first order differential equation for impulse, step, ramp, exponential & sinusoidal signals	
	3.2	Time domain analysis of R-L-C Circuits: Forced and natural response, effect of damping factor. Solution using second order equation for step, ramp, exponential & sinusoidal signals.	
	3.3	Frequency domain analysis: Frequency - domain representation of R, L,C , initial value theorem & final value theorem, applications of Laplace Transform in analyzing electrical circuits	
4		**Network functions**	**08**
	4.1	Network functions for the one port and two port networks, Driving point and transfer functions, Poles and Zeros of Network functions, necessary condition for driving point functions, necessary condition for transfer functions, calculation of residues by analytical and graphical methods,	

		Time domain behavior as related to the Pole-Zero plot Stability & causality, testing for Hurwitz polynomial	
	4.2	Analysis of ladder & symmetrical lattice network	
5		**Two port Networks**	**08**
	5.1	Parameters: Open Circuits, short Circuit, Transmission and Hybrid parameters, relationship among parameters, conditions for reciprocity and symmetry	
	5.2	Interconnections of Two-Port networks T & π representation.	
	5.3	Terminated two-port networks	
6		**Synthesis of RLC circuits**	**08**
	6.1	Positive Real Functions: Concept of positive real function , testing for necessary and sufficient conditions for Positive real Functions	
	6.2	Synthesis of LC, RC & RL Circuits: properties of LC, RC & RL driving point functions, LC, RC & RL network Synthesis in Cauer-I & Cauer-II , Foster-I & Foster-II forms	

Note: Term Work should be based on Tutorials.

Textbooks :

1. Franklin F Kuo, *"Network Analysis and Synthesis",* Wiley Toppan, 2nd.ed. 1966
2. M E Van Valkenburg, *"Network Analysis",* Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000

Reference Books:

1. A Chakrabarti*, "Circuit Theory",* Dhanpat Rai & Co., Delhi, 6h Edition
2. A. Sudhakar, Shyammohan S. Palli "circuits and Networks, Tata McGraw-Hill education
3. Smarajit Ghosh, Network Theory Snallysis & Syntshesis, PHI learning
4. K.S. Suresh Kumar, Elecric circuit analysis, Pearson (2013)
5. D Roy Choudhury, Networks and Systems, New Age International 1998.

TUTORIALS: At least 10 tutorials covering various topics of the syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC305	Electronic Instrumentation & Control	04	--	@2	04	--	1	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC305	Electronic Instrumentation & Control	20	20	20	80	25	--	--	125

@ 2 hour to be taken as tutorial classwise

Course Pre-requisite:
- Basic Electrical Engineering

Course Objectives:
1. To provide basic knowledge about the various sensors and data acquisition systems applied in Wireless sensor network.
2. To provide fundamental concepts of control system such as mathematical modeling, time response and frequency response.
3. To develop concepts of stability and its assessment criteria.

Course Outcome:
After successful completion of the course student will be able to
1. Students will be able to explain principle of operation for various sensors.
2. Students will be able to describe functional blocks of data acquisition system.
3. Students will be able to find transfer functions for given system.
4. Students will be able to calculate time domain and frequency domain parameter for given system
5. Students will be able to predict stability of given system using appropriate criteria.

Module No.	Unit No.	Detailed Content	Hours
1		**Principle of Measurement, Testing and Measuring instruments**	**07**
	1.1	Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration.	
	1.2	Measurement of Resistance: Kelvin's double bridge, Wheatstone bridge and Mega ohm bridge Measurement of Inductance: Maxwell bridge and Hey bridge Measurement of Capacitance: Schering bridge Q-Meter: Operating principle and applications Energy and power meters: Working of energy and power meter	
2		**Sensors and Transducers**	**08**
	2.1	Basics of sensors and Transducers-Active and passive transducers, characteristics and selection criteria of transducers, working principle of Eddy-current sensors, Pizoelectric transducers, photoelectric and photovoltaic sensors, capacitive sensors	
	2.2	Displacement and pressure- Potentiometers, pressure gauges, linear Variable differential transformers(LVDT) for measurement of pressure and displacement strain gauges	
	2.3	Temperature Transducers- Resistance temperature detectors(RTD). Thermistors and thermocouples , their ranges and applications	
3		**Telemetry and Data Acquisition System**	**08**
	3.1	Introduction and characteristics, Landline Telemetry, Radio Telemetry Types of Multiplexing Systems,	
	3.2	Data Acquisition: Components of Analog and Digital Data Acquisition System,	
	3.3	Uses of Data Acquisition System, Use of recorders in Digital systems, Modern Digital Data Acquisition System.	
4		**Introduction to control system Analysis**	**07**

	4.1	Introduction: Open and closed loop systems, example of control systems	
	4.2	Modelling: Modelling, Transfer function model of electrical systems, Block diagram reduction techniques and Signal flow graph	
	4.3	Dynamic Response: Standard test signals, transient and steady state behaviour of first and second order systems , steady state errors in feedback control systems and their types	
5		**Stability Analysis in Time Domain**	**08**
	5.1	Concept of stability: Routh and Hurwitz stability criterion	
	5.2	Root locus Analysis: Root locus concept, general rules for constructing root-locus ,root locus analysis of control system, concept of design of lag and lead compensator	
6		**Stability Analysis in frequency domain**	**10**
	6.1	Introduction: Frequency domain specification, Relationship between time and frequency domain specification of system,stability margins	
	6.2	Bode Plot: Magnitude and phase plot, Method of plotting Bode plot,Stability margins and analysis using bode plot. Frequency response analysis of RC,RL,RLC circuits	
	6.3	Nyquist Criterion: Concept of Polar plot and Nyquist plot, Nyquist stability criterion ,gain and phase margin	

Note: Term Work should be based on Tutorials.

Textbooks :

1. A.K. Sawhney, "*Electrical & Electronic Measurement & Instrumentation"* – DRS . India
2. M.M.S. Anand, "*Electronic Instruments and instrumentation Technology"*.
3. H.S.Kalsi, "*Electronic Instrumentation"*-TMH, 2nd Edition.
4. Nagrath, M.Gopal, "*Control System Engineering*", Tata McGraw Hill.
5. K.Ogata, "*Modern Control Engineering*, Pearson Education", IIIrd edition.

Reference Books:

1. Helfrick&Copper, "*Modern Electronic Instrumentation & Measuring Techniques"* – PHI
2. W.D. Cooper, "*Electronic Instrumentation And Measuring Techniques"* – PHI
3. Benjamin C.Kuo, "*Automatic Control Systems*, Eearson education", VIIth edition

4. Rangan C. S., Sarma G. R. and Mani V. S. V., "*Instrumentation Devices And Systems*", Tata McGraw-Hill, 2nd Ed., 2004.
5. Bell David A."*Electronic Instrumentation and Measurements*", PHI Pearson Education, 2006.
6. Madan Gopal, "*Control Systems Principles and Design"*, Tata McGraw hill, 7th edition,1997.
7. Normon, "*Control System Engineering"*, John Wiley & sons, 3rd edition.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL301	Electronic Devices & Circuits-I Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL301	Electronic Devices & Circuits-I Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Maximum of 8 practicals including **minimum 2 simulations** should be conducted based on following topics

- Study of different measuring instruments such as CRO, Function Generator, Multimeter, and Power Supply. (Compulsory)
- Filter circuits
- Biasing of BJT and FET
- Frequency response
- Zener regulator
- Single stage amplifiers

Minimum One project based on:

- Design of single stage CE and CS amplifier
- Design of filter and regulator circuits
- Design of power supply
- Any other relevant topic based on syllabus

Note : Small project should be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise**". Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.
The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL302	Digital System Design Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL302	Digital System Design Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Maximum of 8 practicals including **minimum 2 simulations** should be conducted.

Suggested list of experiments:

1. Verify different logic gates.
2. Simplification of Boolean functions.
3. Verify Universal gates NAND and NOR and design EXOR and EXNOR gates using Universal gates.
4. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
5. Implement BCD adder using four bit binary adder IC-7483.
6. Flip flops conversion JK to D, JK to T and D to TFF.
7. Implement logic equations using Multiplexer.
8. Design synchronous MOD N counter using IC-7490.
9. Verify encoder and decoder operations.
10. Implement digital circuits to perform binary to gray and gray to binary operations.
11. Verify truth table of different types of flip flops.
12. Verify different counter operations.
13. Write VHDL simulation code for different logic gates.
14. Write VHDL simulation code for combinational and sequential circuits
15. Write VHDL simulation code for 4:1 Multiplexer, 2 line to 4 line binary decoder

Minimum One project

Suggested list of Mini Projects:
1. Design Clock pulse generator.
2. Design Clap operated remote control for Fan.
3. Design BCD counter and show operation on Seven Segment Display.
4. Design digital stop watch.
5. Write VHDL code to implement traffic light controller.
6. Design water level indicator for overhead water tank.
7. Design frequency divider circuit.
8. Design switch debounce circuit.
9. Design sequence generator circuit.
10. Design sequence detector circuit.
11. Design Even/Odd parity generator/checker circuit.
12. Design simple LED flasher circuit.
13. Design digital dice.
14. Design fastest finger first indicator.
15. Design Toggle switch using TFF.

<u>Note : Small project should be considered as a part of term-work.</u>

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.
The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL303	OOP using JAVA laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL303	OOP using JAVA laboratory	--	--	--	--	25	25	--	50

Course Pre-requisites:

- Fundamentals of C-Programming
- Control Structures
- Arrays and String

Course Objectives:

1. To understand Object Oriented Programming and its principles.
2. To describe & explain keywords and Data types.
3. Able to implement Methods, Constructors, Arrays, Multithreding and Applet
4. To help students to understand how to use a programming language to resolve problems.

Course Outcomes:

1. Students will be able to code a program using JAVA constructs.
2. Students will be able to understand fundamental features of an object oriented language: object classes and interfaces, exceptions and libraries of object collections.
3. Students will be able to develop a program that efficiently implements the algorithm for given tasks.
4. Students will be able to utilize the knowledge acquired in this course to develop higher level algorithms.

Module No.	Unit No.	Detailed Content	Hours
1		**Fundamental Concepts of Object Oriented Programming**	**06**
	1.1	Introduction to Object-Oriented Programming	
	1.2	Classes, Objects, Creating Classes and Objects, Principles of OOP**:** Abstraction, Encapsulation, Inheritance, Polymorphism	
	1.3	Differences And Similarity Between C and Java	
2		**Fundamental Of Java Programming**	**08**
	2.1	Features of Java, JDK Environment & Tools, Structure of Java Program	
	2.2	Java Keywords, Super Keyword, Final Keyword, Abstract Class	
	2.3	Data Types, Variables, Operators,Expressions	
	2.4	Input Output Using Scanner Class	
	2.5	Exception Handling, Object-Oriented Containers	
3		**Method, Constructors, Destructors And Arrays**	**04**
	3.1	Passing and Returning Parameters to Methods	
	3.2	Constructor and Types, Destructor	
	3.3	Arrays and Types**:** Create, One Dimensional Arrays, Two Dimensional Array, Multidimensional Array, String Array	
4		**Inheritance, Interface And Package**	**04**
	4.1	Types of Inheritance: Single, Multilevel, Hierarchical	
	4.2	Method Overloading and Method Overriding	
	4.3	Interface	
	4.4	Packages	
5		**Multithreading And Applet**	**04**
	5.1	Life Cycle Of Thread	
	5.2	Priority In Multithreading	
	5.3	Applet Life Cycle	
	5.4	Creating Applet, Applet Tag	

Textbooks :

1. Herbert Schidt, "*The Complete Reference*", Tata McGraw-Hill Publishing Company Limited, Ninth Edition
2. D.T. Editorial Services ,"*Java 8 Programming Black Book*", Dreamtech Press, Edition: 2015
3. Yashwant Kanitkar,"*Let Us Java*", BPB Publications; 2nd Edition edition.

Reference Books:

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

Software Tools:

1. Raptor-Flowchart Simulation:http://raptor.martincarlisle.com/
2. Eclipse: https://eclipse.org/
3. Netbeans:https://netbeans.org/downloads/
4. CodeBlock:http://www.codeblocks.org/
5. J-Edit/J-Editor/Blue J

Online Repository:

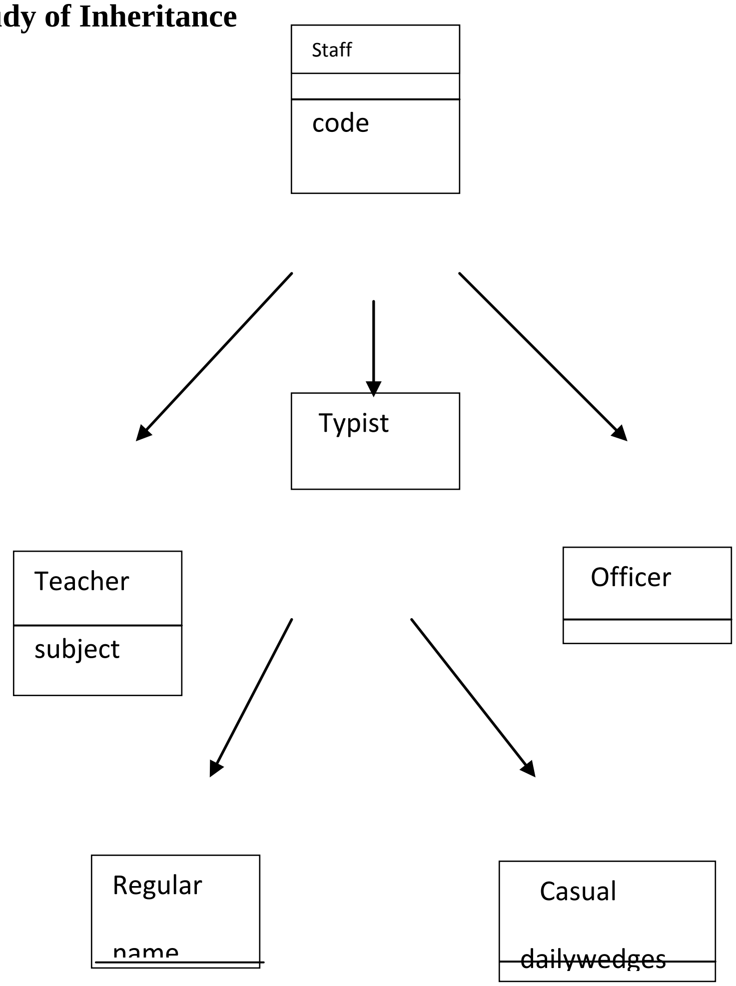
1. Google Drive
2. GitHub
3. Code Guru

Laboratory plan

Maximum of 8 practicals including **minimum 2 simulations** should be conducted based on following topics

Section	Experiment Name	Module
1.	**Write a program using command line argument in java.** • Echoing Command-Line Arguments. • Parsing Numeric Command-Line arguments.	Module 1
2.	**Study of simple java programs** • WAP to calculate area & circumference of circle • WAP to swap given two strings • WAP to separate out digits of a number • WAP to convert temperature from Fahrenheit to Celsius • WAP to find a square , squarroot, and Cube of a given no. using abstraction	Module 1
3.	**Study of different operators in java** • WAP to compare two numbers. • WAP to print truth table for java logical operators • WAP to read the number & shift left & right by 3 bits.	Module 1
4.	**Write a program for various ways of accepting data through keyboard & display its content.** • Read through DataInputstream. • Read input through Scanner. • Read input through BufferedReader.	Module 2
5.	**Study of Arrays** Write a program for addition, subtraction and multiplication of two matrices.	Module 3
6.	**Study of Objects and Classes** • Define a class to represent a bank account. Include the following members: Data: name of the depositor account number	Module 3

	type of account balance amount in the account Methods: 1.to assign initial values 2.to deposit an amount 3.to withdraw an amount after checking balance. 4.to display the name & balance • WAP using this keyword	
7.	**Study of Strings**. Accept the two strings from user & do the following operations • convert to lowercase • convert to uppercase • Replace all appearance of one character by another • Compare two strings • Derive the substring of a string • Derive the position of a character in a string • Calculate the length of a string • Derive the nth character of a string	Module 2
8.	**WAP to implement following constructors** • Default constructor • Parameterized constructor	Module 3
9.	**Study of Interface**. Create an interface Area & implement the same in different classes Rectangle ,circle ,triangle.	Module 4
10.	**Study of utility package** • WAP to generate a year using random class and check whether it is leap or not. • Write a program to display current date. Also display Time in hours &	Module 4

	Minutes using Date class.	
11.	**Study of Inheritance** 	Module 4
12.	**Study of Exception Handling in java**. Write a program to use throw finally and try catch to handle exception.	Module 2

13.	**Study of Multithreading.** WAP to illustrate function yield(), isAlive(), sleep(), join(). Create three threads as P,Q,R. Thread P has maximum priority, thread Q has minimum priority, thread R has normal priority.	Module 5
14.	**Study graphics using applet.** WAP to draw all geometric shapes and fill them with different colors.	Module 5

Minimum One project
Suggested list of mini projects

1. Inventory Control System
2. Develop Calculator
3. Develop Editor (Example: Notepad)
4. Devlop Multimedia App to teach primary students (Sahpes, Colors, etc.)
5. Create an audio or video applet or swing based application with play, pause and stop options.

<u>Note : Small project should be considered as a part of term-work.</u>

Term Work:

At least **10** experiments covering entire syllabus should be set to have well predefined inference and conclusion.

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.
The practical and oral examination will be based on entire syllabus.
Students are encourages to share their experiments/mini project codes on online repository.

Practical from any 10 sections out of 14 sections is compulsory . Practical exam slip should cover all at least 10 sections.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC401	Applied Mathematics-IV	04	--	@2	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC401	Applied Mathematics-IV	20	20	20	80	25	--	--	125

@2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Applied Mathematics I
- Applied Mathematics II
- Applied Mathematics III

Course Objectives:

1. To build the strong foundation in Mathematics of students needed for the field of Electronics and Telecommunication Engineering
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice.
4. To prepare students to work as part of teams on multi-disciplinary projects

Course Outcome:

After successful completion of the course student will be able to

1. Demonstrate basic knowledge of Calculus of variation, Vector Spaces, Matrix Theory, Random Variables, Probability Distributions, Correlation and Complex Integration.
2. Demonstrate an ability to identify and Model the problems in the field of Electronics and Telecommunication and solve it.
3. Apply the application of Mathematics in Telecommunication Engineering.

Module No.	Unit No.	Detailed Content	Hours
1		**Calculus of Variation:**	**06**
	1.1	Euler's Langrange equation, solution of Euler's Langrange equation (only results for different cases for Function) independent of a variable, independent of another variable, independent of differentiation of a variable and independent of both variables	
	1.2	Isoperimetric problems, several dependent variables	
	1.3	Functions involving higher order derivatives: Rayleigh-Ritz method	
2		**Linear Algebra: Vector Spaces**	**06**
	2.1	Vectors in n-dimensional vector space: properties, dot product, cross product, norm and distance properties in n-dimensional vector space.	
	2.2	Vector spaces over real field, properties of vector spaces over real field, subspaces	
	2.3	The Cauchy-Schwarz inequality, Orthogonal Subspaces, Gram-Schmidt process	
3		**Linear Algebra: Matrix Theory**	10
	3.1	Characteristic equation, Eigen values and Eigen vectors, properties of Eigen values and Eigen vectors.	
	3.2	Cayley-Hamilton theorem (without proof), examples based on verification of Cayley- Hamilton theorem.	
	3.3	Similarity of matrices, Diagonalisation of matrices.	
	3.4	Functions of square matrix, derogatory and non-derogatory matrices.	
4		**Probability**	**10**
	4.1	Baye's Theorem (without proof)	
	4.2	Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function, expectation, variance.	
	4.3	Moments, Moment Generating Function.	

	4.4	Probability distribution: Binomial distribution, Poisson & normal distribution (For detailed study)	
5		**Correlation**	**04**
	5.1	Karl Pearson's coefficient of correlation, Covariance, Spearman's Rank correlation,	
	5.2	Lines of Regression.	
6		**Complex integration**	**12**
	6.1	Complex Integration:Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula.	
	6.2	Taylor's and Laurent's Series	
	6.3	Zeros, singularities, poles of f(z), residues, Cauchy's Residue theorem.	
	6.4	Applications of Residue theorem to evaluate real Integrals of different types.	

Note: Term Work should be based on Tutorials.

Textbooks :

1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication
4. P.N.Wartilar&J.N.Wartikar, "*A Text Book of Applied Mathematics*" Vol. I & II, Vidyarthi Griha Prakashan, Pune

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Seymour Lipschutz "*Beginning Linear Algebra*" Schaum's outline series, Mc-Graw Hill Publication
5. SeymourLipschutz "*Probability*" Schaum's outline series, Mc-Graw Hill Publication

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC402	Electronic Devices & Circuits-II	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC402	Electronic Devices & Circuits-II	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Electronic Devices & Circuits-I

Course Objectives:

1. To understand the operation of the various bias circuits of MOSFET and Analyze and design MOSFET bias circuits.
2. To understand the operation and design of multistage amplifier for a given specification.
3. To understand the operation and design of transformer coupled various types of power amplifier circuits.
4. To understand the effects of negative feedback on amplifier circuits.
5. To analyze the different *RC* and *LC* oscillator circuits to determine the frequency of oscillation.

Course Outcome:

After successful completion of the course student will be able to

1. Design and analyse the basic operations of MOSFET.
2. Know about the multistage amplifier using BJT and FET in various configuration to determine frequency response and concept of voltage gain.
3. Know about different power amplifier circuits, their design and use in electronics and communication circuits.
4. Know the concept of feedback amplifier and their characteristics.
5. Design the different oscillator circuits for various frequencies

Module No.	Unit No.	Detailed Content	Hours
1		**Introduction to MOSFET**	**08**
	1.1	MOSFET - Symbol, Types of MOSFET - Depletion and Enhancement type MOSFET (N channel and P channel),	
	1.2	Construction, Operation, and V-I characteristics of MOSFET	
	1.3	MOSFET biasing - Types of Depletion & enhancement MOSFET biasing,	
	1.4	MOSFET as amplifier	
2		**Introduction of Multistage amplifiers**	**06**
	2.1	RC coupled, transformer coupled, direct coupled,	
	2.2	Low and high frequency considerations of cascade amplifier, cascode amplifier (CE-CB), Darlington pair amplifier.	
3		**Design of Multistage amplifiers**	**10**
		Analysis and design considerations of multistage amplifiers (CE-CE, CS-CS, CS-CE,), effect of source and load resistance	
4		**Large signal amplifiers**	**08**
	4.1	Harmonic distortion and power efficiency of Class A, B, AB, and C amplifiers	
	4.2	Design of Class A, Class B, and Push-Pull Power amplifier design.	
	4.3	Thermal considerations and design selection of heat sinks.	
5		**Feedback amplifiers**	**08**
	5.1	Feedback concept, ideal feedback amplifier, classification of feedbacks, Various topologies	
	5.2	Analysis and design of different types of negative feedback.	
6		**Oscillators**	**08**
	6.1	Principle of oscillation, RC oscillator, twin T oscillator	
	6.2	Oscillator with LC feedback. Colpitts oscillator, Hartley oscillator, Crystal controlled oscillator.	
	6.3	Design of different oscillator circuits.	

Textbooks :

1. D. A. Neamen, *"Electronic Circuit Analysis and Design,"* Tata McGraw Hill, 2ndEdition.
2. R. L. Boylestad,"Electronic Devices and Circuit Theory," Pearson, 11thEdition.
3. T. F. Bogart,"Electronic Devices And Circuit," Merrill, 6thEdition.
4. R. S. Dudhe and M. Farhan, "Electronic Devices and Circuits," Synergy Knowledgeware, 1st Edition

Reference Books:

1. Salivahanan, N. Suresh Kumar,"*Electronic Devices and Circuits*," Tata McGraw Hill, 3rdEdition
2. J. Millman, Christos CHalkias, and Satyabratatajit, Millman's,"*Electronic Devices and Circuits*," McGrawHill, 3rdEdition
3. Muhammad H. Rashid, "*Microelectronics Circuits Analysis and Design*," Cengage Learning, 2ndEdition.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC403	Linear Integrated Circuits	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC403	Linear Integrated Circuits	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Basic Electrical Engineering
- Electronic Devices & Circuits-I

Course Objectives:

1. To understand the concepts, working principles and key applications of linear integrated circuits.
2. To perform analysis of circuits based on linear integrated circuits.
3. To design circuits and systems for particular applications using linear integrated circuits.

Course Outcome:

After successful completion of the course student will be able to

1. Understand the fundamentals and areas of applications for the integrated circuits.
2. Analyze important types of integrated circuits.
3. Demonstrate the ability to design practical circuits that perform the desired operations.
4. Understand the differences between theoretical, practical & simulated results in integrated circuits.
5. Select the appropriate integrated circuit modules to build a given application.

Module No.	Unit No.	Detailed Content	Hours
1		**Introduction to operational amplifiers**	**08**
	1.1	Analysis of differential amplifier circuit configurations using FETs, Effect of Swamping resistor, Current sources using FETs, Widlar current source, Wilson current source, Voltage sources and references, DC level shifters.	
	1.2	Ideal & Practical Operational Amplifiers, Operational amplifier characteristics, Operational amplifier parameters, Operational amplifier open loop and closed loop configurations.	
2		**Applications of Operational Amplifier**	**08**
	2.1	Amplifiers: Inverting, non-inverting, buffer, summing & difference amplifiers, integrator & differentiator (ideal & practical), current amplifier, instrumentation amplifier, log and antilog amplifiers..	
	2.2	Converters: Current to voltage converters, voltage to current converters, voltage to frequency converter, frequency to voltage converter.	
	2.3	Active Filters: Second order active low pass, high pass, band pass and band reject filters, Introduction to switch capacitor filters.	
	2.4	Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.	
3		**Non-Linear Applications of Operational Amplifier**	**08**
	3.1	Comparators: Inverting comparator, non-inverting comparator, zero crossing detector, window detector, peak detector, sample & hold circuits.	
	3.2	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.	
	3.3	Waveform Generators: Square wave generator and triangular wave generator.	
	3.4	Precision Rectifiers: Half wave and full wave precision rectifiers.	
4		**Analog to Digital and Digital to Analog Convertors**	**08**
	4.1	Performance specifications of ADC, single ramp ADC, ADC using DAC, dual slope ADC, successive approximation ADC.	
	4.2	Performance specifications of DAC, binary weighted resistor DAC, R/2R ladder DAC, inverted R/2R ladder DAC.	
5		**Special Purpose Integrated Circuits**	**08**
	5.1	Functional block diagram and working of IC 555, design of astable and monostable multivibrator using IC 555, application	

		of IC 555 as pulse position modulator, pulse width modulator and Schmitt Trigger.	
	5.2	Functional block diagram and working of VCO IC 566 and application as frequency modulator, Functional block diagram and working of PLL IC 565 and application as FSK Demodulator, Functional block diagram and working of multiplier IC 534andapplication as a phase detector, Functional block diagram and working of waveform generator XR 2206 and application as sinusoidal FSK generator.	
6		**Voltage Regulators**	**08**
	6.1	Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM 337) voltage regulators.	
	6.2	Functional block diagram, working and design of general purpose 723 (LVLC, LVHC, HVLC and HVHC) with current limit and current fold-back protection, Switching regulator topologies, Functional block diagram and working of LT1070 monolithic switching regulator.	

Textbooks :

1. Ramakant A. Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Pearson Prentice Hall, 4th Edition.
2. K. R. Botkar, "*Integrated Circuits*", Khanna Publishers (2004)
3. D. Roy Choudhury and S. B. Jain, "*Linear Integrated Circuits*", New Age International Publishers, 4th Edition.

Reference Books:

1. Sergio Franco, "*Design with operational amplifiers and analog integrated circuits*", Tata McGraw Hill, 3rd Edition.
2. David A. Bell, "*Operation Amplifiers and Linear Integrated Circuits*", Oxford University Press, Indian Edition.
3. R. F. Coughlin and F. F. Driscoll, "*Operation Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6th Edition.
4. "J. Millman, Christos CHalkias, and Satyabratatajit, Millman's,"Electronic Devices and Circuits," McGrawHill, 3rdEdition".

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC404	Signals and Systems	04	--	2@	04	--	01	05

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC404	Signals and Systems	20	20	20	80	25	--	--	125

@2 hour to be taken as tutorial classwise

Course Pre-requisite:

- Applied Maths-III
- Circuit Theory and Networks

Course Objectives:

1. To introduce students the concept and theory of signals and systems needed in electronics and telecommunication engineering fields.
2. To introduce students to the basic idea of signal and system analysis and its characterization in time and frequency domain

Course Outcome:

After successful completion of the course student will be able to

1. Understand about various types of signals and systems, classify them, analyze them, and perform various operations on them,
2. Understand use of transforms in analysis of signals and system in continuous and discrete time domain.
3. Observe the effect of various properties and operations of signals and systems.
4. Evaluate the time and frequency response of Continuous and Discrete time systems which are useful to understand the behaviour of electronic circuits and communication systems.

Module No.	Unit No.	Detailed Content	Hours
1		**Introduction to signals and systems**	**08**
	1.1	Introduction to signals: Definition, sampling theorem, sampling of continuous time signals, elementary signals: exponential, sine, step, impulse, ramp, rectangular, triangular, signum, sinc, operations on signals,	
	1.2	Classification of signals: Continuous and discrete time, deterministic and non-deterministic, periodic and aperiodic, symmetric (even) and asymmetric (odd), energy and power, causal and anti-causal signal, Case study of different signals from communication and biomedical field	
	1.3	Introduction to systems: Definition, Classification of systems: Static and dynamic, time variant and time invariant, linear and nonlinear, causal and non-causal, stable and unstable systems., communication and control system as examples	
2		**Time domain analysis of continuous time and discrete time systems**	**08**
	2.1	Representation of systems using differential /difference equation, Impulse, step and exponential response, system stability	
	2.2	Use of convolution integral and convolution sum for analysis of LTI systems, properties of convolution integral/sum, impulse response of interconnected systems	
	2.3	Correlation and spectral Density**:** auto-correlation, cross correlation, analogy between correlation and convolution, energy spectral density, power spectral density, relation of ESD,PSD with auto-correlation	
3		**Frequency domain analysis of continuous and discrete signals:**	**10**
	3.1	**Review of Fourier series:** Trigonometric and exponential Fourier series representation of signals, Gibbs phenomenon, Discrete Time Fourier Series, properties, analogy between Continuous Time Fourier Series (CTFS) and Discrete Time Fourier Series (DTFS).	
	3.2	**Fourier Transform (FT):** Fourier Transform and Inverse Fourier Transform on periodic and non-periodic signals, limitations of CT/DT Fourier Transform and need for Laplace/Z Transform.	
	3.3	**Overview of Laplace Transform:** Need of Laplace Transform, review of unilateral and bilateral Laplace	

		Transform, properties, inverse of Laplace Transform, concept of Region of Convergence (ROC),poles and zeros, relation between continuous time Fourier Transform and Laplace Transform.	
4		**Z-Transform**	**08**
	4.1	Need of Z-Transform, definition of unilateral and bilateral Z-Transform, Z-Transform of finite and infinite duration sequences, properties, Inverse Z-Transform, relation between discrete time Fourier Transform and Z-Transform, Z-Transform of standard signals, ROC for ZT, plotting poles and zeros of transfer function.	
	4.2	Analysis of discrete time LTI systems using Z-Transform: Transfer Function, causality and stability of systems, frequency response (impulse and step), relation between Laplace Transform and Z–Transform.	
5		**State Space Analysis and Realization Structures**	**08**
	5.1	State Variable Analysis: Introduction to the notion of 'state', systematic procedure for determining state equations, solution of state equations using Laplace transform, definition of $exp(A)$ where A is a matrix, time domain solution of state equations.	
	5.2	Systems with finite duration and infinite duration, impulse response, recursive and non-recursive discrete time system, realization structures: direct form–I, direct form–II, Transpose, cascade, and parallel forms.	
6		**Applications of Signals and Systems**	**06**
	6.1	Signal Processing Applications: Speech and Audio Processing, Multimedia (image & video) processing, Underwater acoustic signal processing, Biological signal analysis	
	6.2	Communication and Control System Application: Modulation (Analog and Digital) process, Feedback/Feedforward Control system	

Textbooks :

1. NagoorKani, "*Signals and Systems*", Tata McGraw Hill, Third Edition, 2011.
2. B.P. Lathi, "*Principles of Linear Systems and Signals*", Oxford, Second Edition, 2010.
3. S. L. Nalbalwar, A. M. Kulkarni and S. P. Sheth, "*Signals and Systems*", Synergy Knowledgeware, 2016.
4. Simon Haykin and Barry Van Veen, "*Signals and 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. NarayanaIyer, "*Signals and Systems"*, Cenage Learning, First Edition 2011.
4. Michael J Roberts, "*Fundamentals of Signals and systems*", Tata McGraw Hill, special Indian Economy edition, 2009.
5. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, "*Signals and Systems"*, Pearson Education, Fourth Edition 2009.
6. Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, "*Signals and Systems*", Prentice-Hall of India, Second Edition, 2002.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC405	Principles of Communication Engineering	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECC405	Principles of Communication Engineering	20	20	20	80	--	--	--	100

Course Pre-requisite:

- Applied Maths III
- Electronic Devices and Circuits I

Course Objectives:

1. To introduce students to various modulation and demodulation techniques of analog communication.
2. To analyze different parameters of analog communication techniques.
3. To study pulse modulation and demodulation.

Course Outcome:

After successful completion of the course student will be able to

1. Use different modulation and demodulation techniques used in analog communication
2. Identify and solve basic communication problems
3. Analyze transmitter and receiver circuits
4. Compare and contrast design issues, advantages, disadvantages and limitations of analog communication systems

Module No.	Unit No.	Detailed Content	Hours
1		**Basics of Communication System**	**06**
	1.1	Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels, Introduction to time and frequency domain.	
	1.2	Types of noise, signal to noise ratio, noise figure and noise temperature, Friss transmission formula.	
2		**Amplitude Modulation and Demodulation**	**12**
	2.1	Basic concepts, signal representation, need for modulation	
	2.2	Spectrum, waveforms, modulation index, bandwidth, voltage distribution and power calculations	
	2.3	DSBFC: Principles, modulating circuits, low level and high level transmitters DSB suppressed carrier :Multiplier modulator, nonlinear modulator and switching modulator	
	2.4	Amplitude demodulation: Diode detector, practical diode detector, square law detector	
	2.5	Comparison of different AM techniques, Applications of AM and use of VSB in broadcast television	
3		**Angle Modulation and Demodulation**	**12**
	3.1	Frequency modulation (FM): Basic concept, mathematical analysis, spectrum of FM wave, sensitivity, phase deviation and modulation index, deviation and percent modulated waves, bandwidth requirement of angle modulated waves, deviation ratio, narrowband FM and wideband FM	
	3.2	Varactor diode modulator, FET reactance modulator, stabilized AFC, Direct FM transmitter, indirect FM Transmitter, noise emphasis and de-emphasis	
	3.3	Phase modulation (PM): Principle and working of transistor direct PM modulator and relationship and comparison between FM and PM	
	3.4	FM demodulation: Balance slope detector, Foster-Seely discriminator, ratio detector, FM demodulator using Phase lock loop (PLL), amplitude limiting and thresholding, comparison between FM demodulators, comparison between AM, FM and PM	
	3.5	Applications of FM and PM	

4		**Radio Receivers**	**06**
	4.1	TRF, Super - heterodyne receiver, receiver parameters and choice of IF	
	4.2	AM receiver circuits and analysis, simple AGC, delayed AGC, forward AGC, and communication receiver	
	4.3	FM receiver circuits, comparison with AM receiver	
	4.4	Single and independent sideband (SSB and ISB) receivers	
5		**Analog Pulse Modulation & Demodulation**	**08**
	5.1	Sampling theorem for low pass signal, proof with spectrum, Nyquist criteria	
	5.2	Sampling techniques, aliasing error and aperture effect	
	5.3	PAM,PWM, PPM generation and detection	
	5.4	Applications of Pulse Communication	
6		**Multiplexing & De-multiplexing**	**04**
	6.1	Frequency Division Multiplexing transmitter & receiver block diagram	
	6.2	Time Division Multiplexing transmitter & receiver block diagram	
	6.3	Examples and applications of FDM and TDM	

Textbooks :

1. Kennedy and Davis, "*Electronics Communication System*", Tata McGraw Hill, Fourth edition.
2. B.P. Lathi, Zhi Ding "*Modern Digital and Analog Communication system*", Oxford University Press, Fourth edition.
3. Wayne Tomasi, "*Electronics Communication Systems*", Pearson education, Fifth edition.

Reference Books:

1. Taub, Schilling and Saha, "*Taub's Principles of Communication systems*", Tata McGraw Hill, Third edition.
2. P. Sing and S.D. Sapre, "*Communication Systems: Analog and Digital*", Tata McGraw Hill, Third edition.
3. Simon Haykin, Michel Moher, "*Introduction to Analog and Digital Communication*", Wiley, Second edition.

4. Dennis Roddy and John Coolen, "*Electronic Communication*", Prentice Hall, Third Edition.
5. Louis Frenzel, “*Communication Electronics*”, Tata McGraw Hill, Third Edition.
6. Roy Blake, "*Electronic Communication Systems*", Delmar Publication, Second edition

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL401	Electronic Devices & Circuits-II Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL401	Electronic Devices & Circuits-II Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Minimum 8 practicals including **minimum 2 simulations** should be conducted.

Suggested list of experiments

1. Design and Analyze two stage BJT amplifier (Frequency response and performance parameters)
2. Design and Analyze two stage FET amplifier (Frequency response and performance parameters)
3. Design Multistage BJT amplifier and finding its parameters, Verify.
4. Design and Analyze Voltage series feedback amplifier using BJT/FET and verify its effect on frequency response. x
5. Design and Analyze Current series feedback using BJT/FET and verify its effect on frequency response.
6. Design Multistage JFET amplifier and finding its parameters, verify.
7. Design and Analyze RC Phase shift oscillator for different amplitude and frequency.
8. Design and Analyze Colpitt / Hartley oscillator for different amplitude and frequency.
9. Class C power amplifier and its efficiency

Minimum One project based on:

1. Simple Emergency light.
2. DC servo amplifier using MOSFET.
3. Audio tone control circuit.
4. Public address system.
5. Automatic Door Bell

6. Clapp Switch
7. **Topic related to syllabus**

<u>Note :Small project should be considered as a part of term-work.</u>

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit andGrading System"** manual and should be added and averaged. Based on above scheme gradingand term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL402	Linear Integrated Circuits Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL402	Linear Integrated Circuits Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Minimum 8 practicals including **minimum 2 simulations** should be conducted.

Suggested list of experiments

1. Discrete Differential Amplifier
2. Inverting, Non inverting, Buffer, Summing & Difference amplifiers
3. Differentiator & Integrator
4. Instrumentation amplifier
5. I to V and V to I converters
6. V to F and F to V convertors
7. Active Filters
8. Wien Bridge Oscillator
9. RC Phase shift Oscillator
10. Inverting & Non inverting Schmitt trigger
11. Square & Triangular wave generator
12. Precision rectifiers
13. Peak detector & Sample & Hold Circuits
14. Analog to Digital converter

15. Digital to Analog converter
16. Multivibrators using IC 555
17. PPM, PWM and Schmitt trigger using 555
18. Frequency modulatorusing VCO IC 566.
19. FSK DemodulatorusingPLL IC 565.
20. Phase detectorusing multiplier IC 534.
21. Sinusoidal FSK generator using XR 2206
22. Voltage Regulators using 78XX/79XX, 317/337, 723

Minimum One project based on:

1. Variable Power Supply
2. Data Acquisition System
3. Function Generator
4. Topic related to syllabus

Note :Small project should be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise**". Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit andGrading System"** manual and should be added and averaged. Based on above scheme gradingand term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECL403	Principles of Communication Engineering Laboratory	--	02	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECL403	Principles of Communication Engineering Laboratory	--	--	--	--	25	25	--	50

Laboratory plan

Minimum 8 practicals including **minimum 2 simulations** should be conducted.

Suggested list of experiments

1. Generation and detection of AM (DSB-FC, DSB-SC,SSB) signal.
2. Generation and detection of FM signal.
3. Study of AM broadcast receiver (Super heterodyne).
4. Generation of PAM signal and verify the sampling theorem.
5. Generation of PPM, PWM signal.
6. Study of TDM and FDM multiplexing techniques.

Suggested list of Minimum projects

1. AM transmitter /receiver.
2. FM transmitter /receiver.
3. PAM,PPM,PWM circuits with IC 555
4. FM remote encoder/decoder circuits,
5. Transistor Intercom circuit
6. Walkie -Talkie Circuit
7. Arduino based communication circuits

8. Electronic voting machine.
9. Electronic Notice Board Using Android.
10. Home security system.

Note :Small project should be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "**Laboratory session batch wise"**. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time. The grades will be converted to marks as per "**Choice Based Credit and Grading System"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

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**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ETC501	**Microcontroller & Applications**	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					
ETC501	**Microcontroller & Applications**	20	20	20	80	-	-	-	100

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	
3		**Fundamental Concept of Digital Video**	12
	3.1	Digitization, pixel array, scanning notation, viewing distance and angle, aspect ratio, frame rate and refresh rate.	
	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 **c**haracteristics 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, **f**iber gratings, Fabry Perot filters, **a**rrayed 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

<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>Practical</th><th>Tutorial</th><th>Total</th></tr>
<tr><td>ETC 802</td><td>Satellite Communication and Network</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
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<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</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>ETC 802</td><td>Satellite Communication and Network</td><td>20</td><td>20</td><td>20</td><td>80</td><td>-</td><td>-</td><td>-</td><td>100</td></tr>
</table>

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	CHL301	Industrial and Engineering Chemistry I Lab	1
2	CHL302	Fluid Flow Operation Lab	1
3	CHL303	Basic Chemical Engineering Lab	1
4	CHL304	Skilled Based Lab: Chemical Technology Lab	1
5	CHM301	Mini Project 1A	1
6	CHL401	Industrial and Engineering Chemistry II Lab	1
7	CHL402	Numerical Method in Chemical Engineering Lab	1
8	CHL403	Solid Fluid Mechanical Operation Lab	1
9	CHL404	Skilled based lab: Design Calculation of Auxiliary Plant Equipment	1
10	CHM401	Mini Project 1B	1
11	CHC506	Business Communication & Ethics	1
12	CHL507	Chemical Engg Lab (MTO-I)	1
13	CHL508	Chemical Engg Lab (CRE-I)	1
14	CHL509	Chemical Engg Lab (HTO-I)	1
15	CHL510	Chemical Engg Lab (Synthesis)	1
16	CHL607	Chemical Engg Lab (MTO-II)	1
17	CHL608	Chemical Engg Lab (CRE-II)	1
18	CHL609	Chemical Engg Lab (HTO-II)	1
19	CHL707	Chemical Engg Lab (PED)	1
20	CHL708	Chemical Engg Lab (PDC)	1
21	CHL807	Chemical Engineering Lab (EE)	1
22	CHL808	Chemical Engg Lab (MSO)	1
		Total	22

AC: 11-05-2017
Item No. 4.189

UNIVERSITY OF MUMBAI

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

Chemical Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**
Under

FACULTY OF TECHNOLOGY

As per **Choice Based Credit and Grading System**
With effect from the AY 2016–17

From Coordinator's Desk

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

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

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Credit grading based system was implemented for Second Year of B.E. in Chemical Engineering from the academic year 2017-2018. This system is carried forward for Third Year of B.E. in Chemical Engineering in the academic year 2018-2019 and will be implemented for Fourth Year B.E. in the year 2019-2020 respectively.

Dr. S. K. Ukarande

Co-ordinator,

Faculty of Technology,

Member - Academic Council

University of Mumbai, Mumbai

Preamble to the Revision of Syllabus in Chemical Engineering

To match the increasing pace of development in all fields including Chemical Engineering and Biotechnology along with use of softwares for process plant and process engineering, there is demand on academician to upgrade the curriculum in Education. The availability of free software such as Scilab, DW SIM expand the boundaries of learning. Hence, the Undergraduate Curriculum in Chemical Engineering must provide the necessary foundation for a Chemical Engineer to be able to specialize in any area as and when the need and opportunity arise. The Curriculum must integrate knowledge of the basic and advanced sciences with problem solving abilities and inclusion of technological development. The Curriculum must be broad enough to cover all areas from design to operation of Process plants. It should be deep enough to enable the learners to carry out research and develop products to meet rapidly changing needs and demands. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program.

With these objectives, a meeting was organized at Thadomal Shahani Engineering College Bandra on 17th November 2016 which was attended by Industries experts, heads of the departments and subject faculty of affiliating Institutes. The program objectives and outcomes were thoroughly discussed in this meeting and the core structure of the syllabus was formulated keeping in mind choice based credit and grading system curriculum to be introduced in this revised syllabus for B.E. (Chemical Engineering) for all semesters. Views from experts and UG teachers were taken into consideration and final Academic and Exam scheme was prepared with the consent of all the members involved. Subject wise meetings were held to finalize the detail syllabus in Bharati Vidyapeeth College of Engineering on 13th Jan 2017, SS Jondhale College of Engineering on 27th Jan 2017, Datta Meghe College of Engineering Airoli on 20th February 2017 and 13th April 2017 and in D. J. Sanghavi College of Engineering on 17th April 2017.

The Program Educational Objectives finalized for the undergraduate program in Chemical Engineering are:

1. To prepare the student for mathematical, scientific and engineering fundamentals
2. To motivate the student to use modern tools for solving real life problems
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities.
4. To prepare the student in achieving excellence in their career in Indian and Global Market.

Dr. Kalpana S. Deshmukh,

Chairman, Board of Studies in Chemical Engineering (Adhoc),

University of Mumbai

General Guidelines

Tutorials

- The number of tutorial batches can be decided based on facilities available in the institution.
- Tutorials can be creative assignments in the form of models, charts, projects, etc.

Term Work

- Term work will be an evaluation of the tutorial/practical done over the entire semester.
- It is suggested that each tutorial/practical be graded immediately and an average be taken at the end.
- A minimum of eight tutorials/ten practical will form the basis for final evaluation.
- The total 25 marks for term work (except project and seminar) will be awarded as follows:

  Tutorial / Practical Journal – 20 marks

  Overall Attendance – 05

  Further, while calculating marks for attendance, the following guidelines shall be adhered to:

  75 % to 80%. – 03 marks

  81% to 90% - 04 marks

  91% onwards – 05 marks

Theory Examination

- In general all theory examinations will be of 3 hours duration.
- Question paper will comprise of total six questions, each of 20 Marks.
- Only four questions need to be solved.
- Question one will be compulsory and based on maximum part of the syllabus.

Note:

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

Practical Examination:

- Duration for practical examination would be the same as assigned to the respective Lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Project and Seminar Guidelines

- Project Groups: Students can form groups with minimum 2 (Two) and not more than 3 (Three)
- The load for projects may be calculated proportional to the number of groups, not exceeding two hours per week.
- The load for projects may be calculated as:
  Sem VII: ½ hr for teacher per group.
  Sem VIII: 1 hr for teacher per group.
- Each teacher should have ideally a maximum of three groups and only in exceptional cases four groups can be allotted to the faculty.
- Seminar topics will be the consensus of the project guide and the students. Each student will work on a unique topic.
- The load for seminar will be calculated as one hour per week irrespective of the number of students
- Students should spend considerable time in applying all the concepts studied, into the project. Hence, eight hours each were allotted in Project A, B and three hours for Seminar to the students.

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
S.E. Semester III (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC301	Applied Mathematics-III	3	-	1	3	-	1	4
CHC302	Engineering Chemistry I	4	-	-	4	-	-	4
CHC303	Fluid Flow Operations (FFO)	4	-	-	4	-	-	4
CHC304	Chemical Engineering Thermodynamics I	3	-	1	3	-	1	4
CHC305	Process Calculations	3	-	1	3	-	1	4
CHC306	Chemical Technology	4	-	-	4	-	-	4
CHL301	Engineering Chemistry-I Lab	-	3	-	-	1.5	-	1.5
CHL302	Chemical Engineering Lab I (FFO)	-	3	-	-	1.5	-	1.5
CHL303	Chemical Engineering Lab II (Synthesis)	-	2	-	-	1	-	1
	Total	21	8	3	21	4	3	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC301	Applied Mathematics-III	20	20	20	80	3	25	-	-	125
CHC302	Engineering Chemistry I	20	20	20	80	3	-	-	-	100
CHC303	Fluid Flow (FF)	20	20	20	80	3	-	-	-	100
CHC304	Chemical Engineering Thermodynamics I	20	20	20	80	3	25	-	-	125
CHC305	Process Calculations	20	20	20	80	3	25	-	-	125
CHC306	Chemical Technology	20	20	20	80	3	-	-	-	100
CHL301	Engineering Chemistry-I Lab	-	-	-	-	3	-	25	-	25
CHL302	Chemical Engineering Lab I (FFO)	-	-	-	-	3	25	25	-	50
CHL303	Chemical Engineering Lab II (Synthesis)	-	-	-	-	-	25	-	25	50
	Total			120	480	-	125	50	25	800

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
S.E. Semester IV (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC401	Applied Mathematics-IV	3	-	1	3	-	1	4
CHC402	Engineering Chemistry II	4	-		4	-	-	4
CHC403	Chemical Engineering Thermodynamics II	3	-	1	3	-	1	4
CHC404	Solid Fluid Mechanical Operations (SFMO)	4	-	-	4	-	-	4
CHC405	Mechanical Equipment Design (MED)	4	-	-	4	-	-	4
CHC406	Chemical Engineering Economics	3	-	1	3	-	1	4
CHL401	Engineering Chemistry-II Lab	-	3	-	-	1.5	-	1.5
CHL402	Chemical Engineering Lab III (SFMO)	-	3	-	-	1.5	-	1.5
CHL403	MED Lab	-	2	-	-	1	-	1
	Total	21	8	2	21	4	3	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC401	Applied Mathematics-IV	20	20	20	80	3	25	-	-	125
CHC402	Engineering Chemistry II	20	20	20	80	3	-	-	-	100
CHC403	Chemical Engineering Thermodynamics II	20	20	20	80	3	25	-	-	125
CHC404	Solid Fluid Mechanical Operations (SFMO)	20	20	20	80	3	-	-	-	100
CHC405	Mechanical Equipment Design (MED)	20	20	20	80	3	-	-	-	100
CHC406	Chemical Engineering Economics	20	20	20	80	3	25	-	-	125
CHL401	Engineering Chemistry-II Lab	-	-	-	-	3	-	25	-	25
CHL402	Chemical Engineering Lab III (SFMO)	-	-	-	-	3	25	25	-	50
CHL403	MED Lab	-	-	-	-	-	25	-	25	50
	Total			120	480	-	125	50	25	800

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
T.E. Semester V (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC501	Computer programming and Numerical Methods	4	-	-	4	-	-	4
CHC502	Mass transfer Operations-I (MTO- I)	4	-	-	4	-	-	4
CHC503	Heat transfer Operations (HTO)	4	-	-	4	-	-	4
CHC504	Chemical Reaction Engineering-I (CRE I)	4	-	-	4	-	-	4
CHC505	Business Communication & Ethics	2	-	2	-	-	2	2
CHDE501X	Department Elective I	4	-	-	4	-	-	4
CHL501	Computer programming and Numerical Methods lab	-	2	-	-	1	-	1
CHL502	Chemical Engineering Lab IV (MTO-I)	-	3	-	-	1.5	-	1.5
CHL503	Chemical Engineering Lab V (HTO)	-	3	-	-	1.5	-	1.5
CHL504	Chemical Engineering Lab VI (CRE-I)	-	2	-	-	1	-	1
	Total	20	14	-	20	5	2	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC501	Computer programming and Numerical Methods	20	20	20	80	3	-	-	-	100
CHC502	Mass transfer Operations-I (MTO- I)	20	20	20	80	3		-	-	100
CHC503	Heat transfer Operations (HTO)	20	20	20	80	3		-	-	100
CHC504	Chemical Reaction Engineering-I (CRE I)	20	20	20	80	3		-	-	100
CHC505	Business Communication & Ethics	-	-	-	-	-	50	-	-	50
CHDE501X	Department Elective I	20	20	20	80	3		-	-	100
CHL501	Computer programming and Numerical Methods Lab	-	-	-	-	2	25	25	-	50
CHL502	Chemical Engineering Lab IV (MTO-I)	-	-	-	-	3	25	25	-	50
CHL503	Chemical Engineering Lab V (HTO)	-	-	-	-	3	25	25	-	50
CHL504	Chemical Engineering Lab VI (CRE-I)	-	-	-	-	2	25	25	-	50
	Total			100	400	-	150	100	-	750

Department Elective I (Sem V)		
Engineering Stream (Elective Code)	Advanced Sciences Stream (Elective code)	Technology Stream (Elective Code)
1. Piping Engineering (CHDE5011) 2. Instrumentation (CHDE5014)	1. Colloids and Interfaces (CHDE5012)	1. Advanced Material Sciences (CHDE5013)

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
T.E. Semester VI (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC601	Environmental Engineering (EE)	4	-	-	4	-	-	4
CHC602	Mass transfer Operations –II (MTO-II)	4	-	-	4	-	-	4
CHC603	Transport Phenomenon	3	-	1	3	-	1	4
CHC604	Chemical Reaction Engineering –II (CRE- II)	4	-	-	4	-	-	4
CHC605	Plant Engineering & Industrial Safety	3	-	1	3	-	1	4
CHDE602X	Department Elective II	4	-	-	4	-	-	4
CHL601	Chemical Engineering Lab VII (EE)	-	3	-	-	1.5	-	1.5
CHL602	Chemical Engineering Lab VIII (MTO-II)	-	3	-	-	1.5	-	1.5
CHL603	Chemical Engineering LabIX CRE-II)	-	2	-	-	1	-	1
	Total	22	8	2	22	4	2	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC601	Environmental Engineering (EE)	20	20	20	80	3	-	-	-	100
CHC602	Mass transfer Operations –II (MTO-II)	20	20	20	80	3	-	-	-	100
CHC603	Transport Phenomenon	20	20	20	80	3	25	-	-	125
CHC604	Chemical Reaction Engineering –II (CRE- II)	20	20	20	80	3	-	-	-	100
CHC605	Plant Engineering & Industrial Safety	20	20	20	80	3	25	-	-	125
CHDE602X	Department Elective II	20	20	20	80	3	-	-	-	100
CHL601	Chemical Engineering Lab VII (EE)	-	-	-	-	3	25	25		50
CHL602	Chemical Engineering Lab VIII (MTO-II)	-	-	-	-	3	25	25	-	50
CHL603	Chemical Engineering Lab IX CRE-II)	-	-	-	-	2	25	25	-	50
	Total			120	480	-	125	75	--	800

Department Elective II (Sem VI)		
Engineering Stream (Elective Code)	Management Stream (Elective Code)	Technology Stream (Elective Code)
1. Computational Fluid Dynamics (CHDE6021)	1. Operation Research (CHDE6022)	1. Biotechnology (CHDE6023)

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
B.E. Semester VII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC701	Process Equipment Design. (PED)	4	-	-	4	-	-	4
CHC702	Process Engineering	3	-	1	3	-	1	4
CHC703	Process Dynamics and Control (PDC)	4	-	-	4	-	-	4
CHDE703X	Department Elective III	4	-	-	4	-	-	4
ILO701X	Institute Elective I	3	-	-	3	-	-	3
CHP701	Project A	-	-	8	-	-	3	3
CHS701	Seminar	-	-	3	-	-	3	3
CHL701	PED Lab	-	3	-	-	1.5	-	1.5
CHL702	Chemical Engineering Lab X (PDC)	-	3	-	-	1.5	-	1.5
	Total	18	6	12	18	3	7	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC701	Process Equipment Design. (PED)	20	20	20	80	3	-	-	-	100
CHC702	Process Engineering	20	20	20	80	3	25	-	-	125
CHC703	Process Dynamics and Control (PDC)	20	20	20	80	3	-	-	-	100
CHDE703X	Department Elective III	20	20	20	80	3	-	-	-	100
ILO701X	Institute Elective I	20	20	20	80	3	-	-	-	100
CHP701	Project A	-	-	-	-	-	100		25	125
CHS701	Seminar	-	-	-	-	-	50	-	-	50
CHL701	PED Lab	-	-	-	-	-	25	-	25	50
CHL702	Chemical Engineering Lab X (PDC)	-	-	-	-	3	25	25	-	50
	Total			100	400	-	225	25	50	800

Department Elective III (Sem VII)		
Engineering Stream (Elective Code)	**Management Stream (Elective Code)**	**Technology Stream (Elective Code)**
1. Corrosion Engineering (CHDE7031)	2. Industrial organization and Management. (CHDE7032)	1.Petroleum Refining Technology(CHDE7033) 3. Food Technology (CHDE7034)

Institute Level Optional Subject I (Sem VII)		
1. Product Lifecycle Management(ILO7011)	4. Design of Experiments(ILO7014)	7. Disaster Management and Mitigation Measures(ILO7017)
2. Reliability Engineering (ILO7012)	5. Operation Research (ILO7015)	8. Energy Audit and Management (ILO7018)
3. Management Information System (ILO7013)	6. Cyber Security and Laws (ILO7016)	9. Development Engineering (ILO7019)

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
B.E. Semester VIII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC801	Modeling, Simulation & Optimization (MSO)	4	-	-	4	-	-	4
CHC802	Project Engineering & Entrepreneurship Management	3	-	1	3	-	1	4
CHC803	Energy System Design	3	-	1	3	-	1	4
CHDE804X	Department Elective IV	4	-	-	4	-	-	4
ILO802X	Institute Elective II	3	-	-	3	-	-	3
CHP801	Project B	-	-	8	-	-	6	6
CHL801	Chemical Engineering Lab XI (MSO)	-	2	-	-	1	-	1
	Total	17	2	10	17	1	8	26

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC801	Modeling, Simulation & Optimization (MSO)	20	20	20	80	3	-	-	-	100
CHC802	Project Engineering & Entrepreneurship Management	20	20	20	80	3	25	-	-	125
CHC803	Energy System Design	20	20	20	80	3	25	-	-	125
CHDE804X	Department Elective IV	20	20	20	80	3		-	-	100
ILO802X	Institute Elective II	20	20	20	80	3		-	-	100
CHP801	Project B	-	-	-	-	-	100	-	50	150
CHL801	Chemical Engineering Lab XI (MSO)	-	-	-	-	2	25	25	-	50
	Total			100	400	-	175	25	50	750

Department Elective IV (Sem VIII)		
Engineering Stream (Course Code)	**Management Stream (Course Code)**	**Technology Stream (Course Code)**
1. Advanced Process Control (CHDE8041)	1. Total Quality Management (CHDE8042)	1. Advanced Separation Technology (CHDE8043) 2. Polymer Technology(CHDE8044)

Institute Level Optional Subject II (Sem VIII)		
1. Project Management (ILO8021)	4. Human Resource Management (ILO8024)	7. IPR and Patenting (ILO8027)
2. Finance Management (ILO8022)	5. Professional Ethics and CSR (ILO8025)	8. Digital Business Management (ILO8028)
3. Entrepreneurship Development and Management (ILO8023)	6. Research Methodology(ILO8026)	9. Environmental Management (ILO8029)

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
S.E. Semester III (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC301	Applied Mathematics-III	3	-	1	3	-	1	4
CHC302	Engineering Chemistry I	4	-	-	4	-	-	4
CHC303	Fluid Flow Operations (FFO)	4	-	-	4	-	-	4
CHC304	Chemical Engineering Thermodynamics I	3	-	1	3	-	1	4
CHC305	Process Calculations	3	-	1	3	-	1	4
CHC306	Chemical Technology	4	-	-	4	-	-	4
CHL301	Engineering Chemistry-I Lab	-	3	-	-	1.5	-	1.5
CHL302	Chemical Engineering Lab I (FFO)	-	3	-	-	1.5	-	1.5
CHL303	Chemical Engineering Lab II (Synthesis)	-	2	-	-	1	-	1
	Total	21	8	3	21	4	3	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC301	Applied Mathematics-III	20	20	20	80	3	25	-	-	125
CHC302	Engineering Chemistry I	20	20	20	80	3	-	-	-	100
CHC303	Fluid Flow (FF)	20	20	20	80	3	-	-	-	100
CHC304	Chemical Engineering Thermodynamics I	20	20	20	80	3	25	-	-	125
CHC305	Process Calculations	20	20	20	80	3	25	-	-	125
CHC306	Chemical Technology	20	20	20	80	3	-	-	-	100
CHL301	Engineering Chemistry-I Lab	-	-	-	-	3	-	25	-	25
CHL302	Chemical Engineering Lab I (FFO)	-	-	-	-	3	25	25	-	50
CHL303	Chemical Engineering Lab II (Synthesis)	-	-	-	-	-	25	-	25	50
	Total			120	480	-	125	50	25	800

Course Code	Course/Subject Name	Credits
CHC301	Applied Mathematics III	4

Pre-requisites:

- Basics of Complex numbers, Modulus, Argument, Equation of circle, Roots of unity, Euler's formula, Hyperbolic functions, Matrices, Symmetric, Orthogonal and Unitary matrices, Rank, Normal form, Solution of system of linear equations, L. I. & L. D. vectors, Basics of Probability.

Course Objectives:

- To enable students to solve initial value ODE problems using L-transforms.
- To strengthen the knowledge of students in Linear Algebra.
- To study the basics of statistics and Probability.
- To study the basics of Complex Variable.

Course outcomes:

- The student will be able to apply Laplace Transform techniques for solving initial value problems.
- Identify the Analytic function and Harmonic function and to apply Bilinear Transformation.
- Understanding and apply the concept of Probability distribution and Sampling theory to engineering problems.

Module	Topics	Contact hours
1	**Laplace transform:** 1.1 Introduction, Definition of Laplace transform, Laplace transform of constant, trigonometrical, exponential functions. 1.2 Important properties of Laplace transform: First shifting theorem, Laplace transform of L{ $f(at)$ }, L{ $t^n f(t)$ }, L{ $\frac{f(t)}{t}$ }, L{ $\frac{d^n f(t)}{dt^n}$ }, L{ $\int_0^t f(u)du$ }, without proof. 1.3 Unit step function, Heavi side function, Second shifting theorem, Dirac-delta function, Periodic function and their Laplace transforms without proof. 1.4 Inverse Laplace transform with Partial fraction and Convolution theorem. (without proof) 1.5 Application to solve initial and boundary value problem involving ordinary differential equations with one dependent variable and constant coefficients.	10
2	**Matrices:** 2.1 Eigen values and eigen spaces of 2x2 and 3x3 matrices; existence of a basis and finding the dimension of the eigen space (no proofs); diagonalisable matrices. 2.2 Cayley - Hamilton theorem. (without proof)	08

	2.3 Quadratic forms; orthogonal and congruent reduction of a quadratic form in 2 or 3 variables; rank, index, signature; definite and indefinite forms.	
3	**Probability:** 3.1 Random Variables:- discrete & continuous random variables, expectation, Variance, Probability Density Function & Cumulative Density Function. 3.2 Moments, Moment Generating Function. 3.3 Probability distribution: binomial distribution, Poisson & normal distribution.	**07**
4	**Sampling Theory:** 4.1 Test of Hypothesis, Level of significance, Critical region, One Tailed and two Tailed test, Test of significant for Large Samples:-Means of the samples and test of significant of means of two large samples. 4.2 Test of significant of small samples:- Students t- distribution for dependent and independent samples. 4.3 Chi square test:- Test of goodness of fit and independence of attributes, Contingency table. **Correlation:** 4.4 Karl Pearson's coefficient of correlation, covariance, Spearman's Rank correlation. 4.5 Regression Lines.	**07**
5	**Complex Variable:** 5.1 Functions of a complex variable, Analytic functions, Cauchy-Riemann equations in Cartesian co-ordinates, Polar co-ordinates. (without proof) 5.2 Harmonic functions, Analytic method and Milne Thomson methods to find f(z), Orthogonal trajectories. (without proof) **Mapping** 5.3 Conformal Mapping, Linear, Bilinear transformations, Cross ratio, fixed points and standard transformation such as rotation and magnification, invertion, translation.	**07**

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Reference Books

1. Higher Engineering Mathematics by Dr. B. S. Grewal 42th edition, Khanna Publication.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
3. A Text Book of Applied Mathematics Vol. II by P.N.Wartilar & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.
4. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
5. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
6. Laplace Transforms by Murry R. Spieget, Schaun'sout line series-McGraw Hill Publication.
7. Theory And Problems of Statistics by Murry R. Spieget, Schaun'sout line series-McGraw Hill Publication.
8. Fundamentals Of Mathematical Statistics by S. C. Gupta, V. K. Kapoor, Sultan Chand & Sons -2003

Course Code	Course/Subject Name	Credits
CHC302	Engineering Chemistry– I	4

Prerequisites:

- Knowledge of Vander-Waal's forces, various bonds, Octet rule, Resonance theory, Hybridization.
- Knowledge of variable valency, ligands.
- Knowledge of properties of transition metals.
- Knowledge of intermediate steps involved in conversion of reactants to products.
- Basic concept of quantum chemistry & wave theory approach.

Course Objectives:

- To understand chemical bonding.
- To study chelation and its advantages.
- To understand structures of different bio-molecules and their chemistry.
- To study importance of iron compounds for life.
- To understand different concepts of organic reactions.
- To study the effect of temperature and time on chemical reactions.
- To become aware of industrially important reactions.
- To understand mechanism of aromatic substitution and elimination reactions.

Course Outcomes:

- Students will understand different theories of chemical bonding, organometallic chemistry, mechanism and application of Photochemical processes.
- Students will also be capable of defining Stability of Coordination compounds, Kinetics and energy profile diagrams of reactions.
- Students will have knowledge of metal carbonyls and their properties.
- Students will able to express role of metalloproteins in biological processes.
- Students will be able to carry out organic estimations, gravimetric analysis and handle different instruments in the laboratory.

Module	Content	Contact Hours
1	**Basic Concepts of Chemistry and Molecular Structures-** Hydrogen bonding, Valence bond theory (application for H_2 molecule). Molecular orbital theory, Bonding, Non-bonding and anti-bonding orbitals, LCAO method, VSEPR theory .Structure of BrF_3,SF_4, XeF_4, and IF_7. Molecular orbital diagrams of homonuclear and heteronuclear molecules H_2, Be_2, B_2, C_2, N_2, O_2, F_2,HF CO,NO and NO^+typesetc, metallic bond.	**08**

2	**Co-ordination chemistry** Definitions- Co-ordination number or ligancy, Ligand, Complex ion, Co-ordination or dative bond. Nomenclature and isomerism (Only Geometrical and Structural) in co-ordination compounds with respectto co-ordination number 4 and 6. Theories of coordination compounds- Werner's Co-ordination theory, Valence bond theory, Crystal field theory (CFT), Ligand field theory. Effective Atomic Number (EAN), Application of CFT to tetrahedral and octahedral complexes, drawbacks of CFT. Measurement of CFSE (10Dq), and Numericals based on EAN and 10Dq measurement.	**08**
3	**Organometallic compounds and Bio-inorganic chemistry** Chemistry of Fe-Carbonyls –$Fe(CO)_5$,$Fe_2(CO)_9$w.r.t preparation, properties, structure and bonding. Biochemistry of proteins containing Fe and Zn. O_2 atom transfer reactions of bio molecules containing Fe.	**06**
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** Definition,carbocation, carbanion, carbon free radicals and carbenes – their formation, structure & stability. Reactive intermediate formation with mechanism and applications- Carbocation – Pinacol - Pinacolone reaction. Carbanion – Michael reaction. Free radical - Wohl-Ziegler bromaination reaction. Carbene - Reimer-Tiemann reaction.	**08**
6	**Photochemistry** Introduction,difference between Photochemical and thermochemical reaction, laws of Photochemistry i) Grothus Draper Law ii) Stark Einstein Law. Fluorescence and phosphorescence. Jablonskii diagram, Quantum yield, reasons for high quantum yield. **Photochemical reactions of carbonyl compounds-**(i) Norrish type- I cleavage (ii) Norrish type-II cleavage with mechanism.	**08**

Assessment

Internal:

Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

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

- Total 4 questions need to be solved.
- Question No.1 should be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Principles of Inorganic Chemistry- Puri, Sharma, Kalia – Milestone/Vishal Publishers
2. Advanced Inorganic Chemistry – J. D. Lee
3. Organic Chemistry - I L Finar volume I and II.
4. Advanced Organic Chemistry – Jerry March, John Wiley & Sons (Wiley India)
5. Organic Chemistry – J. Clayden, Greeves, Warren, Wothers. Oxford
6. Organic reaction Mechanisms- V.K. Ahluwalia , Rakesh Parashar, Narosa Publication
7. A textbook of Physical Chemistry - Glasston Samuel, Macmillan India Ltd. (1991)
8. Inorganic Chemistry: Huheey.
9. Principles of Physical Chemistry- B. R. Puri, L. R. Sharma, M.S. Pathania.
10. Photochemistry and Pericyclic Reactions- Jagdamba Singh, Jaya Singh
11. Organic reaction mechanism – Peter sykes
12. Vogel's Textbook of Practical organic chemistry.

Course Code	Course/Subject Name	Credits
CHC303	**Fluid Flow Operation**	**4**

Prerequisites:

- Students are assumed to have adequate background in physics, units and dimensions and thermodynamics.

Course Objectives:

- Students should be able to understand the scope of the subject in chemical industry.
- They should be comfortable with measurement of pressure or pressure drop.
- They should be able to calculate pressure drop and flow rates in conduits for incompressible as well as compressible fluids.
- They should be able to determine viscosity using different methods such as Stokes Law, Capillary viscometer.
- They should be able to calculate power requirement in agitation and to be able to select and calculate power requirement for pumps.
- They should be able to select proper valves.

Course Outcomes:

- After studying this subject, students would be able to measure pressure drop, flow rates etc.
- Students will able to understand basic concepts and pressure measurement.
- Students will able to understand kinetics and rheological behavior of fluid flow.
- Students will able to understand flow equations for compressible and incompressible flow.
- Students will able to select pumps and valves and would be able to calculate power requirement for pumping as well as agitation operations.

Module	Contents	Contact Hours
1	**Introduction and Basic Concepts:** Scope and Applications of fluid flow, Properties of fluids such as Density, viscosity, surface tension, capillarity effect, vapour pressure. **Pressure and Fluid Statics:** • Fluid Pressure at a Point, Pascal's Law, Pressure Variation in a fluid at rest. Hydrostatic Equilibrium. • Measurement of Pressure, Manometers – Peizometers, U-Tube, Single Column manometer, U – Tube differential manometer, Inverted Differential U – tube manometer, inclined manometer.	**7**
2	**Fluid Kinematics:**	**2**

	• Types of fluid flow namely steady and unsteady, Uniform and non- uniform, laminar and turbulent, compressible and incompressible internal and external, one, two dimensional flow. • Newton's Law of Viscosity, Rheological behavior of fluid, capillary viscometer.	
3	**Basic Equations of Fluid Flow:** • Bernoulli's equation Euler's Equation, Modified Bernoulli's equation. • Major and Minor losses, Equivalent length, flow through pipe in series, parallel, pipe network. **Practical Application of Bernoulli's Equation:** • Venturimeter: Horizontal and inclined, Orificemeter, Pitot tube • Notches and Weirs: Introduction, classification, Derivation for V – notch, Rectangular notch.	**10**
4	**Flow through Pipes:** **A] Incompressible flow:** Shear stress distribution and velocity distribution. Relationship between Skin friction and wall shear, friction factor, Darcy-Weisbach equation. Reynolds experiment and Reynolds no., Formation of Boundary. **Laminar Flow:** 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 (No Numericals on universal velocity). Von Carman equation and friction factors, Moody diagram. Equivalent diameter for circular and non-circular ducts. Pipes in series and parallel. Frictional Losses in different pipe fittings. **B] Compressible Fluids:** Introduction, Mach no, Sonic, supersonic and subsonic flow, continuity equation and Bernoulli's equation, stagnation properties, Acoustic velocity. Adiabatic Flow. Isothermal Flow. Isentropic Flow.	**12**
5	**Flow past immersed bodies:** Drag forces, Coefficient of drag, Terminal settling velocity, Stoke's law.	**2**
6	**Pumps, Valves and Agitators:** Classification and types, Centrifugal pumps – Construction and working, Power required, Definitions of heads and efficiency, NPSH, Priming, Cavitations, characteristic curves. Specific speed, minimum speed.	**12**

	Reciprocating Pump: Classifications and working. **Power Consumption in Agitation:** Power curves, Power No., types of impellers. **Introduction to Compressors, Fans and Blowers**. **Types of Valves:** Globe valves, Gate valves, butterfly valves and non – Return valves.	

Assessment

Internal:

Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Warren L. Mccabe, Julian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, McGraw Hill International Edition.
2. Okiishi, Huebsch, Rothmayer Munson, Fluid Mechanics - SI Version, Wiley, 7th edition, 2015.
3. Coulson J. M., Richardson J. F., Backhurst J. R. and J. H. Harker, Chemical Engineering, Vol. 1 and 2.
4. Suresh Ukarande, Fluid Mechanics and Hydraulics, Ane Books, 2012.
5. Robbert W. Fox, Philip J. Pritchard, Alan T. McDonald, Introduction to Fluid Mechanics, 7th edition, WILEY, India Edition.
6. Yunus A. Cengel, John M. Cimbala, Adapted by S. Bhattacharya, Fluid Mechanics Fundamentals and Applications, The McGraw Hill Companies.
7. Dr. R. K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications Pvt. Ltd.
8. Fluid Mechanics for Chemical Engineers by Noel de Nevers, McGraw Hill Education

Course Code	Course/Subject Name	Credits
CHC304	**Chemical Engineering Thermodynamics I**	**04**

Prerequisites:

- Basic thermodynamic properties, laws and equations.
- Engineering Mathematics: Differential Equations, Linear Algebraic Equations.

Course Objectives:

- To make students understand the Laws of Thermodynamics and Basics of Chemical Engineering Thermodynamics
- To make students learn to apply the concepts of Chemical Engineering Thermodynamics to various Chemical Engineering Processes

Course Outcomes:

- The students will be able to apply thermodynamic laws and equations to various Chemical Engineering processes.

Module	Contents	Contact Hours
01	• First Law of Thermodynamics for flow and non-flow processes • Calculation of heat and work for various types of processes	**08**
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 change of various processes • Third Law of Thermodynamics	**08**
03	• Concept of Exergy, Exergy Balance • Steady flow Exergy equation and its application	**06**
04	• Equations of State for non-ideal gases: Virial equation of state, van der Waals equation of state, Redlich-Kwong, Redlich-Kwong-Soave and Peng-Robinson equation of state	**06**
05	• Maxwell Equation, Joule Thomson effect • Enthalpy and Entropy departure functions (vander Waals and RedlichKwong EOS) • Thermodynamic Charts, Diagrams and their applications • Fugacity and fugacity coefficient(vander Waals and RedlichKwong EOS)	**08**

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks

Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Reference

1. Introduction to Chemical Engineering Thermodynamic by J.M. Smith, H.C. Van Ness, M.M. Abbott, Latest Edition, McGraw Hill Publishing Company Limited
2. A textbook of Chemical Engineering Thermodynamics by K.V. Narayanan, Latest Edition, Prentice Hall of India Private Limited
3. Chemical Engineering Thermodynamics by Y.V.C. Rao, Latest Edition, University Press
4. Fundamentals of Engineering Thermodynamics by Micheal J Moran , Howard N Shaprio, Latest Edition, Wiley publication.
5. Introduction to Chemical Engineering Thermodynamics by Gopinath Halder, PHI learning Pvt. Ltd

Course Code	Course/Subject Name	Credits
CHC305	Process Calculations	4

Prerequisites:

- Linear algebra.
- Differential equations

Course Objectives:

- Students will learn to write mass balances on various process equipments with and without recycle.
- Students will learn to write energy balances on various process equipments with and without recycle.
- Students will learn to write mass and energy balances for chemical reactions with and without recycle.
- Students will learn to flow sheeting calculations.

Course Outcomes:

- Students will learn to calculate mass and energy flow rates into and out of various process equipments.
- Students will learn to calculate conversion, selectivity etc for various reactions with and without recycle.
- Students will learn to carry out degrees of freedom analysis for various units.

Module	Contents	Contact Hours
1	Introduction. Basic Chemical Calculations .Units And Dimensions Various systems of units, conversion of units. Density, specific volume, specific gravity, Concentration & composition of mixtures and solutions. Ideal Gas law, Dalton's law, Amagat,s law, Raoult's law, Henry's law	06
2	Material Balance without chemical reactions. General material balance equation, degree of freedom analysis for individual units, solving material balance problems for various unit operations using steady state equation, Material Balance for Unsteady Processes. Recycle, Bypass and Purge Calculations.	07
3	Material Balance with chemical reactions. Concept of limiting and excess reactants, conversion and yield, selectivity and degree of completion of reaction, material balance problems related to chemical reactions including recycle, bypass and purge Calculations.	07
4	Energy Balance. Heat capacity, sensible heat, latent heat, calculation of enthalpy changes. General energy balance equation. Energy balances for process involving chemical reaction including adiabatic reactions & combustion processes (Orsat Analysis & Net, Gross Calorific Value determination).	10

5	Combined Material and Energy balance. Material and Energy balance for binary distillation, combustion and evaporation.	**08**

Tutorials

1. Basic chemical calculations.
2. Material balance without chemical reaction.
3. Material balance without chemical reaction for unsteady. Bypass, recycle and purge operations
4. Material balance without chemical reaction for unsteady. Bypass, recycle and purge operations.
5. Energy balance based on heat capacity, enthalpy change.
6. Energy balance based on Hess's law, temperature of reaction.
7. Energy balance based on orsat analysis, NCV and GCV.
8. Combined material and energy balance.

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Text Books

1. Narayan, K. V. and Lakshmikutty, B. "Stioichiometry and Process Calculations", 1^{st} edition, Prentice Hall of India Pvt. Ltd., New Delhi (2006)
2. Bhatt, B. I. and Thakore, S. B., "Stoichimetry, 5^{th} edition Tata McGraw Hill Education Private Limited, New Delhi
3. Ch. Durga Prasad Rao and D. V. S. Murthy, " Process Calculations for Chemical Engineers", McMilan India Ltd. (2010)
4. O. A. Hougen, K. M. Watson, and R. A. Ragatz., "Chemical process principles-part 1, Material and Energy Balances". Second Edition. John Wiley & Sons, Inc., New York (1954). 525 pages.

Reference books

1. Himmelblau, D. M. and Riggs, J. B., "Basic Principles and Calculations in Chemical Engineering, 7^{th} edition, Prentice Hall of India Pvt. Ltd., New Delhi (2009)
2. Stoichiometry and Process calculations by K.V. Narayanan and B. Lakshmikutty, PHI learning Pvt. Ltd

Course Code	Course/Subject Name	Credits
CHC306	Chemical Technology	4

Prerequisites

- Knowledge of Inorganic, Organic and Physical Chemistry, Physics and Mathematics.

Course Objectives

- To give students an insight of different chemical processes.
- To understand the development of a process from its chemistry.
- To understand different engineering problems in process industries.

Course Outcomes

At the end of the course the student will be able to:

- Describe various manufacturing processes used in the chemical process industries.
- Explain industrial processing and overall performance of any chemical process including the major engineering problems encountered in the process.
- Determine the overall process aspects including yield, formation of by-products and generation of waste, etc.
- Draw and illustrate the process flow diagram for a given process.

Module	Contents	Contact Hours
1	**Introduction :** Concept and brief description of the Unit Operations and Unit Processes used in Chemical Industries. **Overview of Industrially Important Products in the Chemical Process Industries:** Soaps and Detergents Dyes and Intermediates Agrochemicals	05
2	**Manufacture of Acids :** Sulphuric Acid (DCDA Process), Nitric Acid, Phosphoric Acid (Wet Process) and Acetic Acid (by reaction of carbon monoxide with methanol). **Manufacture of Fertilizers :** Ammonia, Urea and Superphosphate (SSP and TSP).	12
3	**Natural Product Industries :** Hydrogenation of Vegetable Oils Manufacture of Sugar from Sugarcane, By-products obtained in manufacture of sugar, Inversion of sugar Manufacture of ethanol by fermentation of molasses **Introduction to Biodiesel Processing :** Biodiesel production by base- catalysed transesterification process **Chloro-Alkali Industries :**	12

	Manufacture of Caustic Soda Manufacture of Hydrochloric Acid by combustion of chlorine and hydrogen Manufacture of Soda Ash (Solvay and Dual Processes)	
4	**Synthesis of Important Heavy Organic Chemicals and Intermediates :** Manufacture of Styrene by dehydrogenation of ethylbenzene Manufacture of Cumene from benzene and propylene Manufacture of Phenol from cumene by peroxidation-hydrolysis process Manufacture of Purified Terephthalic Acid (PTA) by oxidation of p-xylene	**05**
5	**Synthesis of Polymers :** Manufacture of Polyethylene : LDPE and HDPE Manufacture of Nylon 66	**03**
6	**Basic Building Blocks of Petrochemical Industry :** Introduction to Petroleum Refining Catalytic Cracking by Fluidized Catalytic Cracking Unit (FCCU) Naphtha Cracking for manufacture of ethylene and propylene Naphtha Reforming Separation of BTX (Benzene-Toluene-Xylene) Isomerization of Xylenes Separation of Xylene isomers	**08**

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Reference

1. Austin G.T., Shreve's Chemical Process Industries, 5th Edition, McGraw Hill International Edition.
2. Pandey, G.N., A Textbook of Chemical Technology, Vol.I and II, Vikas Publications, 1984.
3. Rao, G.N. and Sittig M., Dryden's Outlines of Chemical Technology for 21st Century, East West Press, 3rd Edition.
4. B.K. Bhaskara Rao, Modern Petroleum Refining Processes.
5. B.K. Bhaskara Rao, A Textbook of Petrochemicals.

6. Heaton, C.A., An Introduction to Industrial Chemistry, Leonard Hill, 1984.
7. Thomson, R., Modern Inorganic Chemical Industries, Royal Society of Chemistry, 2nd. Edition, 1994.
8. Kirk-Othmer's Encyclopedia of Chemical Technology, John Wiley and Sons, Inc., 4th Edition, 1990.
9. Ullmann's Encyclopedia of Industrial Chemistry, VCH, 1985.
10. McKetta's Encyclopedia of Chemical Processing and Design, Marcel Dekker, 1999.
11. Pletcher D. and Walsh, F.C., Industrial Electrochemistry, Chapman and Hall, 1990.
12. Alok Adholeya and Pradeepkumar Dadhich, Production and Technology of Biodiesel: Seeding a Change, TERI Publication, New Delhi, 2008.
13. NIIR Board of Consultants and Engineers, The complete book on Jatropha (Biodiesel) with Ashwagandha, Stevia, Brahmi and Jatamansi Herbs (Cultivation, Processing and Uses), Asia Pacific Business Press Inc.

Course Code	Course/Subject Name	Credits
CHL301	**Engineering Chemistry Lab– I**	**1.5**

List of Experiments Suggested:

Volumetric analysis-[Any 2]
Preparation of standard solutions and to find normality and deviation factor.

Titrimetric analysis- [Any 3]

- Analysis of talcum powder for Mg content by EDTA method
- Analysis of Aspirin as per I.P. or USP
- Determination of Strength of $KMnO_4$
- Determination of fluoride content in the toothpaste spectrophotometrically
- Estimation of CaO in cement
- Estimation of Vitamin C using Ceric ammonium sulphate
- Estimation of Glycine by non aqueous titration using perchloricacid

Organic estimations - [Any 2]

- Estimation of aniline
- Estimation of phenol
- Estimation of Acetamide

Gravimetric estimation - [Any 2]

- Barium as BaCl2
- Tin as SnCl2
- Nickel as Ni D.M.G.
- Zinc as ZnSO4

Preparation.

- Preparation of Methyl Salicylate

Students have to perform any 10 practicals from the above during the semester.

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
CHL302	**Chemical Engineering Lab (FFO)**	**1.5**

List of Experiments Suggested

Minimum Ten experiments must be performed

- Viscosity by Efflux time
- Reynolds Apparatus
- Bernoulli's apparatus
- Venturimeter
- Orificemeter
- Pitot tube
- V – Notch/ Rectangular notch
- Friction through Circular pipe
- Flow through Annulus.
- Flow through Helical coil
- Pipe Fitting (Minor Losses)
- Pumps
- Power Consumption in agitated vessel
- Viscosity by Stoke's Law

Term work

Term work shall be evaluated based on performance in practical.
Practical Journal: 20 marks
Attendance: 05 marks
Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
CHL303	Chemical Engineering Lab II (Synthesis)	1

s.n	Preparation	Chemicals required	Apparatus/ glassware required
1	Soap	Sodium hydroxide (20% solution), ethanol saturated solution of sodium chloride ,calcium chloride (5% solution), magnesium chloride (5% solution), ferric chloride (5% solution), cooking oil, phenolphthalein indicator solution.	250-mL beaker, 100- mL beaker; wire gauze; laboratory burner; glass stirring rod; test tubes; filter flask and Buchner funnel; filter paper; graduated cylinder
2	Alum from Aluminum	Aluminum can or aluminum metal, Crushed ice, 9M H2SO4, 1.5M KOH solution, Methanol, NaHCO3 (sodium bicarbonate)	Glass filter funnel, Buchner filter funnel, filter paper, steel wool, two 150 mL and two 150 ml beakers, 500 ml beaker, thermometer, ruler, stirring rod
3	Asprin	2 gm salicylic acid, 5.0 ml of acetic anhydride, ve drops of 85% phosphoric acid, distilled water	burette clamp, burner, stand with iron ring, wire gauze, ice bath,50 ml ask beaker, Buchner funnel aspirator
4	Methyl orange	0.29 g of anhydrous sodium carbonate, 1.0 g of sulfanilic acid monohydrate, 0.375 g of sodium nitrite, 0.7 ml of dimethylaniline and 0.5 mL of glacial acetic acid, 10% aqueous sodium hydroxide, 1.25 ml of concentrated hydrochloric acid	50 ml Erlenmeyer ask, lter,100 ml beaker, test tube
5	Thiokol rubber	Sodium hydroxide solution, 1M Sulfur 1,2-dichloroethane distilled or deionized water	Copper wire, approximately 6 inches long (15 cm); two 10 ml vials with teflon cap liners, two 400 ml beakers ,10 ml graduated cylinder ,glass pipette (dropper), hot plate, chemical resistant gloves
6	RUBBER BALL FROM RUBBER LATEX	15 ml rubber latex, 15 ml vinegar, 15 ml wate	Two paper cups (5 ounce), stir- ring rod (popsicle stick or equiv-

			alent), small bucket or large beaker (1000 ml or larger)
7	p-BROMO-NITROBENEZENE FROM BRO-MOBENEZENE	Conc. H2SO4, conc. HNO3 , bromobenzene, ethyl alcohol, conical ask, funnel, lter paper, water Bath	Conical flask, funnel, filter paper, water bath.
8	DETERGENT	Dodecanol (dodecyl alcohol), sulphuric acid, concentrated sodium hydroxide, 6M phenolphthalein solution, 1% sodium chloride	Erlenmeyer ask, 125 ml beakers, 400 ml, 150 ml, 100 ml graduated cylinders, 10 ml, 25 ml, 125 ml funnel, spatula, stirring rod, Cheese cloth, watch glass, scissors

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks

Attendance: 05 marks

Total: 25 marks

University of Mumbai
Program Structure for B.E. Chemical Engineering (Revised 2016)
S.E. Semester IV (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
CHC401	Applied Mathematics-IV	3	-	1	3	-	1	4
CHC402	Engineering Chemistry II	4	-		4	-	-	4
CHC403	Chemical Engineering Thermodynamics II	3	-	1	3	-	1	4
CHC404	Solid Fluid Mechanical Operations (SFMO)	4	-	-	4	-	-	4
CHC405	Mechanical Equipment Design (MED)	4	-	-	4	-	-	4
CHC406	Chemical Engineering Economics	3	-	1	3	-	1	4
CHL401	Engineering Chemistry-II Lab	-	3	-	-	1.5	-	1.5
CHL402	Chemical Engineering Lab III (SFMO)	-	3	-	-	1.5	-	1.5
CHL403	MED Lab	-	2	-	-	1	-	1
	Total	21	8	2	21	4	3	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract /Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
CHC401	Applied Mathematics-IV	20	20	20	80	3	25	-	-	125
CHC402	Engineering Chemistry II	20	20	20	80	3	-	-	-	100
CHC403	Chemical Engineering Thermodynamics II	20	20	20	80	3	25	-	-	125
CHC404	Solid Fluid Mechanical Operations (SFMO)	20	20	20	80	3	-	-	-	100
CHC405	Mechanical Equipment Design (MED)	20	20	20	80	3	-	-	-	100
CHC406	Chemical Engineering Economics	20	20	20	80	3	25	-	-	125
CHL401	Engineering Chemistry-II Lab	-	-	-	-	3	-	25	-	25
CHL402	Chemical Engineering Lab III (SFMO)	-	-	-	-	3	25	25	-	50
CHL403	MED Lab	-	-	-	-	-	25	-	25	50
	Total			120	480	-	125	50	25	800

Course Code	Course/Subject Name	Credits
CHC401	Applied Mathematics- IV	4

Prerequisites:

- The concepts of basic Mathematics as well as a few concepts of higher mathematics.
- The concepts of basic chemistry, basic civil engineering, basic mechanical engineering, etc. in order to understand the concepts like, corrosion, corrosion allowance, construction costs, equipment costs, etc.

Course Objectives:

- The Fourier Series, Fourier Transform and Partial Differential Equation
- Module does the Ground work for the techniques required to solve and find the answer for various physiochemical problems.
- To study the basics of Finite Differences.
- To study the basics of Complex Integration.
- To introduce the basics of NLPP.

Course outcomes:

- Demonstrate the ability of using Fourier Series and Fourier Transform in solving PDE.
- Enable the students to solve boundary value Problem using Finite Differences Approximations.
- Identify the applicability of theorems and evaluate the Contour Integral.
- The students will be ready for any further course on Optimization.

Module	Topics	Contact Hours
01	Fourier Series: 1.1 Orthogonal and Ortho-normal functions 1.2 Dirichlet's conditions, Fourier series of periodic functions with period 2π and 2L. Parsevel's identities (without proof). 1.3 Fourier series for even and odd functions. 1.4 Half range sine and cosine Fourier series, 1.5 Complex form of Fourier series. 1.6 Fourier Integral Representation, sine & cosine Integrals 1.7 Fourier Transform sine & cosine transforms, complex transforms. NO PROOFS REQUIRED.	10
02	Partial Differential Equations: 2.1 Solutions of linear partial differential Equation by method of separation of variables 2.2 Partial differential equations governing transverse vibrations of elastic string its solution using Fourier series. 2.3 Heat equation, steady-state configuration for heat flow. 2.4 Two dimensional Laplace equations.	08

	(ONLY NUMERICAL PROBLEMS. NO PROOFS REQUIRED).	
	Finite Differences and Interpolation 3.1 Forward difference operator Δ, backward difference operator ∇ , shift operator E, properties of operators Δ, ∇ and E, relation between E and D where D = $\frac{d}{dx}$. 3.2Missing terms (equal Intervals),Factorial Notation 3.3 Assumption of interpolation, Gregory Newton's Forward Interpolation formula for equal Intervals, Gregory Newton's Backward Interpolation formula for equal Intervals 3.4 Interpolation with arguments at unequal Intervals-Divided Difference table Newton's Divided Difference Formula , 3.5 Lagrange's Interpolation Formula.	**07**
04	Complex Integration 4.1 Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula(without proof) 4.2 Taylor's and Laurent's series (without proof) 4.3 Zeros, poles of f(z), Residues, Cauchy's Residue theorem 4.4 Applications of Residue theorem to evaluate Integrals of the type $\int_0^{2\pi} f(sin\theta, cos\theta)d\theta, \int_{-\infty}^{\infty} f(x)dx,$	**07**
05	Optimization (No theory) 5.1Non-linear programming: Lagrange multiplier method for one and two equality constraints for 2 and 3 variables, conditions on the Hessian matrix (no proof); 5.2 Non-linear programming: Kuhn-Tucker conditions with at most 2 constraints with two variables.	**07**

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.

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

Reference Books

1. Higher Engineering Mathematics by Dr. B. S. Grewal 42th edition, Khanna Publication 2005.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
3. A Text Book of Applied Mathematics Vol. II by P.N.Wartilar & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.
4. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Edition.
5. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage Learning.
6. Lapplace Treansforms by Murry R. Spieget, Schaun'sout line series-McGraw Hill Publication.
7. Operation Research by S. D. Sharma.
8. Operation Research by ER.Prem Kumar Gupta & Dr. D. S. Hira.

Course Code	Course/Subject Name	Credits
CHC402	**Engineering Chemistry– II**	**4**

Prerequisites:

- Knowledge of electronic structure of atom and electrolytic properties and their laws.
- Basic concept of quantum chemistry & wave theory approach.
- Knowledge of intermediate steps involved in conversion of reactants to products.
- Knowledge of properties of solutions.

Course Objectives:

- To understand applications of EMF measurement.
- To understand the principles of different instrumental and chromatographic techniques.
- To state and understand Nernst distribution law in extraction.
- To be able to solve numerical on solvent extraction and ion exchange.
- To understand colloidal phenomenon and its applications.
- To be able to predict the significance of active methylene group.
- To state and understand the Huckel's rule of aromaticity and its application to aromatic hydrocarbons and heterocyclic compounds.

Course Outcomes:

- They should be able to understand the role of different conductivity cells and different tirimetric methods and solvent extractions.
- Students will be able to detect the organic and inorganic biological compound by the use of spectrophotometer.
- Students will know the colloidal phenomenon applied in food industry and pesticides.
- Students will be to identify the significance of rearrangement reactions, active methylene group.
- Students will be able to predict and synthesize different products by learning reaction mechanism.
- Students will have deep knowledge of Qualitative (Analysis) and Quantitative (estimations) methods.

Module	Content	Contact Hours
1	**Electrochemistry** Conductance, specific conductance, equivalent conductance, molar conductance. Effect of dilution and temperature on conductance. Transport number (Numerical on moving boundary method). Debye Huckel theory of strong electrolytes. Hydrogen ion concentration by glass electrode/Quinhydrone electrode. Concentration cells with and without transference w.r.t. cations. Weston Standard cells. Application of emf measurement for	**08**

	determination of solubility product (Ksp) of sparingly soluble salt.	
2	**Instrumental methods of Analysis** Conductometry -Principle and types of titrations - Acid-base and precipitation. Potentiometry- Principle and types of titrations –precipitation only. **Chromatography** Adsorption and partition. Study of Paper Chromatography, ThinLayer Chromatography, High Performance Liquid Chromatography (HPLC), Gas (Liquid and solid) Chromatography –Principle and their applications. **Optical Methods** (Principle, Instrumentation and applications) UV, IR, NMR spectroscopy, flame photometry.	**10**
3	**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.	**06**
4	**Colloids and surfactants** Origin of charge on colloidal particles. Concept of electrical double layer-Helmholtz and stern model. Electro-kinetic Phenomenon- Electrophoresis, electro-osmosis, streaming potential and Dorn effect (Sedimentation potential). Colloidal electrolytes, Donnam Membrane equilibrium and its significance. **Catalysis-** Definition. Criteria of catalysis. Types (Homogeneous and Heterogeneous).Catalytic promoters, poisons. Negative catalysis and inhibition. Autocatalysis and Induced catalysis. Activation energy. Intermediate compound formation theory. Adsorption theory. Acid Base catalysis and mechanism. Enzyme catalysis- Characteristics and mechanism.	**10**
5	**Industrially important esters and Aromaticity** Synthesis and properties of malonic ester and acetate acetic ester. Huckel's rule of aromaticity, Aromatic character and reactions of Benzene,Naphthalene,Pyrrole, Furan, Thiophene, Pyridine.	**06**
6	**Name reactions.** Definition, meachanism and application of -Beckman rearangement, Fishcher-Indole synthesis, Favorskii reaction, Reformatsky reaction, Paal-Knorr synthesis of pyrrole, Benzil-Benzilic acid rearrangement.	**05**

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Principles of Physical Chemistry- B. R. Puri, L. R. Sharma, M.S. Pathania.
2. A textbook of Physical Chemistry - Glasston Samuel, Macmillan India Ltd. (1991).
3. Physical chemistry - Castellan G.W.Addison Hesly-Haroda Student Edition (1994).
4. Instrumental methods of Analysis - Willard, Merritt, CBS publishers and Distributor.
5. Instrumental Methods of Chemical Analysis - S.M.Khopkar
6. Principle of instrumental analysis - Douglas A. Skoog
7. Organic Chemistry - I L Finar volume I and II.
8. Advanced Organic Chemistry – Jerry March, John Wiley& Sons(Wiley India)
9. Organic Chemistry – J. Clayden, Greeves, Warren, Wothers. Oxford
10. Organic reaction Mechanisms- V.K. Ahluwalia , Rakesh Parashar, Narosa Publication
11. Spectroscopy – P.S. Kalsi
12. Introduction to Spectroscopy – Pavia, lampman, Kritz.
13. Engineering Chemistry- Jain & Jain Dhanapat Rai publication.
14. Vogels Textbook of Practical organic chemistry.

Course Code	Course/Subject Name	Credits
CHC403	**Chemical Engineering Thermodynamics II**	**04**

Prerequisites:

- Engineering Mathematics, Chemical Engineering Thermodynamics-I

Course Objectives:

- To make students understand the concepts of equilibrium in phases and in chemical reactions
- To make students learn to calculate conditions and compositions of ideal and non-ideal vapor liquid equilibrium systems and of various chemical reactions at equilibria.
- To make students understand the concept of refrigerator and learn to calculate COP, power required etc. for a given duty of refrigeration

Course Outcomes

- Students learn the application of First law and second law to the problem of phase equilibrium and reaction equilibrium.
- Students learn to calculate the refrigerant flow rate for a given duty of refrigeration.
- Students learn to calculate the compressor sizes and loads for refrigeration.
- The calculation of phase equilibria and the understanding of it is a fundamental concept to design of mass transfer

Module	Contents	Contact hrs
01	• Properties of ideal mixtures and solutions • Non idealities of solutions and mixtures • Chemical potential • Activity and activity coefficients • Gibbs Duhem equations	**04**
02	• Partial molar properties • Properties changes of mixing • Excess properties	**06**
03	• Concept of equilibrium between phases • Review of Raoult's law and Henry's law • Phase diagrams for binary solutions • Vapor liquid equilibria in ideal and non-ideal solutions • Estimation of activity coefficients using van Laar equation, Margules equation, Wilson equation	**10**
04	• Representation of reaction stoichiometry • Concept of reaction equilibrium in single and multiple reactions • Estimation of standard enthalpy change of a reaction • Heat of reaction in a batch and continuous reactor	**10**

	• Estimation of standard Gibbs free change and equilibrium constantof a reaction • Estimation of degree of conversion and composition of reactor effluents • Degree of freedom for single and multiple reactions	
05	• Theory of Refrigeration • Vapor compression refrigeration system • Vapor absorption refrigeration system • Refrigeration cycle diagrams (P-V, T-S, H-S, H-X) • Estimation of COP, power of compression, refrigerant flow rate etc.	**06**

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Reference

1. Introduction to Chemical Engineering Thermodynamic by J.M. Smith, H.C. Van Ness, M.M. Abbott, Latest Edition, McGraw Hill Publishing Company Limited
2. A textbook of Chemical Engineering Thermodynamics by K.V. Narayanan, Latest Edition, Prentice Hall of India Private Limited
3. Chemical Engineering Thermodynamics by Y.V.C. Rao, Latest Edition, University Press
4. Elementary Principle of Chemical Processes by Felder and Rousseau Latest Edition.
5. Introduction to Chemical Engineering Thermodynamics by GopinathHalder, PHI learning Pvt. Ltd

Course Code	Course/Subject Name	Credits
CHC404	**Solid Fluid Mechanical Operations**	**4**

Prerequisites:
- Fluid Flow Operations
- Engineering Mechanics
- Differential Equations

Course Objectives:
- understanding basic concept of particle size analysis and size reduction
- Understanding concept of flow through packed bed fluidization and filtration
- Understanding concept of sedimentation & gas solid separation
- Understanding concept of size enlargement, solid mixing and solid storage &conveying.

Course outcomes:
- The students would understand the concept of particle size analysis and size reduction.
- The students would understand the concept of flow through packed bed, fluidization and filtration
- The students would understand the concept of sedimentation and gas- solid separation.
- The students would understand the concept of solid mixing, solid storage & conveying, size enlargement.

Module	Contents	Contact Hours
1	Introduction- scope &application of solid fluid operation • Particle size analysis, particle size measurement and distribution • Sieve analysis • Capacity and effectiveness of screen • Screening Equipment: Vibrating screens; Grizzlier; Trommels • Size reduction of solids • Mechanism of size reduction and method of operation • Energy of size reduction • Size reduction Equipments:Jaw Crusher; Hammer Mill; Ball Mill; Roll Crusher	**12**
2	• Flow through packed bed • Types of packing • Flow of a single fluid through a packed bed, Ergun’s equipment • Fluidization: Conditions for fluidization; Minimum	**12**

	fluidization velocity; Types of fluidization; Application of Fluidization; Numerical on Fluidization • Filtration: Mechanism of Filtration; Types of Filtration – constant rate & constant pressure; Filtration; Filter aids, washing of filter cake; Flow of filtrate through the cloth & cake combine; Numerical onconstant pressure & constant cloth rate & combine cake. • Filters: Rotary drum vacuum filter, Plate & frame filter press	
3	• Economics of production and Growth • Sedimentation: Batch sedimentation; Kynch Theory of sedimentation; Area and Depth of thickener • Particle separation by Flotation and Elutriation • Gas solid separation Equipments: Cyclone separator- theory and derivation for minimum particle separated in cyclone separator. Fabric filter, Electrostatic precipitator	**10**
4	• Size enlargement of particles: Agglomeration & granulation Growth mechanism; Size enlargement processes • Storage of solids: Properties of particulate masses; Pressures in Bins &Silos; Jansen's equation • Conveying of solids: Belt conveyor, bucket conveyer, screw conveyer, pneumatic conveyer • Solid mixing: Introduction to solid mixing, degree of mixing, mixing Index & rate of mixing; Mixing Equipments:1) Mixers for cohesive solids: Muller Mixer; Kneaders . 2) Mixers for free flowing solids: Ribben Blender; Internal Screw mixer	**10**

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Unit operations of Chemical engineering, WC McCabe & J C Smith, McGraw Hill
2. Chemical Engineering, Vol II J M Coulson & J F Richardson, pergamon Press
3. Unit operations by foust
4. Perry's Handbook for chemical Engineers, Robert H. Perry & Don W. Green, 8th edition, McGraw Hill

Course Code	Course/Subject Name	Credits
CHC405	Mechanical Equipment Design (MED)	4

Prerequisites:

- Fundamentals of units
- Elementary theory of engineering mechanics
- Engineering drawing

Course Objectives:

- To understand the basics for design as per the codes & standards for the mechanical design of equipments used in the process industry.
- Selection of material of construction and stress analysis by determining values of stresses arising out of different loading conditions.

Course Outcomes:

- Students will demonstrate ability to design various components of process equipment as heads, shell, flanges and supports and complete design of chemical equipment
- Students will demonstrate understanding of design of storage vessel
- Students will demonstrate general understanding of fabrication techniques and equipment testing as a designer.

Module	Contents	Contact Hours
1	Introduction to Chemical process equipment design. Nature of process equipment, General design procedure. Basic consideration in process equipment design, Standards, codes & their significance, equipment classification & selection. Fundamentals of various stresses due to compression, tension, bending, torsion& thermal stresses. Fundamental of bending moment and shear stress. Concept of moment of inertia. Calculating moment of inertia for I, T, circle and solid bar. Calculation of bending moment of cantilever and simply supported beam and uniform distributed load. Principal stress and theories of failure. Concept of hook's law, material behavior and 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.	6
2	Design of Unfired Pressure Vessels Type of pressure vessels, code & standard for pressure vessels (IS: 2825:1969). Material of Construction, Selection of corrosion Allowance & weld joint efficiency. Thin cylinder theory for internal pressure. PART A: Pressure Vessel Subjected to Internal Pressure. Complete design of cylindrical pressure vessel as per IS: 2825: 1969. Study, selection & design of various heads such	10

	as flat, hemispherical, torispherical, elliptical & conical openings/nozzles & manholes etc. Flanged joints. Gasket: Types, selection & design. Bolt design & selection. Flange dimensions & optimization for bolt spacing. PART B: Pressure Vessel Subjected to External Pressure. Design of shell, heads nozzles, flanged joints & stiffening rings as per IS 2825: 1969 equation. Appendix F by use of charts. Analytical approach by elastic bucking & plastic deformation.	
3	Study of Various types of storage vessels and application. Atmospheric vessels, vessels for storing volatile & non-volatile liquids. Storage of gases, Losses in storage vessel. Various types of roofs used for storage vessels. Manholes, Nozzles and mounting. Design of cylindrical storage vessels as per IS: 803 should include base plates, shell plates ,roof plate and wind girders.	**5**
4	Study of various types of agitators & their application. Baffling. Power requirement of agitators & their applications, system which includes design of shaft based on equivalent bending moment and critical speed. Design of blades & Blade assembly, key & key ways. Study of seals. Design of stuffing box and gland.	**6**
5	Introduction, Classification of reaction vessels, Material of Construction, Heating system. Material of Construction, Heating system. Design of vessel. Study & design of various types of jackets like plain and half coil.	**4**
6	Introduction & classification of support. Design of skirt Support considering stresses due to dead weight, wind load, Seismic load & period of vibration. Design of base plates, skirt bearing plate, anchor bolt and bolting chair. Introduction to bracket support. Design of saddle supports.	**5**
7	Fundamentals of pipeline design. Optimum diameter of pipelines. Supporting structure for pipelines. Pipeline design for liquids and gases, steam and thermic fluids. Material of construction for pipelines.	**4**
8	Equipment fabrication and inspection Metal forming techniques (bending, Rolling, Forming). Metal Joining techniques – welding (Gas of Arc & Electric) for various types such as Butt, Lap, fillet, corner. Inspection of vessel by radiography.	**4**

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

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

- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Text Books

1. Process Equipment Design, 4^{th}Edition,V.V.Mahajani, Umarji, Macmillan Publishers
2. Process Design of Equipments, 4^{th} Edition, S.D. Dawande, Central Techno publications
3. Introduction to Chemical Equipment Design, B.C.Bhattacharya, CBS publications
4. Design of machine elements, V.B. Bhandari, McGraw Hill publications
5. Machine Drawing, N.D. Bhatt and V.M. Panchal, Charotar publication
6. Process Equipment Design and Drawing by Kiran Ghadyalji, Nandu publication. Kiran Ghadyalji, Nandu publication

Reference books

1. RC's Chemical Engineering, Fourth edition, R. K. Sinnott, Pergamon Press publications
2. Chemical Engineering Design, Fifth edition, Ray Sinnott and Cavin Towler, Elseveir, Butterworth-Heinemann publications
3. Equipment design handbook for refineries and chemical plants, volume 1 & 2,Evans F.L, Gulf publications
4. Process equipment design-vessel design, Brownell L.E., Edwin Young, John Wiley publications

Course Code	Course/Subject Name	Credits
CHC406	**Chemical Engineering Economics**	**4**

Prerequisites:

- The concepts of basic Mathematics as well as a few concepts of higher mathematics.
- The concepts of basic chemistry, basic civil engineering, basic mechanical engineering, etc. in order to understand the concepts like, corrosion, corrosion allowance, construction costs, equipment costs, etc.

Course Objectives:

- To understand various economical terms and economics related activities which can be helpful to them during economical evaluation of any chemical engineering related problem.
- To learn about various basic economic aspects like need, demand, supply, price, cost and market.
- To make familiar to calculate the interest amount on investments as well as loans by different methods
- To understand the concepts of present and future worth of property.
- To understand existing rules and regulations as well as types related to taxes and insurance.
- To understand the methodology of cost estimation including fixed and variable costs by considering the concept of cost indices.
- To have the knowledge about evaluation of depreciation cost as well as salvage value, scrap value, book value of property
- To understand the concept of profitability evaluation of project and select best process alternative based on its economic evaluation.
- To understand the concept of balance sheet, profit and loss accounting and income statement

Course Outcomes:

- Students should will be expose to market And demand driven economics in chemical industry.
- Get an idea on the growth and development of futuristic planning.
- Students will be able to calculate the profitability, rate of return on investments and cost estimation.
- After acquiring the knowledge in this subject, students become familiar with various aspects related to economics and can apply them for economic evaluation of chemical process and decide its economical feasibility.
- The knowledge in this subject will make the students well aware about economic evaluation of dissertation work that they will undertake in final year of their curriculum.
- Students will learn to prepare realistic cost estimation to prepare plan and offer.

Module	Contents	Contact hours
1	**Introduction to Basic Principles of Economics:** • 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 & futuristic planning • 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 03 • 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	**06**

	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 Project	
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 • Depreciation , types of depreciation, Methods of depreciation &Numericals	**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; Components of costs in FCI; • Methods of Cost Estimation • Estimation of Total Product Cost; • Break even Analysis • Cost estimation to prepare offer.	**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**

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Peters, M. S. and Timmerhaus, K. D. , “Plant design and economics for chemical engineers”, latest edition, Mcgraw Hill, New York
2. Pravin Kumar “Fundamentals of Engineering Economics” Wiley India.
3. Kharbanda, O. P. and Stallworthy, E. A. “Capital cost estimating for process industries”, Butterworths, Londen
4. K. K Dewett and Adarshchand, “ Modern Economic Theory”, latest edition, S Chand and Company
5. O. P Khanna, “Industrial Engineering and Management” DhanpatRai Publications (P) Ltd.
6. AtulSathe, ShubhadaKanchan, “Chemical Engineering Economics”, VipulPrakashan, Mumbai
7. Indrajit N. Yadav, “Chemical Engineering Economics” Sai- publication,Pune 2nd edition, 2017

Course Code	Course/Subject Name	Credits
CHL401	Engineering Chemistry Lab– II	1.5

List of Experiments Suggested:

- **Organic spotting-** Identification of organic compounds [**at least 05]**.
- **Potentiometric Titrations**
- Titration of strong acid and strong base potentiometrically.
- Determination of solubility and solubility product of AgCl.
- **pH-metry.**
- Determination of dissociation constant of dibasic organic acids such as malonic acid, succinic acid.
- **Conductometric Titrations.**
- Titration of strong acid with strong base.
- Weak acid against strong base.
- Titration of mixture of weak acid and strong acid against strong base.
- **Flame photometry.**
- Determination of Na / K / Ca present in the given sample.
- **Chromatography.**
- Estimation of Sodium by Ion Exchange chromatography.
- Paper Chromatography and TLC [Demonstration of techniques].
- **Organic Estimations.**
- Estimation of Glucose Iodometrically.
- Estimation of Ester by Hydrolysis.
- Volume strength and amount of H_2O_2.
- **Organic preperations**
- Nitration of benzene
- Nitration of Salicylic Acid
- Sulphonation of Benzene

Students have to perform any 10 practicals from the above during the semester.

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
CHL402	**Chemical Engineering Lab III (SFMO)**	**1.5**

List of Experiments Suggested

Minimum Ten Experiments must be performed

1. Sieve Analysis
2. Effectiveness Of Screen
3. Size reduction by Jaw Crusher
4. Size reduction by Hammer Mill
5. Size reduction by Ball Mill
6. Batch Sedimentation
7. Flow through Packed Bed
8. Flow through Fluidized Bed
9. Filtration
10. Mixing
11. Cyclone Separator
12. Roll Crusher
13. Elutriation
14. Froth Floatation

Term work

Term work shall be evaluated based on performance in practical.

Practical Journal: 20 marks
Attendance: 05 marks
Total: 25 marks

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
CHL403	**MED Lab**	**1**

Drawing sheets based on (Minimum of 8 sheets):

1. Design of Unfired Pressure Vessel with internal pressure.
2. Design of Unfired Pressure Vessel with external pressure.
3. Storage Vessel.
4. Agitator.
5. Reaction Vessel.
6. Vessel Supports.

Term work

Term work shall be evaluated based on performance in Lab.

Drawing Sheets: 20 marks
Attendance: 05 marks
Total: 25 marks

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

continued ...

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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 BRO-MOBENEZENE	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

continued ...

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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	BML301	Human Anatomy and Physiology for Engineers (HAPE)	1
2	BML302	Medical Sensors Lab	1
3	BML303	Electronic Circuits Analysis and Design Lab	1
4	BML304	Electronics Lab (SBL)	1
5	BMM301	Mini Project – 1 A	1
6	BML401	Integrated Circuit Design Lab	1
7	BML402	Principles of Control Systems Lab	1
8	BML403	Medical Imaging – I Lab	1
9	BML404	Computing Lab (SBL)	1
10	BMM401	Mini Project – 1 B	1
11	BMC501	Biomedical Instrumentation-I	1
12	BMC502	Microprocessors	1
13	BMC503	Analog and Digital Circuits Design	1
14	BMC504	Biomedical Digital Signal Processing	1
15	BMC505	Principles of Communication Engineering	1
16	BML506	Business Communication and Ethics	1
17	BMC601	Biomedical Instrumentation –II	1
18	BMC603	Biological Modeling and Simulation	1
19	BMC604	Microcontrollers and Embedded Systems	1
20	BMC605	Medical Imaging –I	1
21	BMC606	Digital Image Processing	1
22	BMC701	Biomedical Instrumentation-III	1
23	BMC702	Medical Imaging – II	1
24	BMC703	Biomechanics Prosthesis and Orthosis	1
25	BMC704	Very Large Scale Integrated Circuits	1
26	BMC705	Networking and Information System in Medicine	1
27	BMP706	Project Stage – I	1
28	BMC802	Biomedical Microsystems	1
29	BME804	Elective	1
30	BMP805	Project Stage – II	1
		Total	30

AC 11/05/2017

Item No. 4.179

UNIVERSITY OF MUMBAI

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

FACULTY OF TECHNOLOGY

Biomedical Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

From Co-ordinator's Desk:

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

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

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System were implemented for First Year Bachelor of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Bachelor of Engineering in the academic year 2017-2018.

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

Preamble:

The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and to achieve recognition of the institution or program meeting certain specified standards. The focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a student will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Electrical Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for the graduate program in Biomedical Engineering, more than ten senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for graduate program in Biomedical Engineering are listed below:

Program Educational Objectives (PEOs)

1. To provide sound knowledge of basic sciences, human anatomy, human physiology, electrical and electronic systems, building a strong foundation for career advancement.

2. To develop a logical approach, analytical thinking and problem solving capabilities in order to make the learner competent to face and address the global challenges in their chosen field.

3. To impart technical knowledge and competency skills to perform in various areas like sales & marketing, product engineering, research-development, hospital administration, regulatory affairs and also to venture into entrepreneurship.

4. To develop proficiency in various soft skills and bring awareness about social obligations and professional ethics to pursue professional career in a healthcare industry.

5. Motivate to pursue research and specialization in a plethora of domains in the field of Biomedical Engineering covering disciplines such as, Medical Instrumentation, Neuroscience, Computational Engineering, Robotics Engineering, Medical Signal and Image processing, Rehabilitation Engineering, VLSI, Nanotechnology and Biosensors, etc.

Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Dr. S. R. Deore,
Chairman,
Board of Studies in Electrical Engineering,
Member - Academic Council
University of Mumbai

Program Structure for
B.E. Biomedical Engineering
University of Mumbai
(With effect from academic year 2017 - 18)

Scheme for Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC301	Applied Mathematics III	04	----	01	04	----	01	05
BMC302	Basics of Human Physiology	04	----	----	04	----	----	04
BMC303	Electrical Network Analysis and Synthesis	04	----	----	04	----	----	04
BMC304	Electronic Circuit Analysis and Design	04	----	----	04	----	----	04
BMC305	Biomaterials, Prosthetics and Orthotics	04	----	----	04	----	----	04
BML301	Object Oriented Programing	----	04#	----	----	02	----	02
BML302	Basics of Human Physiology	----	02	----	----	01	----	01
BML303	Electrical Network Analysis and Synthesis	----	02	----	----	01	----	01
BML304	Electronic Circuit Analysis and Design	----	02	----	----	01	----	01
BML305	Biomaterials, Prosthetics and Orthotics	----	02	----	----	01	----	01
Total		**20**	**12**	**01**	**20**	**06**	**01**	**27**

 # Out of four hours, 2 hours theory shall be taught to the entire class and 2 hours practical in batches.

Examination Scheme for Semester III

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC301	Applied Mathematics III	80	32	20	8	25	10	---	---	---	---	---	---	125
BMC302	Basics of Human Physiology	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC303	Electrical Network Analysis and Synthesis	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC304	Electronic Circuit Analysis and Design	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC305	Biomaterials, Prosthetics and Orthotics	80	32	20	8	---	---	---	---	---	---	---	---	100
BML301	Object Oriented Programing	---	---	---	---	50	20	---	---	---	---	50	20	100
BML302	Basics of Human Physiology	---	---	---	---	25	10	---	---	25	10	---	---	50
BML303	Electrical Network Analysis and Synthesis	---	----	---	---	25	10	---	---	25	10	---	---	50
BML304	Electronic Circuit Analysis and Design	---	---	---	---	25	10	---	---	---	---	25	10	50
BML305	Biomaterials, Prosthetics and Orthotics	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		**400**	**160**	**100**	**40**	**175**	**70**	**---**	**---**	**75**	**30**	**75**	**30**	**825**

Scheme for Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC401	Applied Mathematics IV	04	----	01	04	----	01	05
BMC402	Biomedical Transducers and Measuring Instruments	04	----	----	04	----	----	04
BMC403	Linear Integrated Circuits	04	----	----	04	----	----	04
BMC404	Digital Electronics	04	----	----	04	----	----	04
BMC405	Signals and Control Systems	04	----	----	04	----	----	04
BML401	Introduction to Simulations Tools	----	02	----	----	01	----	01
BML402	Biomedical Transducers and Measuring Instruments	----	02	----	----	01	----	01
BML403	Linear Integrated Circuits	----	02	----	----	01	----	01
BML404	Digital Electronics	----	02	----	----	01	----	01
BML405	Signals and Control Systems	----	02	----	----	01	----	01
Total		**20**	**10**	**01**	**20**	**05**	**01**	**26**

Examination Scheme for Semester IV

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC401	Applied Mathematics - IV	80	32	20	8	25	10	---	---	---	---	---	---	125
BMC402	Biomedical Transducers and Measuring Instruments	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC403	Linear Integrated Circuits	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC404	Digital Electronics	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC405	Signals and Control Systems	80	32	20	8	---	---	---	---	---	---	---	---	100
BML401	Introduction to Simulations Tools	---	---	---	---	25	10	25	10	---	---	---	---	50
BML402	Biomedical Transducers and Measuring Instruments	---	---	---	---	25	10	---	---	25	10	---	---	50
BML403	Linear Integrated Circuits	---	----	---	---	25	10	---	---	---	---	25	10	50
BML404	Digital Electronics	---	---	---	---	25	10	---	---	---	---	25	10	50
BML405	Signals and Control Systems	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		**400**	**160**	**100**	**40**	**150**	**60**	**25**	**10**	**50**	**20**	**50**	**20**	**775**

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC301	Applied Mathematics III (Abbreviated as AM – III)	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC301	Applied Mathem-atics III (AM – III)	20	20	20	80	03	25	--	--	--	125

Course Code	Course Name	Credits
BMC301	Applied Mathematics III	05
Course Objectives	• To build the strong foundation in Mathematics of learner needed for the field of Biomedical Engineering. • To provide learner with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems. • To prepare student to apply reasoning informed by the contextual knowledge to engineering practice. • To prepare learner to work as part of teams on multi-disciplinary projects.	
Course Outcomes	• Learner will demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable. • Learner will demonstrate an ability to identify and Model the problems of the field of Biomedical Engineering and solve it. • Learner will be able to apply the application of Mathematics in Biomedical Engineering.	

Module No	Unit No.	Topic	Hours
1		**Laplace Transform**	
	1.1	**Laplace Transform (LT) of Standard Functions:** Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace transform of $e^{at}, Sin(at), \cos(at), \sinh(at), \cosh(at), t^n$ Heaviside unit step function, Dirac-delta function, Laplace transform of Periodic function	7

	1.2	**Properties of Laplace Transform:** Linearity, first shifting theorem, second shifting theorem, multiplication by t^n ,Division by *t*, Laplace Transform of derivatives and integrals, change of scale, convolution theorem, Evaluation of integrals using Laplace transform.	
2		**Inverse Laplace Transform & its Applications**	
	2.1	Partial fraction method, Method of convolution, Laplace inverse by derivative	**6**
	2.2	**Applications of Laplace Transform:** Solution of ordinary differential equations, Solving RLC circuit differential equation of first order and second order with boundary condition using Laplace transform (framing of differential equation is not included)	
3		**Fourier Series**	
	3.1	**Introduction:** Orthogonal and orthonormal set of functions, Introduction of Dirichlet's conditions, Euler's formulae	**11**
	3.2	**Fourier Series of Functions:** Exponential, trigonometric functions of any period =2L, even and odd functions, half range sine and cosine series	
	3.3	Complex form of Fourier series, Fourier integral representation, Fourier Transform and Inverse Fourier transform of constant and exponential function.	
4		**Vector Algebra & Vector Differentiation**	
	4.1	**Review of Scalar and Vector Product**: Scalar and vector product of three and four vectors, Vector differentiation, Gradient of scalar point function, Divergence and Curl of vector point function	**7**
	4.2	**Properties:** Solenoidal and irrotational vector fields, conservative vector field	
5		**Vector Integral**	
	5.1	Line integral	**6**
	5.2	Green's theorem in a plane, Gauss' divergence theorem and Stokes' theorem	
6		**Complex Variable & Bessel Functions**	
	6.1	**Analytic Function:** Necessary and sufficient conditions (No Proof), Cauchy Reiman equation Cartesian form (No Proof) Cauchy Reiman Equation in polar form (with Proof), Milne Thomson Method and it application, Harmonic function, orthogonal trajectories	**11**
	6.2	**Mapping:** Conformal mapping, Bilinear transformations, cross ratio, fixed points	
	6.3	**Bessel Functions:** Bessel's differential equation, Properties of Bessel function of order +1/2 and -1/2, Generating function, expression of	

		cos (xsin θ), sin (x sin θ) in term of Bessel functions	

Books Recommended:

Text Books:

1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Murry R. Spieget, *"Vector Analysis",* Schaum's outline series, Mc-Graw Hill Publication

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Term work:

Term work shall consist of minimum eight tutorials and assignments (minimum 2).
The distribution of marks for term work shall be as follows:

Tutorials	:15 marks
Assignments	:05 marks
Attendance (Theory and Tutorial)	:05 marks

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

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC302	Basics of Human Physiology (Abbreviated as BHP)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC302	Basics of Human Physiology (BHP)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC302	Basics of Human Physiology	04
Course Objectives	• To understand the human anatomy and functions of various body structures. • To understand different physiological processes taking place inside human body.	
Course Outcomes	Learners will be able to: • Understand the structure and function of cell, the action potential and muscle physiology. • Distinguish the different anatomical parts of cardiovascular and respiratory system. Understand the physiology of heart, and other organs of cardiovascular system, concept of Blood pressure and use of ECG. Understand the exchange in gases taking place in body and use of spirometer. • To know the composition of blood, blood cells with their functions, basics of cell counting, blood grouping and coagulation of blood. • Distinguish different organs of digestive and urinary system. Understand the process of digestion, secretions and their functions. Understand the process of urine formation and micturition • Understand the anatomy of nervous system, working of different parts of brain, parasympathetic and sympathetic nervous system, reflex arc and reflex action. Distinguish different parts of eyes and ear, their structure and function. Understand the hearing mechanism and image formation on the retina, understand the use of ophthalmoscope and design of hearing aid • Understand the different parts of male and female reproductive system with their working, action of sex hormones. To know all the endocrine glands with their secretion and function, and control action.	

Module	Contents	Hours
1	**Organization of Human Body:** Cell, Tissue, Organ, Organ system, Structure and functions of cell, Polarization and Depolarization of Cell, Types of tissues, Homeostasis, Positive and Negative Feedback Mechanism **Muscle Physiology:** Muscle physiology and aspects of Skin Resistance	05
2	**Cardiovascular System**: Anatomy of Cardiovascular System, Heart, Conductive Tissues of Heart, Cardiac Cycle, Heart Valves, Systemic and Pulmonary Circulation, Transmission of Cardiac Impulse, Blood Pressure, ECG, Einthoven's Triangle, Twelve Lead System and ECG Waveforms **Respiratory System:** Anatomy of Respiratory System, Ventilation, Exchange in gases in the alveoli, Spirometer (Forced Expiratory Volumes)	12
3	**Blood:** Composition of Blood – Blood cells and their functions, Haemoglobin, Blood Grouping, Coagulation, Wound Healing.	05
4	**Alimentary System:** All organs of the Digestive System, other secretions and main Functions, Deglutition and Defecation. **Urinary System:** Structure of Nephron, Function of Kidney, Urinary Bladder, Urethra, Internal/External Sphincters, Formation of Urine, Micturition	08
5	**Nervous System:** Different parts, their functions. Reflex actions and reflex are, Function of Sympathetic and Parasympathetic nervous system. Nerve conduction and action potentials. **Special Senses:** **Eyes-**Structure, Refractive Medias of the Eye, Formation of Image on the Retina. **Ear** – Structure of Cochlea, Hearing mechanism	10
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.	08

Books Recommended:

Text books:

1. Anatomy and Physiology in Health and Illness: Ross and Wilson. (ELBS Pub)
2. Essentials of Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Reference Books:

1. Physiology of Human Body. : Guyton. (Prism Book)
2. Review of Medical Physiology: William Ganong. (Prentice Hall Int)
3. Principles of Anatomy and Physiology: Tortora and Grabowski. (Harper collin Pub)
4. Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

3. Question paper will comprise of 6 questions, each carrying 20 marks.
4. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Name</th><th colspan="3">Teaching scheme</th><th colspan="4">Credit 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>BMC303</td><td>Electrical Network Analysis and Synthesis (Abbreviated as ENAS)</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
</table>

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="10">Examination Scheme</th></tr>
<tr><th colspan="5">Theory</th><th rowspan="3">Term work</th><th rowspan="3">Pract.</th><th rowspan="3">Oral</th><th rowspan="3">Pract. / Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal Assessment</th><th rowspan="2">End sem</th><th rowspan="2">Duration (hrs)</th></tr>
<tr><th>Test 1</th><th>Test 2</th><th>Avg.</th></tr>
<tr><td>BMC303</td><td>Electrical Network Analysis and Synthesis (ENAS)</td><td>20</td><td>20</td><td>20</td><td>80</td><td>03</td><td>--</td><td>--</td><td>--</td><td>--</td><td>100</td></tr>
</table>

Course Code	Course Name	Credits
BMC303	**Electrical Network Analysis and Synthesis**	**04**
Course Objectives	• To learn a number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, source transformation and several methods of simplifying networks. • To apply concept of network theorems to the electrical circuits. • To understand the concept of graphical solution to electrical network. • To understand frequency response in electrical circuits. • To make the learner learn how to synthesize an electrical network from a given impedance/admittance function.	
Course Outcomes	Learner will be able to • Apply number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, source transformation and several methods of simplifying networks. • Apply the concept of circuit analysis to understand network theorems • Apply the concept of graphical solution to electrical network. • Distinguish between different one port and two port network parameters • Analyse time and frequency response of the electrical circuits. • To make the learner learn how to synthesize an electrical network from a given impedance/admittance function.	

Module	Contents	Hours
1	**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**
2	**Network Theorems (** D.C. & A.C. circuits)**:** Superposition, Thevenin's & Norton's Theorem (with independent and dependent sources), Maximum power transfer theorem.	**06**
3	**Circuit Analysis:** Introduction to Graph Theory. Tree, link currents, branch voltages, cut set & tie set, Mesh & Node Analysis, Duality.	**06**
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**
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**
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**

Books Recommended:

Text Books:

1. Sudhakar & S.P. Shyammohan, Circuits and Networks, Tata McGraw Hill, thirteenth reprint, 2000.
2. William H. Hayt, Jack e. Kemmerly & Steven M. Durbin, Engineering Circuit Analysis, McGraw Hill International, sixth edition, 2202.
3. Raymond A. DeCarlo & Pen-Min Lin, Linear Circuit Analysis, Oxford University Press, second edition, 2001.
4. M. E. Van Valkenburg, Introduction to Modern Network Synthesis, Wiley Eastern Ltd.

Reference Books:

1. Artice M. Davis, Linear Circuit Analysis, Thomson Asia Pte. Ltd, Singapore, first edition, 2001.

2. M.E. Van Valkenburg, Network Analysis, Prentice Hall of India, third edition
3. C.L.Wadhwa, Network Analysis and Synthesis, New Age International Publisher, Third Edition.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
BMC304	Electronic circuit analysis and design (Abbreviated as ECAD)	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC304	Electronic Circuit Analysis and Design (ECAD)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC304	Electronic Circuit Analysis and Design	04
Course Objectives	• To understand basic characteristics of semiconductor devices. • To design small signal amplifiers using BJT and FET	
Course Outcomes	Learner will be able to: • Understand the basic semiconductor components like P-N junction diodes, zener diodes and their various applications. • Understand BJT working and its various configurations and DC operating conditions • Understanding AC operating conditions and Design of single stage small signal CE amplifiers • Design of single stage small signal CS amplifiers • Understand the working of MOSFETs, its characteristics and its various applications • Understanding the concept of multistage amplifiers	

Module	Contents	Hours
1.	**Diodes Circuits:** Basics of PN junction diode - Equation, characteristics. Clipper and Clamper Circuits using diodes, Zener Diode – Characteristics and Working, Study Zener as a voltage regulator	**05**
2.	**Bipolar Junction Transistor**: Working of PNP and NPN Transistor. Configurations (CB, CC, CE), comparison, Q-Point, DC load line. BJT Biasing - DC analysis, Stability. (Fixed, Self, Voltage divider, Collector to base, Collector to base self). BJT as a switch.	**10**
3.	.**A.C. Equivalent Model** – $\mathbf{r_e}$ model, h-parameter model (Exact and Approximate), Hybrid-π model A.C. Analysis-(Using any one model): A.C. load line, A.C. analysis of CE, CB, CC amplifier configurations, Effects of R_S and $R_{L,}$ Comparison between various amplifiers. Low frequency and High frequency analysis, Frequency response of Single stage amplifier. Design of single stage amplifier using BJT.	**10**
4.	**Junction Field Effect Transistor:** Working and basic terminology related to JFET. Configurations (CS, CG, CD), comparison, Q-Point, DC load line. JFET Biasing – Fixed, Self, Voltage divider, Concept of stability against device parameters and temperature, zero temperature drift. A.C. Equivalent model of JFET. A.C. Analysis of amplifiers using CS, CG and CD amplifier configurations, Effects of R_S and R_L, Comparison between various amplifiers. Low frequency and High frequency analysis, Frequency response of Single stage amplifier. Design of single stage amplifier using JFET.	**12**
5.	**MOSFET:** Working of Depletion and Enhancement type MOSFET Construction, Characteristics and equations, Basic MOSFET Applications	**04**
6.	**Multistage Amplifiers:** Cascade: BJT-BJT, FET-BJT. Cascode – DC and AC analysis, characteristics Darlington amplifier- DC and AC analysis, characteristics	**07**

Books Recommended:

Text Books:

1. Neamen Donald A., *Electronics Ckt. Analyzer & Design*, 2nd ed., Tata McGraw Hill.
2. Boylestad Robert L., Nashelsky Louis, *Electronics Devices & Circuits*, Pearson Education.
3. *Semiconductor Data Manual*, BPB Publications.

Reference Books:

1.Malvino—Electronic Principles , 6/e ,TMH
2. Millman & Halkias: Basic Electronic Principles; TMH.
3..Martin Roden, Gordon carpenter, William Wieseman, Electronic design, Fourth edtion, Sroff publishers.
4. Donald Schilling & Charles Belove, Electronic Circuits Discrete and Integrated, Third edition, Mcgraw Hill.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.

3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.

4: Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC305	Biomaterials , Prosthetics and Orthotics (Abbreviated as BPO)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC305	Biomaterials Prosthetics and Orthotics (BPO)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC305	Biomaterials, Prosthetics and Orthotics	04
Course Objectives	• To understand the fundamentals of materials used for manufacturing implants that has wide application in healthcare industry. • To understand design principles of prostheses and orthoses.	
Course Outcomes	• Understand the definition, classification and general applications of biomaterials. Study the surface characterization techniques. • Understand properties and applications of polymeric, degradable and composite biomaterials. • Understand properties and applications of metals and ceramic biomaterials. • Selection of materials on the basis of testing of the biomaterials done biologically, mechanically, physio-chemically and thermally before implantation in the human body. • Study anatomical levers, gait cycle and gait parameters • Understand the definition of prostheses and orthoses and its design principles.	

Module	Contents	Hours
1	**Introduction**: Introduction of Biomaterials, Classification of Biomaterials, General Applications. **Techniques for characterization of Surface properties of Biomaterials:** Electron Spectroscopy for Chemical Analysis (ESCA), Secondary Ion Mass Spectrometry(SIMS), Infrared Spectroscopy, Contact Angle Method.	**08**
2	**Properties and Applications of Polymeric and degradable Biomaterials:** Classification, polyurethanes, PTFE, Polyethylene, Polypropylene, Polyacrylates, PMMA, PHEMA, Hydrogel, Silicone rubber, Biopolymer in fabrication of biodevices and implants, Thermoplastic and thermosetting plastics. Degradable biomaterials (PGA and PLA), applications in drug delivery systems. **Composite Biomaterials:** Properties, classification and Applications of Composite Biomaterials in fabrication of biodevices and implants. Applications of biomaterials in Drug delivery systems,	**09**
3	**Properties and Applications of Metallic Biomaterials and its Biocompatibility:** Stainless steel, Titanium, Titanium based alloys, Cobalt – Chromium alloys in fabrication of bio-devices and implants. **Properties and Applications of Ceramic Biomaterials:** Classification, Alumina, Zirconia and types, Bioglass, Calcium Phosphate, Tricalcium phosphate in fabrication of biodevices and implants.	**08**
4	**Biological Testing of Biomaterials:** Physiochemical Test, Mechanical Test, Invitro and Invivo types, Different forms of corrosion, Wear, Electrochemical Corrosion Testing.	**08**
5	**Movement biomechanics** Overview of joints and movments, anatomical levers, gait cycle (stance and swing phase with stick diagram), gait parameters	**05**
6	**Prosthetics and Orthotics** Principles of three point pressure, Lower limb prostheses, partial weight bearing-PTB socket, total contact- quadrilateral socket. Upper limb prosthesis (terminal devices) Spinal orthoses.	**10**

Books Recommended:

Text Books:

1. Biomaterial Science and Engineering: J.V. Park (Plenum Press- New York)
2. Fundaments of Biomedical Engineering: G S. Sawhney (New Age International Publication)
3. Biomaterial Science: An Introduction to Materials in Medicine, Ratner & Hoffmann
4. American Atlas of Orthopedics: Prosthetics, C. V. Mosby.
5. American Atlas of Orthopedics: Orthotics, C. V. Mosby
6. Basics of Biomechanics by Ajay Bahl, Jaypee publications.

Reference Books:

1. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).
2. Encyclopedia – Handbook of Biomaterials and Bioengineering: Part-A: Materials Vol I, II (Marcel Dekkar Pub) Part – B: Applications Vol. I, II.
3. Design Engineering on Biomaterials for medical devices: David Hill, John Willey Publication
4. Biological Performance of Materials, 2nd Edition – Jonathan Black, Marcel Dekker Inc. New York. Basel. Hong Kong

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML301	Object Oriented Programming (Abbreviated as OOPM)	--	04#	--	--	02	--	02

 # Out of four hours, 2 hours theory shall be taught to the entire class and 2 hours practical in batches.

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML301	Object Oriented Programming (OOPM)	--	--	--	--	50	--	--	50	100

Course Code	Course Name	Credits
BML301	Object Oriented Programming	02
Course Objective	• To learn the object oriented programming concepts • To study various java programming constructs like multithreading, exception handling, packages etc. • To explain components of GUI based programming.	
Course Outcome	• To apply fundamental programming constructs. • To illustrate the concept of packages, classes and objects. • To elaborate the concept of strings, arrays and vectors. • To implement the concept of inheritance and interfaces. • To implement the notion of exception handling and multithreading. • To develop GUI based application.	

Prerequisite: Structured Programming Approach

Sr. No.	Module	Detailed Content	Hours

1	**Introduction to Object Oriented Programming**	**1.1OO Concepts:** Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism. **1.2Features of Java, JVM** **1.3 Basic Constructs/Notions:** Constants, variables and data types, Operators and Expressions,Revision of Branching and looping	02
2	**Classes, Object and Packages**	**2.1**Class,Object, Method. **2.2** Constructor, Static members and methods **2.3** Passing and returning Objects **2.4**Method Overloading **2.5** Packages in java, creating user defined packages, access specifiers.	05
3	**Array, String and Vector**	**3.1** Arrays, Strings, StringBuffer **3.2** Wrapper classes, Vector	04
4	**Inheritance and Interface**	**4.1**Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword, **4.2** Implementing interfaces, extending interfaces	03
5	**Exception Handling and Multithreadin g**	**5.1** Error vs Exception, try, catch, finally, throw, throws, creating own exception **5.2** Thread lifecycle, Thread class methods, creatingthreads, Synchronization	04
6	**GUI programming in JAVA**	**6.1 Applet:** Applet life cycle, Creating applets, Graphics class methods, Font and Color class, parameter passing. **6.2 Event Handling:** Event classes and event listener **6.3 Introduction to AWT:** Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Check Box, and Radio Buttons.	06

Note: #Out of four hours of practical two hours to be conducted as theory

List of Laboratory Experiments: (Any Fifteen experiments and three assignments)

1. Program on various ways to accept data through keyboard and unsigned right shift operator.
2. Program on branching, looping, labelled break and labelled continue.
3. Program to create class with members and methods, accept and display details for single object.
4. Program on constructor and constructor overloading
5. Program on method overloading
6. Program on passing object as argument and returning object
7. Program on creating user defined package
8. Program on 1D array

9. Program on 2D array
10. Program on String
11. Program on StringBuffer
12. Program on Vector
13. Program on single and multilevel inheritance (Use super keyword)
14. Program on abstract class
15. Program on interface demonstrating concept of multiple inheritance
16. Program on dynamic method dispatch using base class and interface reference.
17. Program to demonstrate try, catch, throw, throws and finally.
18. Program to demonstrate user defined exception
19. Program on multithreading
20. Program on concept of synchronization
21. Program on Applet to demonstrate Graphics, Font and Color class.
22. Program on passing parameters to applets
23. Program to create GUI application without event handling using AWT controls
24. Program to create GUI application with event handling using AWT controls

Books Recommended:

Text books:

1. Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
2. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.
2. DietalandDietal, 'Java: How to Program', 8/e,PHI
3. 'JAVA Programming', Black Book, Dreamtech Press.

Assessment:

Term Work:

Term work shall consist of minimum 15 experiments and 3 Assignments
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments)	: 20 Marks
Laboratory work (journal)	: 10 Marks
Assignments	: 15 Marks
Attendance	: 5 Marks

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

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML302	**Basics of Human Physiology (BHP)**	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML302	**Basics of Human Physiology (BHP)**	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML302	**Basics of Human Physiology**	**01**
Course Objective	• To understand the human anatomy and functions of various body structures. • To understand different physiological processes taking place inside human body	
Course Outcome	• To measure blood pressure using occlusive cuff method • To apply blood cell counting principle for measuring blood composition. • To analyse electrical activity of heart. • To apply the knowledge of instruments used for supporting cardio-vascular system	

Syllabus: Same as that of BMC302 Basics of Human Physiology.

List of Laboratory Experiments: (Any Seven)

1. To measure Blood Pressure using sphygmomanometer using occlusive cuff method.
2. To determine hemoglobin count in the blood by Sahli's method.
3. In-vitro recognition of A, B, O blood groups by slide test.
4. To find the total Red Blood Cell count using Neubauer's haemocytometer.
5. To find the total White Blood Cell count using Neubauer's haemocytometer.
6. To study ECG Machine

7. To study electrical activity of heart
8. To measure heart-beats using PQRST Waveform of ECG.
9. To study Cardiac Pacemaker.
10. To study Defibrillator.
11. Visit to the hospital anatomy department to view specimen.
12. Presentations on the given topic.

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text books:

1. Anatomy and Physiology in Health and Illness: Ross and Wilson. (ELBS Pub)
2. Essentials of Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Reference Books:

1. Physiology of Human Body. : Guyton. (Prism Book)
2. Review of Medical Physiology: William Ganong. (Prentice Hall Int)
3. Principles of Anatomy and Physiology: Tortora and Grabowski. (Harper collin Pub)
4. Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML303	Electrical Network Analysis and Synthesis (ENAS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML303	Electrical Network Analysis and Synthesis (ENAS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML303	Electrical Network Analysis and Synthesis	01
Course Objective	• To implement several methods of simplifying networks. • To verify network theorems for analyzing electrical circuits. • To understand the concept of graphical solution to electrical network • To study frequency response in electrical circuits. • To make the learner learn how to synthesize an electrical network from a given impedance/admittance function.	
Course Outcome	Learner will be able to • Apply number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, source transformation and several methods of simplifying networks. • Implement network theorems to analyze the circuit • Apply the concept of graphical solution to electrical network. • Discriminate between different one port and two port network parameters • Analyze time and frequency response of the electrical circuits • Synthesize an electrical network from a given impedance/admittance function.	

Syllabus: Same as that of BMC303 Electrical Network Analysis and Synthesis.

List of Laboratory Experiments: (Any five)

1. To study superposition theorem
2. To study Norton theorem
3. To study Thevenin's theorem
4. To study and verify Maximum power theorem
5. To study transfer functions
6. a) To study Y parameters of a two-port network.
   b) To study Z parameters of a two-port network.
7. Interconnection of two-port network
8. To study Time Response of first order system
9. To study the second order frequency response of an RLC circuit

Suggested Tutorials: (Any six)

1. Mesh & Node Analysis with Independent Sources
2. Mesh & Node Analysis with Dependent Sources
3. Network Theorems
4. Circuit Analysis
5. Time and Frequency Response of Circuits (Transient Analysis)
6. Time and Frequency Response of Circuits (Laplace Transform Analysis)
7. Two-Port Networks (Two-Port Parameters)
8. Two-Port Networks (Inter Relationship of different parameters. Interconnections of two-port networks)
9. Fundamentals of Network Synthesis (Hurwitz polynomials and Positive real functions)
10. Fundamentals of Network Synthesis (Driving Point Synthesis with L-C, R-C, R-L and R-L- C networks)

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1. Sudhakar & S.P. Shyammohan, Circuits and Networks, Tata McGraw Hill, thirteenth reprint, 2000.
2. William H. Hayt, Jack e. Kemmerly & Steven M. Durbin, Engineering Circuit Analysis, McGraw Hill International, sixth edition, 2202.
3. Raymond A. DeCarlo & Pen-Min Lin, Linear Circuit Analysis, Oxford University Press, second edition, 2001.
4. M. E. Van Valkenburg, Introduction to Modern Network Synthesis, Wiley Eastern Ltd.

Reference Books:

1. Artice M. Davis, Linear Circuit Analysis, Thomson Asia Pte. Ltd, Singapore, first edition, 2001.
2. M.E. Van Valkenburg, Network Analysis, Prentice Hall of India, third edition
3. C.L.Wadhwa, Network Analysis and Synthesis, New Age International Publisher, Third Edition.

Assessment:

Term Work:

Term work shall consist of minimum 5 experiments and 6 tutorials

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

Laboratory work (Experiments) : 10 Marks

Laboratory work (Tutorials) : 10 Marks

Attendance : 5 Marks

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

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
BML304	Electronic Circuit Analysis and Design (ECAD)	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML304	Electronic Circuit Analysis and Design (ECAD)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML304	Electronic Circuit Analysis and Design	01
Course Objective	• To apply the theoretical knowledge of semiconductor devices to practical circuits. • To design and implement Clippers, Clampers, Zener regulator and small signal amplifiers	
Course Outcome	Learner will be able to: • Verify the outputs of various electronic circuits such as clipper, clampers etc. • Verify the transfer characteristics of basic semiconductor devices. • Design amplifier circuits and verify their results practically. • Study frequency response of small signal amplifiers.	

Syllabus: Same as that of BMC304 Electronic Circuit Analysis and Design.

List of Laboratory Experiments: (Any seven)

1. To study Clipper circuit
2. To study Clampers circuit
3. Study of zener as a regulator
4. Study of BJT characteristics
5. Study of BJT as switch
6. Implementation of biasing circuit of BJT

7. Study of frequency response of CE amplifier
8. Study of FET characteristics
9. Implementation of biasing circuit of FET
10. Study of Frequency response of CE amplifier

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1. Neamen Donald A., *Electronics Ckt. Analyzer & Design*, 2nd ed., Tata McGraw Hill.
2. Boylestad Robert L., Nashelsky Louis, *Electronics Devices & Circuits*, Pearson Education.
3. *Semiconductor Data Manual*, BPB Publications.

Reference Books:

1.Malvino—Electronic Principles , 6/e ,TMH
2. Millman & Halkias: Basic Electronic Principles; TMH.
3..Martin Roden, Gordon carpenter, William Wieseman, Electronic design, Fourth edtion, Sroff publishers.
4. Donald Schilling & Charles Belove, Electronic Circuits Discrete and Integrated, Third edition, Mcgraw Hill.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments)	: 10 Marks
Laboratory work (Journal)	: 10 Marks
Attendance	: 5 Marks

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

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
BML305	Biomaterials, Prosthetics and Orthotics (BPO)	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML305	Biomaterials, Prosthetics and Orthotics (BPO)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML305	Biomaterials, Prosthetics and Orthotics	01
Course Objective	• To understand the fundamentals of materials used for manufacturing implants that has wide application in healthcare industry. • To understand design principles of prostheses and orthoses	
Course Outcome	Learners will be able to: • Understand the definition, classification and general applications of biomaterials. Study the surface characterization technique • Understand properties and applications of polymeric, degradable and composite biomaterials. • Understand properties and applications of metals and ceramic biomaterials. • Selection of materials on the basis of testing of the biomaterials done biologically, mechanically, physio-chemically and thermally before implantation in the human body. • Study anatomical levers, gait cycle and gait parameters • Understand the definition of prostheses and orthoses and its design principles.	

Syllabus: Same as that of BMC305 Biomaterials, Prosthetics and Orthotics

List of Laboratory Experiments: (Any seven)

1) Introduction of Biomaterials.
2) Techniques for characterization of Surface properties of Biomaterials.
3) Biological Testing of Biomaterials.
4) Mechanical and Physiochemical Testing of Biomaterials
5) Properties and Applications of Metallic Biomaterials and its Biocompatibility.

6) Properties and Applications of Polymeric Biomaterials.
7) Properties and Applications of Ceramic Biomaterials.
8) Properties and Applications of Composite Biomaterials.
9) Corrosion of biomaterials
10) Biomaterials for Soft Tissue Replacements.

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1. Biomaterial Science and Engineering: J.V. Park (Plenum Press- New York)
2. Fundaments of Biomedical Engineering: G S. Sawhney (New Age International Publication)
3. Biomaterial Science: An Introduction to Materials in Medicine, Ratner & Hoffmann
4. American Atlas of Orthopedics: Prosthetics, C. V. Mosby.
5. American Atlas of Orthopedics: Orthotics, C. V. Mosby
6. Basics of Biomechanics by Ajay Bahl, Jaypee publications.

Reference Books:

1. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).
2. Encyclopedia – Handbook of Biomaterials and Bioengineering: Part-A: Materials Vol I, II (Marcel Dekkar Pub) Part – B: Applications Vol. I, II.
3. Design Engineering on Biomaterials for medical devices: David Hill, John Willey Publication
4. Biological Performance of Materials, 2nd Edition – Jonathan Black, Marcel Dekker Inc. New York. Basel. Hong Kong

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments / tutorials
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments / Tutorials): 20 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC401	Applied Mathematics IV (Abbreviated as AM - IV)	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Dur a tion (hrs)					
		Test 1	Test 2	Av g.							
BMC401	Applied Mathematics IV (AM - IV)	20	20	20	80	03	25	--	--	--	125

Course Code	Course Name	Credits
BMC401	Applied Mathematics IV	05
Course Objectives	• To develop analytical insight of the student to prepare them for graduates studies in Biomedical Engineering • To enhance their ability to solve and analyse Biomedical Engineering problem. • To provide learner with a strong mathematical foundation to acquire the professional competence knowledge and skills.	
Course Outcomes	• It is expected that learner will develop the proactive approach towards the selection of methods to a solution of Biomedical Engineering problems. • Learner will be able identify different probability distribution , learn sampling technique, compute Eigen values and Eigen vectors and evaluate complex integrals and use their application in Biomedical Engineering problems. • Learner will be able to know new subjects that are required to solve in industry.	

1		**Calculus of Variation:**	**06**
	1.1	Euler's Langrange equation, solution of Euler's Langrange equation (only results for different cases for Function) independent of a variable, independent of another variable, independent of differentiation of a variable and independent of both variables	
	1.2	Isoperimetric problems, several dependent variables	
	1.3	Functions involving higher order derivatives: Rayleigh-Ritz method	
		Linear Algebra: Vector Spaces	**06**
2	**2.1**	Vectors in n-dimensional vector space: properties, dot product, cross product, norm and distance properties in n-dimensional vector space.	
	2.2	Vector spaces over real field, properties of vector spaces over real field, subspaces.	
	2.3	The Cauchy-Schwarz inequality, Orthogonal Subspaces, Gram-Schmidt process.	
3		**Linear Algebra: Matrix Theory**	**10**
	3.1	Characteristic equation, Eigen values and Eigen vectors, properties of Eigen values and Eigen vectors	
	3.2	Cayley-Hamilton theorem (without proof), examples based on verification of Cayley- Hamilton theorem.	
	3.3	Similarity of matrices, Diagonalisation of matrices.	
	3.4	Functions of square matrix, derogatory and non-derogatory matrices.	
4		**Probability**	**10**
	4.1	Baye's Theorem (without proof)	
	4.2	Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function, expectation, variance.	
	4.3	Moments, Moment Generating Function.	
	4.4	Probability distribution: Binomial distribution, Poisson & normal distribution (For detailed study)	
5		**Correlation**	**04**
	5.1	Karl Pearson's coefficient of correlation, Covariance, Spearman's Rank correlation,	
	5.2	Lines of Regression.	
6		**Complex integration**	**12**
	6.1	Complex Integration: Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula.	
	6.2	Taylor's and Laurent's Series	
	6.3	Zeros, singularities, poles of f(z), residues, Cauchy's Residue theorem.	
	6.4	Applications of Residue theorem to evaluate real Integrals of different types.	

Books Recommended:

Text books:

1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication
4. P.N.Wartilar & J.N.Wartikar, "*A Text Book of Applied Mathematics*" Vol. I & II, Vidyarthi Griha Prakashan., Pune.

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Seymour Lipschutz "*Beginning Linear Algebra*" Schaum's outline series, Mc-Graw Hill Publication
5. Seymour Lipschutz "*Probability*" Schaum's outline series, Mc-Graw Hill Publication

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Term Work:

Term work shall consist of minimum 8 tutorials

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

Tutorials	: 20 Marks
Attendance	: 5 Marks

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

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3 Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked
4: Remaining question will be randomly selected from all the modules.

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Name</th><th colspan="3">Teaching scheme</th><th colspan="4">Credit 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>BMC402</td><td>Biomedical Transducers and Measuring Instruments (Abbreviated as BTMI)</td><td>04</td><td>--</td><td>--</td><td>04</td><td>--</td><td>--</td><td>04</td></tr>
</table>

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="10">Examination Scheme</th></tr>
<tr><th colspan="5">Theory</th><th rowspan="3">Term work</th><th rowspan="3">Pract</th><th rowspan="3">Oral</th><th rowspan="3">Pract. / Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal Assessment</th><th rowspan="2">End sem</th><th rowspan="2">Dur a tion (hrs)</th></tr>
<tr><th>Test 1</th><th>Test 2</th><th>Av g.</th></tr>
<tr><td>BMC402</td><td>Biomedical Transducers and Measuring Instruments (BTMI)</td><td>20</td><td>20</td><td>20</td><td>80</td><td>03</td><td>--</td><td>--</td><td>--</td><td>--</td><td>100</td></tr>
</table>

<table>
<tr><th>Course Code</th><th>Course Name</th><th>Credits</th></tr>
<tr><td>BMC402</td><td>Biomedical Transducers and Measuring Instruments</td><td>04</td></tr>
<tr><td>Course Objectives</td><td colspan="2">

To provide the knowledge of basic concepts such as measuring instruments and generalized instrumentation system, general properties of input transducers, static and dynamic characteristics of transducers and sensors.
To provide a thorough understanding of principle and working of transducers and sensors used for displacement, motion, pressure and temperature measurement, bio-potential electrodes, chemical sensors, biosensors, fiber optic sensors, and radiation sensors.
To study the biomedical applications of the above transducers and sensors.
To perform experiments based on some of the above transducers and sensors.
</td></tr>
<tr><td>Course Outcomes</td><td colspan="2">

To clearly understand generalized medical instrumentation system, general properties of transducers, static and dynamic characteristics of transducers and sensors.
Understand the fundamental principles and applications of various types of sensors including motion, displacement and pressure sensors.
Present different transduction methods for measuring temperature.
To understand principle of various biopotential electrodes
Understand principle and working of chemical sensor
To understand principle of various biosensors, and differentiate various amperometric and potentiometric sensors.
</td></tr>
</table>

Module	Contents	Hours
1	**Introduction:** Generalized Instrumentation System, General Properties Of Input Transducer. Static Characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift, Hysteresis, Linearity, Input Impedance and Output Impedance. Dynamic Characteristics: First Order and Second Order Characteristics, Time Delay, Error Free Instrument, Transfer Functions. Design Criteria, Generalized Instrument Specifications.	04
2	**Medical Instruments:** **Electronic and Digital Voltmeter** Types: FET Voltmeter, Peak and Average Responding voltmeter, True RMS responding voltmeter. Digital to Analog Converter: Binary weighted and R-2R ladder. Analog to digital converter: Ramp type, Dual Slope type, Successive Approximation type ADC, DVM: Ramp type, Dual Slope type, Successive Approximation type, Flash type DVM. Resolution & Sensitivity. Multimeter: Working, Specifications. **Oscilloscopes:** Block Diagram of C.R.O (in details). Requirements of Time base, Delayed Time Base, Post deflection acceleration, triggering. Description of Panel Layout and working of controls. Specifications of CRO. Applications: Measurement of voltage, current. Types: Dual trace, Dual beam, Digital Storage – Block diagram, working, application, comparison.	14
3	**Displacement, motion and Pressure Measurement**: (with applications) Resistive: Potentiometers, Strain Gauges and Bridge Circuits. Inductive: Variable Inductance and LVDT Capacitive type, Piezoelectric Transducers. Types of Diaphragms, Bellows, Bourdon Tubes.	10
4	**Temperature Measurement:** Thermistor, Thermocouple, Resistive Temperature Detector, IC based Temperature Measurement Radiation Sensors	06
5	**Bio potential Electrodes:** Electrodes Electrolyte Interface, Half-Cell Potential, Polarization, Polarizable and Non Polarizable, Electrodes, Calomel Electrode, Electrode Circuit Model, Electrode Skin-Interface and Motion Artifact. Body Surface Electrodes. Internal Electrodes: Needle and Wire Electrodes (Different Types). Microelectrodes: Metal, Supported Metal Micropipette (Metal Filled Glass And Glass Micropipette Electrodes)	06
6	**Chemical Sensors:** Blood gas and Acid- Base Physiology, Potentiometric Sensors (pH, pCO_2 Electrodes, Amperometric Sensors (pO_2), ISFETS, Transcutaneous Arterial O_2 and CO_2 Tension Monitoring. **Fiber Optic Sensors:** Principle of Fiber Optics, Fiber Optic Sensors - Temperature, Chemical, Pressure. **Biosensor:** Classifications and types with examples.	08

Books Recommended:

Text Books:

1. Kalasi H.S.- Electronic Instrumentation
2. A.K. Sawhney- Electrical & Electronic Measurement & Instrumentation.
3. Medical Instrumentation-Application and Design by John G. Webster.
4. Instrument Transducer – An Intro to their performance and design, Hermann K P. Neubert.
5. Biomedical sensors – fundamentals and application by Harry N, Norton.
6. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamma and P. Ake Öberg.
7. Electronics in Medicine and Biomedical Instrumentation by Nandini K. Jog PHI Second Edition 2013.

Reference Books:

1. Principles of applied Biomedical Instrumentation by La Geddes and L.E. Baker.
2. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred. J. Weibell and Pfeiffer.
3. Principles of Biomedical Instrumentation and Measurement, Richard Aston, Merril Publishing Co., Columbus, 1990.
4. Measurement Systems, Application and Design, Ernest O. Doeblin, McGraw-Hill, 1985.
5. Handbook of Modern Sensors – Physics, Design and Application, Jacob Fraden, AIP press.
6. Transducers for Biomedical Measurements: Principles and Applications, Richard S.C. Cobbold, John Wiley & Sons, 1974.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules

Course Code	Course Name	Teaching scheme			Credit assigned			
BMC403	Linear Integrated Circuits (Abbreviated as LIC)	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Dur a tion (hrs)					
		Test 1	Test 2	Av g.							
BMC403	Linear Integrated Circuits (LIC)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC403	Linear Integrated Circuits	04
Course Objectives	• To provide concepts of differential, operational and power amplifiers with their applications and design methodology • To cover analysis of circuits with negative feedback	
Course Outcomes	Learner will be able to: • Analyse different types of differential amplifiers • Demonstrate basics of operational amplifiers • Analyse and design operational amplifier to perform mathematical operations • Analyse and design operational amplifier as oscillators • Illustrate basics of negative feedback and perform analysis on different types of circuits with negative feedback • Exhibit working of power amplifiers, its types and DC and AC analysis and designing	

Module	Contents	Hours
1.	**Differential Amplifiers:** • Basic Concept • Types: Dual Input Balanced Output, Dual Input Unbalanced Output, Single Input Balanced Output And Single Input Unbalanced Output. • Common mode and Differential mode analysis - DC and AC analysis. • Differential amplifiers with Swamping Resistor • Constant current source, current mirror circuits	**05**
2.	**Introduction to operational Amplifier :** • Introduction to an Ideal Operational Amplifier, Block Diagram, DC and AC Characteristics, Equivalent circuit of Op-amp • Op-amp IC 741 characteristics, frequency response and concept of virtual ground.	**05**
3.	**Applications of operational Amplifier :** • Adder, Subtractor /differential Amplifier, Voltage follower, Integrator (practical and Ideal), Differentiator (practical and Ideal), Instrumentation amplifier • Voltage to Current and Current to Voltage converters, Active Half wave rectifiers, Active Full wave rectifier, Clipper, Clampers, Log and Antilog amplifiers, Sample & hold circuits, Peak detector, Multipliers and Dividers, • Schmitt Trigger (Regenerative comparator), Voltage comparators, zero crossing detector.	**15**
4.	**Oscillators using Operational Amplifier:** • Concepts of Oscillation. Barkhausen's criteria for an oscillator. • Types of oscillators: RC Phase shift Oscillator, Wien Bridge oscillator, Colpitt's Oscillator, Hartley Oscillator, Crystal Oscillator, Clapp Oscillator, (Phase shift, Frequency of oscillation, condition of sustained oscillation, circuit operation and Amplitude stability in the above oscillators).	**08**
5.	**Negative Feedback:** • Introduction to Feedback • Negative feedback characteristics: Gain Sensitivity, Bandwidth Extension, Noise Sensitivity, Reduction of Non-Linear Distortion. • Feedback Topologies, Series-Shunt, Shunt-Series, Series-Series, Shunt-Shunt Configurations • Negative feedback amplifiers: Voltage Amplifiers, Current Amplifiers, Trans-Conductance Amplifiers, Trans-Resistance Amplifiers (DC and AC analysis.	**10**
6.	**Power Amplifiers :** • Classes of Power amplifiers, Class-A, Class-B, Class AB, Class C • Analysis: Class-A Power Amplifiers (Direct coupled and Transformer coupled), Class-B Power Amplifiers, Class-AB Push Pull and Complementary Symmetry Power amplifier • Power amplifier design, Heat Sinks and its design	**05**

Books Recommended:

Text Books:

1.. Electronic Circuit Analysis and Design- Donald A Neamen,
2. Electronic Devices and circuits – R Bolystead.
3. Op-Amps and linear integrated circuits – R. Gayakwad
4. Linear Integrated Circuits: Roy Chaudhary

Reference Books:

1. Integrated Electronics –Millman & Halkias
2. Opamps and linear integrated circuits, Theory and Applications- James Fiore

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC404	Digital Electronics (Abbreviated as DE)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC404	Digital Electronics (DE)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC404	Digital Electronics	04
Course Objectives	• To make learner aware of basics of Digital circuits, logic design, various Logic Families and Flip-flops. • Learner should be able to design of various counters, registers and their applications.	
Course Outcomes	Learner will be able to: • Understand various number systems and its arithmetic (BCD, Binary, Octal, Hexadecimal etc.) • Solve sums on K-maps, Boolean algebra and SOP-POS implementations. • Design code converter circuits, parity generator-checker circuits and magnitude comparator circuits. • Design circuits using multiplexers, demultiplexers, and decoders. • Design synchronous and asynchronous counters and registers using flip flops. • Design various gates using various logic families.	

Module	Contents	Hours
1.	**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.	**05**
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.	**05**
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.	**15**
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, State transition diagrams, Use of Denounce switch. Counter Modulus of a counter, Ripple counter, Up/Down Counter, Designing sequential counters using gate IC and counter IC by drawing state transition Diagram & state transition table. Ring counter Johnson counter, twisted ring counter, Pseudo Random number generator, Unused states and locked conditions.	**08**
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, Universal shift register	**10**
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.	**05**

Books Recommended:

Text Books:

1. R.P.Jain, "Modern Digital Electronics," Tata McGraw Hill, 1984
2. M Morris Mono, "Digital Design," Prentice Hall International-1984.
3. Malvino & Leach, "Digital Principal and Applications", Tata McGraw Hill, 1991.
4. Malvino, "Digital Electronics", Tata McGraw Hill, 1997.

Reference Books:

1. James Bignell & Robert Donovan, “Digital Electronics”, Delmar, Thomas Learning,
2. Jog N.K, “Logic Circuits”, 2nd edition, Nandu Publisher & Printer Pvt .Ltd. 1998.
3. Alan b. Marcovitz, “Introduction to Logic Design “, McGraw Hill International 2002.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC405	Signals and Control System (Abbreviated as SCS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC405	Signals and Control System (Abbreviated as SCS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC405	Signals and Control Systems	04
Course Objectives	• To introduce the concepts and techniques associated with the understanding of signals and systems such as the basic parameters, properties and interaction of signals and system. • To familiarize with techniques suitable for analysing and synthesizing signals and systems in continuous domain.	
Course Outcomes	• Represent signals and system mathematically • Represent integral of LTI systems, properties of system in terms of impulse response • Determine Fourier series representation of CT, properties of Fourier series • Derive and determine Laplace transform, region of convergence, application of Laplace transform, Inverse Laplace transform. • Analyse given systems and suggest modifications.	

Module	Contents	Hours
1	**Introduction to Signals:** Basic of continuous time signals like unit step, ramp, exponential, operation on signals like flipping, shifting, scaling, and multiplication. Classification of signals: Periodic /Aperiodic, Power and Energy, Even and Odd.	07
2	**Introduction to Systems:** System representation in the continuous and discrete time domain. Classification of systems on the basis of Causal/non-Causal, Time variance/Time invariance, Linear/Non-Linear, Stable/Unstable. Continuous convolution	07

3	**Fourier Analysis of Continuous time Signals** Orthogonal functions, Representation of signals in terms of weighted orthogonal basis functions, Coefficient calculation on the basis of minimum square error**.** Fourier series: Representation of Fourier series in terms of sine, cosine, exponential functions. The complex Fourier spectrum, Properties of Fourier series, convergence of Fourier series, Gibbs phenomenon. Fourier transform and its properties. Fourier transform of singular functions. Energy density spectrum	**07**
4	**Laplace Transform:** Double sided Laplace transforms, Region of Convergence, properties, Unilateral Laplace Transform, properties, applications of Laplace transform to the solution of differential equations. Inverse Laplace Transform.	**08**
5	**Introduction to Control Systems**: Basic concepts of control systems, open loop and closed loop systems, difference between open loop and closed loop systems, signal flow graph.	**07**
6	**Time domain and Frequency domain behaviour of Systems** Time domain analysis of first order and second order systems. Condition of BIBO stability in time domain. Frequency response of linear systems. Stability and Routh array, Bode plots, Root Locus	**12**

Books Recommended:

Text Books:

1. Oppenheim A. V. & Alan S.Wllisky, Signals and Systems, Pearson Education
2. Simon Haykin & Barry Van Veen, Signals and Systems, Wiley-India
3. Modern Control Engineering : D.Roy Choudhury, PHI
4. Modem Control Engineering : K. Ogata , PHI
5. Control Systems Engineering: L.J. Nagrath, M. Gopal, Third Edition, New Age International Publishers.

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 & Eve A Riskin, Signals, Systems and Transforms, Pearson Education
4. Control System, Theory & Applications : Samarjit Ghosh, Pearson Education
5. System Dynamic and Control : Eroni Umez Erani., PWS Publishing, International Thompson Publishing Company

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML401	Introduction to Simulations Tools (IST)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML401	Introduction to Simulations Tools (IST)	--	--	--	--	25	25	--	--	50

Course Code	Course Name	Credits
BML401	Introduction to Simulations Tools	01
Course objective	• To study Simulation software • Study Proteus	
Course Outcome	Learner will be able to: • Understand various tools of simulation software • Write Programme in Programming Software • Simulate Digital and analog circuits • Understand use of Proteus software • Simulate differential equations	

List of Laboratory Experiments: (Any seven)

1. Study of Various simulation software Commands
2. Plotting variable using software
3. Study of various Proteus commands.
4. Simulating Inverting and Non inverting Amplifier in Proteus
5. Implementing logic gates using Proteus
6. Decade Counter using flip-flop in Proteus
7. Simulating differential Equations
8. Simulate basic electrical circuit using pspice

Any other experiment using these simulation tools which will help learner to understand the application of these tools during their B.E project work

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

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

Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks

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

Practical examination will be based on suggested practical list.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML402	Biomedical Transducers and Measuring Instruments (BTMI)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML402	Biomedical Transducers and Measuring Instruments (BTMI)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML402	Biomedical Transducers and Measuring Instruments	01
Course objective	• To display and record signals using CRO. • To implement digital to analog converter. • To analyse step response of a thermometer and measure temperature using various temperature transducers. • To measure displacement using various displacement transducers. • To measure pressure using a pressure transducer. • To measure pH of a solution using pH electrodes.	
Course Outcome	Learner will be able to: • Record and display signals using CRO. • Convert analog data into digital form. • Analyse step response of a thermometer and measure temperature using various temperature transducers. • Measure displacement using various displacement transducers. • Measure pressure using a pressure transducer. • Measure pH of a solution using pH electrodes.	

Syllabus: Same as that of BMC402 Biomedical Transducers and Measuring Instruments

List of Laboratory Experiments: (Any seven)

1. Study of Front panel of CRO
2. A to D converter
3. To study the dynamic behaviour of thermometer system.
4. To study the characteristics of a thermistor.
5. To study thermistor linearization.
6. To study the characteristics of a light dependent resister.

7. To study the principle and working of a thermocouple.
8. To study principle and working of LVDT.
9. To study principle and working of a capacitive Transducer.
10. To study principle and working of a strain gage sensor.
11. To study principle and working of a pressure sensor.
12. To study pH electrode.

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1. Kalasi H.S.- Electronic Instrumentation
2. A.K. Sawhney- Electrical & Electronic Measurement & Instrumentation.
3. Medical Instrumentation-Application and Design by John G. Webster.
4. Instrument Transducer – An Intro to their performance and design, Hermann K P. Neubert.
5. Biomedical sensors – fundamentals and application by Harry N, Norton.
6. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamma and P. Ake Öberg.
7. Electronics in Medicine and Biomedical Instrumentation by Nandini K. Jog PHI Second Edition 2013.

Reference Books:

1. Principles of applied Biomedical Instrumentation by La Geddes and L.E. Baker.
2. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred. J. Weibell and Pfeiffer.
3. Principles of Biomedical Instrumentation and Measurement, Richard Aston, Merril Publishing Co., Columbus, 1990.
4. Measurement Systems, Application and Design, Ernest O. Doeblin, McGraw-Hill, 1985.
5. Handbook of Modern Sensors – Physics, Design and Application, Jacob Fraden, AIP press.
6. Transducers for Biomedical Measurements: Principles and Applications, Richard S.C. Cobbold, John Wiley & Sons, 1974.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks

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

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML403	Linear Integrated Circuits (LIC)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML403	Linear Integrated Circuits (LIC)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML403	Linear Integrated Circuits	01
Course Objective	• To provide designing methodology and implementation technique for differential, operational and power amplifiers.	
Course Outcome	• To design and implement various mathematical operations using operational amplifier • To implement waveform generation using operational amplifier • To implement circuits of differential amplifiers, power amplifiers and negative feedback.	

Syllabus: Same as that of BMC403 Linear Integrated Circuits

List of Laboratory Experiments: (Any seven)

1. Differential amplifier
2. Inverting amplifier
3. Non-inverting amplifier
4. Designing circuit using operational amplifier for given mathematical equation
5. Integrator
6. Differentiator
7. Half wave rectifier
8. RC-phase shift oscillator
9. Wein bridge oscillator
10. Instrumentation amplifier
11. Negative feedback

12. Schmitt trigger
13. Comparator
14. Zero crossing detector
15. Class B push pull power amplifier

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1.. Electronic Circuit Analysis and Design- Donald A Neamen,

2. Electronic Devices and circuits – R Bolystead.
3. Op-Amps and linear integrated circuits – R. Gayakwad
4. Linear Integrated Circuits: Roy Chaudhary

Reference Books:

1. Integrated Electronics –Millman & Halkias
2. Opamps and linear integrated circuits, Theory and Applications- James Fiore

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

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

Laboratory work (Experiments) : 10 Marks

Laboratory work (Journal) : 10 Marks

Attendance : 5 Marks

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

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML404	Digital Electronics	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML404	Digital Electronics	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML404	Digital Electronics	01
Course Objective	• To make learner aware of basics of digital circuits, logic design and Flip-flops. • Learner should be able to design of various counters, registers and their applications.	
Course Outcome	Learners will be able to: 1. Understand various ICs used for basic gates,EX-OR and EX-NOR gates 2. Design code converter circuits. 3. Design parity generator-checker circuits, adder-subtractor circuits and magnitude comparator circuits 4. Design circuits using multiplexers, demultiplexers, and decoders. 5. Design synchronous and asynchronous counters using flipflops. 6. Design various registers using flip flops.	

Syllabus: Same as that of BMC404 Digital Electronics

List of Laboratory Experiments: (Any seven)

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 decade counter
12. To design Synchronous counter.

Any other experiment based on syllabus which will help learner to understand topic/concept

Books Recommended:

Text Books:

1. R.P.Jain, “Modern Digital Electronics,” Tata McGraw Hill, 1984
2. M Morris Mono, “Digital Design,” Prentice Hall International-1984.
3. Malvino & Leach, “Digital Principal and Applications”, Tata McGraw Hill, 1991.
4. Malvino, “Digital Electronics”, Tata McGraw Hill, 1997.

Reference Books:

1. James Bignell & Robert Donovan, “Digital Electronics”, Delmar, Thomas Learning,
2. Jog N.K, “Logic Circuits”, 2nd edition, Nandu Publisher & Printer Pvt .Ltd. 1998.
3. Alan b. Marcovitz, “Introduction to Logic Design “, McGraw Hill International 2002.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

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

Laboratory work (Experiments) : 10 Marks

Laboratory work (Journal) : 10 Marks

Attendance : 5 Marks

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

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML405	Signals and Control Systems (SCS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML405	Signals and Control Systems (SCS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML405	Signals and Control Systems	01
Course objective	• To introduce the concepts and techniques associated with the understanding of signals and systems such as the basic parameters, properties and interaction of signals and system. • To familiarize with techniques suitable for analyzing and synthesizing signals and systems in continuous domain.	
Course Outcome	• Represent signals and system mathematically • Represent integral of LTI systems, properties of system in terms of impulse response • Determine Fourier series representation of CT, properties of Fourier series • Derive and determine Laplace transform, region of convergence, application of Laplace transform, Inverse Laplace transform. • Analyze given systems and suggest modifications.	

Syllabus: Same as that of BMC405 Signals and Control Systems

List of Laboratory Experiments: (Any Five)

1. Introduction to signals and plotting of signals
2. Operations on Signal
3. Classification of Signals
4. Open Loop and Closed loop
5. Stability
6. Bode Plot
7. Root Locus
8. Convolution
9. Pole Zero plot

List of suggested Tutorials: (Any Six)

1. Introduction to signals and systems
2. Fourier Series
3. Laplace Transform
4. Inverse Laplace Transform
5. Application of Laplace Transform
6. Open Loop and Closed loop
7. Signal Flow graph
8. Stability
9. Bode Plot
10. Root Locus
11. Time domain analysis

Any other practical and tutorial based on syllabus which will help learner to understand topic/concept

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

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

Laboratory work (Experiments) : 10 Marks

Laboratory work (Tutorial) : 10 Marks

Attendance : 5 Marks

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

Oral examination will be based on suggested practical list and entire syllabus.

Program Structure for
TE Biomedical Engineering
University of Mumbai
(With effect from academic year 2018 - 19)

Scheme for Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC501	Diagnostic & Therapeutic Instruments	04	----	----	04	----	----	04
BMC502	Analog and Digital Circuit Design	04	----	----	04	----	----	04
BMC503	Principles of Communication Engineering	04	----	----	04	----	----	04
BMC504	Biomedical Digital Image Processing	04	----	----	04	----	----	04
BMDLO501X	Department Level Optional Course – I	04	----	----	04	----	----	04
BML501	Business Communication and Ethics	----	02*+02	----	----	02	----	02
BML502	Diagnostic and Therapeutic Instruments	----	02	----	----	01	----	01
BML503	Integrated and Communication Circuit Design	----	02	----	----	01	----	01
BML504	Biomedical Digital Image Processing	----	02	----	----	01	----	01
BMDLL501X	Department Level Optional Course Laboratory – I	----	02	----	----	01	----	01
Total		**20**	**12**	----	**20**	**06**	----	**26**

***2 hrs. theory shall be taught to the entire class.**

Examination Scheme for Semester V

Course Code	Course Name	Theory External (UA) Max Marks	Theory External (UA) Min Marks	Theory Internal (CA) Max Marks	Theory Internal (CA) Min Marks	Term work Max Marks	Term work Min Marks	Practical Max Marks	Practical Min Marks	Oral Max Marks	Oral Min Marks	Pract./Oral Max Marks	Pract./Oral Min Marks	Total Marks
BMC501	Diagnostic & Therapeutic Instruments	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC502	Analog and Digital Circuit Design	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC503	Principles of Communication Engineering	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC504	Biomedical Digital Image Processing	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 501X	Department Level Optional Course – I	80	32	20	8	---	---	---	---	---	---	---	---	100
BML501	Business Communication and Ethics	---	---	---	---	50	20	---	---	---	---	---	---	50
BML502	Diagnostic and Therapeutic Instruments	---	---	---	---	25	10	---	---	25	10	---	---	50
BML503	Integrated and Communication Circuit Design	---	----	---	---	25	10	25	10	---	---	---	---	50
BML504	Biomedical Digital Image Processing	---	---	---	---	25	10	---	---	---	---	25	10	50
BMDLL 501X	Department Level Optional Course Laboratory – I	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		**400**	**160**	**100**	**40**	**150**	**60**	**25**	**10**	**50**	**20**	**25**	**10**	**750**

Scheme for Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC601	Biomedical Monitoring Equipment	04	----	----	04	----	----	04
BMC602	Microprocessors and Microcontrollers	04	----	----	04	----	----	04
BMC603	Digital Image Processing	04	----	----	04	----	----	04
BMC604	Medical Imaging-I	04	----	----	04	----	----	04
BMDLO602X	Department Level Optional Course – II	04	----	----	04	----	----	04
BML601	Biomedical Monitoring Equipment	----	02	----	----	01	----	01
BML602	Microprocessors and Microcontrollers	----	02	----	----	01	----	01
BML603	Digital Image Processing	----	02	----	----	01	----	01
BML604	Medical Imaging-I	----	02	----	----	01	----	01
BMDLL602X	Department Level Optional Course Laboratory – II	----	02	----	----	01	----	01
Total		**20**	**10**	----	**20**	**05**	----	**25**

Examination Scheme for Semester VI

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC601	Biomedical Monitoring Equipment	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC602	Microprocessors and Microcontrollers	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC603	Digital Image Processing	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC604	Medical Imaging-I	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 602X	Department Level Optional Course – II	80	32	20	8	---	---	---	---	---	---	---	---	100
BML601	Biomedical Monitoring Equipment	---	---	---	---	25	10	---	---	---	---	25	10	50
BML602	Microprocessors and Microcontrollers	---	---	---	---	25	10	---	---	---	---	25	10	50
BML603	Digital Image Processing	---	----	---	---	25	10	---	---	---	---	25	10	50
BML604	Medical Imaging-I	---	---	---	---	25	10	---	---	25	10	---	---	50
BMDLL 602X	Department Level Optional Course Laboratory – II	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		**400**	**160**	**100**	**40**	**125**	**50**	**---**	**---**	**50**	**20**	**75**	**30**	**750**

Program Structure for
BE Biomedical Engineering
University of Mumbai
(With effect from academic year 2019 - 20)

Scheme for Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC701	Life Saving and Surgical Equipment	04	----	----	04	----	----	04
BMC702	Very Large Scale Integrated System	04	----	----	04	----	----	04
BMC703	Medical Imaging-II	04	----	----	04	----	----	04
BMDLO703X	Department Level Optional Course – III	04	----	----	04	----	----	04
ILO701X	Institute Level Optional Course – I	03	----	----	03	----	----	03
BML701	Life Saving and Surgical Equipment	----	02	----	----	01	----	01
BML702	Very Large Scale Integrated System	----	02	----	----	01	----	01
BML703	Medical Imaging-II	----	02	----	----	01	----	01
BMDLL703X	Department Level Optional Course Laboratory – III	----	02	----	----	01	----	01
BML704	Project Stage I	----	06	----	----	03	----	03
Total		**19**	**14**	----	**19**	**07**	----	**26**

Examination Scheme for Semester VII

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC701	Life Saving and Surgical Equipment	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC702	Very Large Scale Integrated System	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC703	Medical Imaging-II	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 703X	Department Level Optional Course - III	80	32	20	8	---	---	---	---	---	---	---	---	100
ILO701 X	Institute Level Optional Course – I	80	32	20	8	---	---	---	---	---	---	---	---	100
BML701	Life Saving and Surgical Equipment	---	---	---	---	25	10	---	---	25	10	---	---	50
BML702	Very Large Scale Integrated System	---	---	---	---	25	10	---	---	25	10	---	---	50
BML703	Medical Imaging-II	---	----	---	---	25	10	---	---	25	10	---	---	50
BMDLL 703X	Department Level Optional Course Laboratory – III	---	---	---	---	25	10	---	---	25	10	---	---	50
BML704	Project Stage I	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		**400**	**160**	**100**	**40**	**125**	**50**	**---**	**---**	**125**	**50**	**---**	**---**	**750**

Scheme for Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC801	Biomedical Microsystems	04	----	----	04	----	----	04
BMC802	Hospital Management	04	----	----	04	----	----	04
BMDLO804X	Department Level Optional Course – IV	04	----	----	04	----	----	04
ILO802X	Institute Level Optional Course – II	03	----	----	03	----	----	03
BML801	Biomedical Microsystems	----	02	----	----	01	----	01
BML802	Hospital Management	----	02	----	----	01	----	01
BMDLL804X	Department Level Optional Course Laboratory – IV	----	02	----	----	01	----	01
BML803	Project Stage II	----	12	----	----	06	----	06
Total		**15**	**18**	----	**15**	**09**	----	**24**

Examination Scheme for Semester VIII

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC801	Biomedical Microsystems	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC802	Hospital Management	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 804X	Department Level Optional Course - IV	80	32	20	8	---	---	---	---	---	---	---	---	100
ILO802X	Institute Level Optional Course –II	80	32	20	8	---	---	---	---	---	---	---	---	100
BML801	Biomedical Microsystems	---	---	---	---	25	10	---	---	25	10	---	---	50
BML802	Hospital Management	---	---	---	---	25	10	---	---	25	10	---	---	50
BMDLL 801X	Department Level Optional Course Laboratory – IV	---	----	---	---	25	10	---	---	25	10	---	---	50
BML803	Project Stage II	---	---	---	---	50	20	---	---	---	---	100	40	150
Total		**320**	**128**	**80**	**32**	**125**	**50**	**---**	**---**	**75**	**30**	**100**	**40**	**700**

Department Level Optional Courses

Course Code	Department level Optional Course - I
BMDLO5011	Healthcare Database Management
BMDLO5012	Biostatistics
BMDLO5013	Rehabilitation Engineering

Course Code	Department level Optional Course - II
BMDLO6021	Healthcare Software
BMDLO6022	Lasers and Fibre Optics
BMDLO6023	Biological Modelling and Simulation

Course Code	Department level Optional Course - III
BMDLO7031	Networking and Information in Medical System
BMDLO7032	Advanced Image Processing
BMDLO7033	Embedded Systems

Course Code	Department level Optional Course - IV
BMDLO8041	Health Care Informatics
BMDLO8042	Robotics in Medicine
BMDLO8043	Nuclear Medicine

Institute Level Optional Courses

Course Code	Institute level Optional Course - I
ILO7011	Product Lifecycle Management
ILO7012	Reliability Engineering
ILO7013	Management Information System
ILO7014	Design of Experiments
ILO7015	Operation Research
ILO7016	Cyber Security and Laws
ILO7017	Disaster Management and Mitigation Measures
ILO7018	Energy Audit and Management
ILO7019	Development Engineering

Course Code	Institute level Optional Course - II
ILO8021	Project Management
ILO8022	Finance Management
ILO8023	Entrepreneurship Development and Management
ILO8024	Human Resource Management
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)
ILO8026	Research Methodology
ILO8027	IPR and Patenting
ILO8028	Digital Business Management
ILO8029	Environmental Management

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 2nd 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, 12^{th} 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	BTL301	Microbiology Lab	1
2	BTL302	Biochemistry Lab	1
3	BTL303	Unit Operations-I Lab	1
4	BTL401	Fermentation Technology Lab	1
5	BTL402	Analytical Methods in Biotechnology Lab	1
6	BTL403	Unit Operations –II Lab	1
7	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: 11-05-2017
Item No. 4.188

UNIVERSITY OF MUMBAI

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

Biotechnology

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

Under

FACULTY OF TECHNOLOGY

As per **Choice Based Credit and Grading System**
With effect from the AY 2016–17

From Coordinator's Desk

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

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

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and grading based system is implemented for Second Year of B.E. in Biotechnology Engineering from the academic year 2017-2018. This system will be carried forward for Third Year of B.E. in Biotechnology Engineering in the academic year 2018-2019 and for Fourth Year B.E. in the year 2019-2020 respectively.

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

Preamble to the Revision of Syllabus in Biotechnology Engineering

The onset of nineties brought about some paradigm shifts. One was in the sphere of market economics. Suddenly the Indian manufacturing sector started jostling for a place with international competition in the arena. The presence of International products at competitive rates and quality forced some small and medium scale units to close their operations. The larger industry players realized the importance of R&D and accordingly set up separate cells to optimize production and improve quality. The second major impact was in the sphere of knowledge. With the advent of World Wide Web in the early nineties and its subsequent growth, the latest research trends have become accessible from drawing rooms across the globe. This acted as a positive feedback mechanism in increasing the pace of research in all fields including 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 Biotechnology at Thadomal Shahani College of Engineering Bandra on 3rd February 2017. It was attended by the various heads of departments of Biotechnology engineering as well as experts from industry. The academic scheme and exam scheme of the program was discussed along with the program objectives and outcomes. The core structure of the syllabus was formulated keeping in mind **choice based credit and grading system** curriculum to be introduced in this revised syllabus for B.E. (Biotechnology) for all semesters. A second meeting was held in Datta Meghe College of Engineering Airoli on 20th February 2017 and detailed syllabus of Semesters III and IV was finalised. Subsequently another meeting was held in Thadomal Shahani Engineering College Bandra on 11th April 2017 to finalise the detail syllabus of subjects pertaining to semester V, VI, VII and VIII.

Dr. Kalpana S. Deshmukh,
Chairman, Board of Studies in Chemical Engineering (Adhoc),
University of Mumbai, Mumbai.

General Guidelines

Tutorials

- The number of tutorial batches can be decided based on facilities available in the institution.
- Tutorials can be creative assignments in the form of models, charts, projects, etc.

Term Work

- Term work will be an evaluation of the tutorial/practical done over the entire semester.
- It is suggested that each tutorial/practical be graded immediately and an average be taken at the end.
- A minimum of eight tutorials/ten practical will form the basis for final evaluation.
- The total 25 marks for term work (except project and seminar) will be awarded as follows:
  Tutorial / Practical Journal – 20 marks
  Overall Attendance – 05
    Further, while calculating marks for attendance, the following guidelines shall be adhered to:
    75 % to 80%. – 03 marks
    81% to 90% - 04 marks
    91% onwards – 05 marks

Theory Examination

- In general all theory examinations will be of 3 hours duration.
- Question paper will comprise of total six questions, each of 20 Marks.
- Only four questions need to be solved.
- Question one will be compulsory and based on maximum part of the syllabus.

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

Practical Examination:

- Duration for practical examination would be the same as assigned to the respective Lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Project and Seminar Guidelines

- Project Groups: Students can form groups with minimum 2 (Two) and not more than 3 (Three)

- The load for projects may be calculated proportional to the number of groups, not exceeding two hours per week.

- The load for projects may be calculated as:
  Sem VII: ½ hr for teacher per group.
  Sem VIII: 1 hr for teacher per group.

- Each teacher should have ideally a maximum of three groups and only in exceptional cases four groups can be allotted to the faculty.

- Seminar topics will be the consensus of the project guide and the students. Each student will work on a unique topic.

- The load for seminar will be calculated as one hour per week irrespective of the number of students

- Students should spend considerable time in applying all the concepts studied, into the project. Hence, eight hours each were allotted in Project A, B and three hours for Seminar to the students.

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
S.E. Semester III (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC301	Applied Mathematics-III	3	-	1	3	-	1	4
BTC302	Microbiology	4	-	-	4	-	-	4
BTC303	Cell Biology	3	-	1	3	-	1	4
BTC304	Biochemistry	4	-	-	4	-	-	4
BTC305	Unit Operations-I	3	-	-	3	-	-	3
BTC306	Process Calculations	3	-	1	3	-	1	4
BTL301	Microbiology Lab	-	3	-	-	1.5	-	1.5
BTL302	Biochemistry Lab	-	3	-	-	1.5	-	1.5
BTL303	Unit Operations-I Lab	-	2	-	-	1	-	1
	Total	20	8	3	20	4	3	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC301	Applied Mathematics-III	20	20	20	80	3	25	-	-	125
BTC302	Microbiology	20	20	20	80	3	-		-	100
BTC303	Cell Biology	20	20	20	80	3	25	-	-	125
BTC304	Biochemistry	20	20	20	80	3	-		-	100
BTC305	Unit Operations-I	20	20	20	80	3		-	-	100
BTC306	Process Calculations	20	20	20	80	3	25	-	-	125
BTL301	Microbiology Lab							25		25
BTL302	Biochemistry Lab							25		25
BTL303	Unit Operations-I Lab								25	25
	Total			120	480	-	75	50	25	750

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
S.E. Semester IV (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC401	Applied Mathematics-IV	3	-	1	3	-	1	4
BTC402	Molecular Genetics	3	-	1	3	-	1	4
BTC403	Fermentation Technology	4		-	4		-	4
BTC404	Analytical Methods in Biotechnology	4	-	-	4	-	-	4
BTC405	Immunology and Immunotechnology	3	-	1	3	-	1	4
BTC406	Unit Operations -II	3		-	3		-	3
BTL401	Fermentation Technology Lab	-	3	-		1.5	-	1.5
BTL402	Analytical Methods in Biotechnology Lab	-	3	-		1.5	-	1.5
BTL403	Unit Operations –II Lab	-	2	-		1	-	1
	Total	20	8	3	20	4	3	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC401	Applied Mathematics-IV	20	20	20	80	3	25	-	-	125
BTC402	Molecular Genetics	20	20	20	80	3	25	-	-	125
BTC403	Fermentation Technology	20	20	20	80	3	-		-	100
BTC404	Analytical Methods in Biotechnology	20	20	20	80	3	-	-	-	100
BTC405	Immunology and Immunotechnology	20	20	20	80	3	25	-	-	125
BTC406	Unit Operations -II	20	20	20	80	3	-	-	-	100
BTL401	Fermentation Technology Lab		-	-	-	3	-	25		25
BTL402	Analytical Methods in Biotechnology Lab	-	-	-	-	3	-	25	-	25
BTL403	Unit Operations –II Lab	-	-	-	-	-	-	-	25	25
	Total			120	480	-	75	50	25	750

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
T.E. Semester V (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC501	Bioinformatics	4	-	-	4	-	-	4
BTC502	Genetic Engineering	4	-	-	4	-	-	4
BTC503	Thermodynamics and Biochemical Engineering	3	-	1	3	-	1	4
BTC504	Bioreactor Analysis and Technology	3	-	1	3	-	1	4
BTC505	Business Communication and Ethics	2	-	2	-	-	2	2
BTE501X	Elective I	3	-	1	3	-	1	4
BTL501	Bioinformatics Lab	-	2	-	-	1	-	1
BTL502	Genetic Engineering Lab		3			1.5		1.5
BTL503	Lab I		3			1.5		1.5
	Total	17	12	3	17	6	3	26

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC501	Bioinformatics	20	20	20	80	3	-		-	100
BTC502	Genetic Engineering	20	20	20	80	3			-	100
BTC503	Thermodynamics and Biochemical Engineering	20	20	20	80	3	25	-	-	125
BTC504	Bioreactor Analysis and Technology	20	20	20	80	3	25	-	-	125
BTC505	Business Communication and Ethics	-	-	-	-	-	50	-		50
BTE501X	Department Elective I	20	20	20	80	3	25	-	-	125
BTL501	Bioinformatics Lab					2		25		25
BTL502	Genetic Engineering Lab					3		25		25
BTL503	Lab I	-	-	-	-	3		25	-	25
	Total			100	400	-	125	75	-	700

Department Elective I (Sem V)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Biosensors and Diagnosis (BTE5011)	1.Biophysics (BTE5012) 2.Biostatistics (BTE5013)	1. Pharmaceutical Technology (BTE5014)

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
T.E. Semester VI (w.e.f 2018-2019)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC601	Food Technology	3	-	1	3	-	1	4
BTC602	Cell & Tissue Culture	4	-	-	4	-	-	4
BTC603	Enzyme Engineering	4	-		4	-	-	4
BTC604	IPR, Bioethics and Bio safety	3	-	1	3	-	1	4
BTC605	Process Control & Instrumentation	3	-	1	3	-	1	4
BTE602X	Elective-II	3	-	1	3	-	1	4
BTL601	Lab-II	-	3	-	-	1.5	-	1.5
BTL602	Lab-III	-	3	-	-	1.5	-	1.5
	Total	20	6	4	20	3	4	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC601	Food Technology	20	20	20	80	3	25	-	-	125
BTC602	Cell & Tissue Culture	20	20	20	80	3	-	-	-	100
BTC603	Enzyme Engineering	20	20	20	80	3	-	-	-	100
BTC604	IPR, Bioethics and Bio safety	20	20	20	80	3	25	-	-	125
BTC605	Process Control & Instrumentation	20	20	20	80	3	25	-	-	125
BTE602X	Elective-II	20	20	20	80	3	25	-	-	125
BTL601	Lab-II	-	-	-	-	3	-	25		25
BTL602	Lab-III	-	-	-	-	3	-	25	-	25
	Total			120	480	-	100	50	--	750

Department Elective II (Sem VI)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Computational Fluid Dynamics (BTE6021)	1. Protein Engineering (BTE6022) 2. Cancer Biology(BTE6023)	1. Green technology (BTE6024)

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
B.E. Semester VII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC701	Bioseperation & Downstream Processing Technology-I	4	-	1	4	-	1	5
BTC702	Bioprocess Modelling and Simulation	4	-	1	4	-	1	5
BTC703	Agriculture Biotechnology	3	-	1	3	-	1	4
BTE703X	Department Elective III	3	-	1	3	-	1	4
ILO701X	Institute Level optional Subject I	3	-	-	3	-	-	3
BTP701	Project A	-	-	6	-	-	3	3
BTL701	Lab - IV	-	3	-	-	1.5	-	1.5
BTL702	Lab - V	-	3	-	-	1.5	-	1.5
	Total	17	6	10	17	3	7	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC701	Bioseperation & Downstream Processing Technology-I	20	20	20	80	3	25	-	-	125
BTC702	Bioprocess Modelling and Simulation	20	20	20	80	3	25	-	-	125
BTC703	Agriculture Biotechnology	20	20	20	80	3	25	-	-	125
BTE703X	Department Elective III	20	20	20	80	3	25	-	-	125
ILO701X	Institute Level optional Subject I	20	20	20	80	3	-	-	-	100
BTP701	Project A	-	-	-	-	-	100		50	150
BTL701	Lab - IV	-	-	-	-	-	-	25	-	25
BTL702	Lab - V	-	-	-	-	-	-	25	-	25
	Total			100	400	-	200	50	50	800

Department Elective III (Sem VII)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Stem Cell & Tissue Engineering (BTE7031)	1. Operation research in Biotechnology (BTE7032) 2. Project Management (BTE7033)	1. Nanotechnology (BTE7034)

Institute Level Optional Subject I (Sem VII)		
1. Product Lifecycle Management (ILO7011)	4. Design of Experiments (ILO7014)	7. Disaster Management and Mitigation Measures (ILO7017)
2. Reliability Engineering (ILO7012)	5. Operation Research (ILO7015)	8. Energy Audit and Management (ILO7018)
3. Management Information System (ILO7013)	6. Cyber Security and Laws (ILO7016)	9. Development Engineering (ILO7019)

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
B.E. Semester VIII (w.e.f 2019-2020)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC801	Environmental Biotechnology	4	-	-	4	-	-	4
BTC802	Bioseperation & Downstream Processing technology-II	4	-	-	4	-	-	4
BTC803	Bioprocess Plant & Equipment design	3	-	1	3	-	1	4
BTE804X	Department Elective IV	3	-	1	3	-	1	4
ILO802X	Institute Level optional Subject II	3	-	-	3	-	-	3
BTP801	Project B	-	-	8	-	-	6	6
BTL801	Lab - VI	-	3	-	-	1.5	-	1.5
BTL802	Lab - VII	-	3	-	-	1.5	-	1.5
	Total	17	6	10	17	3	8	28

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC801	Environmental Biotechnology	20	20	20	80	3	-	-	-	100
BTC802	Bioseperation& Downstream Processing technology-II	20	20	20	80	3	-	-	-	100
BTC803	Bioprocess Plant & Equipment design	20	20	20	80	3	25	-	-	125
BTE804X	Department Elective IV	20	20	20	80	3	25	-		125
ILO802X	Institute Level optional Subject II	20	20	20	80	3	-	-	-	100
BTP801	Project B	-	-	-	-	-	100	-	50	150
BTL801	Lab - VI	-	-	-	-	3	-	25	-	25
BTL802	Lab - VII	-	-	-	-	3	-	25	-	25
	Total			100	400	-	150	50	50	750

Department Elective IV (Sem VIII)		
Engineering Stream	Advanced Science Stream	Technology Stream
1. Non-conventional Sources of Energy (BTE8041)	1. Total Quality Management (BTE8042) 2. Entrepreneurship (BTE8043)	1. Advanced Bioinformatics (BTE8044)

Institute Level Optional Subject II (Sem VIII)		
1. Project Management (ILO8021)	4. Human Resource Management (ILO8024)	7. IPR and Patenting (ILO8027)
2. Finance Management (ILO8022)	5. Professional Ethics and CSR (ILO8025)	8. Digital Business Management (ILO8028)
3. Entrepreneurship Development and Management (ILO8023)	6. Research Methodology (ILO8026)	9. Environmental Management (ILO8029)

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
S.E. Semester III (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC301	Applied Mathematics-III	3	-	1	3	-	1	4
BTC302	Microbiology I	4	-	-	4	-	-	4
BTC303	Cell Biology	3	-	1	3	-	1	4
BTC304	Biochemistry	4	-	-	4	-	-	4
BTC305	Unit Operations-I	3	-	-	3	-	-	3
BTC306	Process Calculations	3	-	1	3	-	1	4
BTL301	Microbiology Lab	-	3	-	-	1.5	-	1.5
BTL302	Biochemistry Lab	-	3	-	-	1.5	-	1.5
BTL303	Unit Operations-I Lab	-	2	-	-	1	-	1
	Total	20	8	3	20	4	3	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC301	Applied Mathematics-III	20	20	20	80	3	25	-	-	125
BTC302	Microbiology I	20	20	20	80	3	-	-	-	100
BTC303	Cell Biology	20	20	20	80	3	25	-	-	125
BTC304	Biochemistry	20	20	20	80	3	-	-	-	100
BTC305	Unit Operations-I	20	20	20	80	3	--	-	-	100
BTC306	Process Calculations	20	20	20	80	3	25	-	-	125
BTL301	Microbiology Lab	-	-	-	-	3	--	25	-	25
BTL302	Biochemistry Lab	-	-	-	-	3	--	25	-	25
BTL303	Unit Operations-I Lab	-	-	-	-	-	--	-	25	25
	Total			120	480	-	75	50	25	750

Course Code	Name of Subject	Credits
BTC301	**Applied Mathematics III**	**04**

Pre-requisites:

- Basics of complex numbers: modulus, argument; equation of a circle, roots of unity, Euler's formula; hyperbolic functions; matrices: symmetric, orthogonal and unitary matrices, rank, normal form, solutions of systems of linear equations; basics of LPP: graphical method; calculus: partial derivatives, Hessian, maxima/minima of functions of 1 and 2 real variables.

Course Objectives:

- To introduce students to the basic methods of Laplace transforms.
- Laplace transforms and inverse Laplace transforms of all the standard functions.
- To enable students to solve initial value ODE problems using L-transforms.
- To study eigen values and eigen spaces of matrices.
- Orthogonal and congruent reduction of quadratic forms.
- Complex analysis: C-R equations, Milne-Thomson method.
- Bilinear transformations and cross-ratios.
- Introduction to statistics.
- Lagrange multiplier method for 2 and 3 variables with no more than two constraints.
- To introduce the basics of optimization using Kuhn-Tucker conditions.

Course outcomes:

- The student will be able to solve initial value ODE problems.
- The student will have a good understanding of real and complex analysis.
- The student will have a thorough grounding in matrix algebra.
- The student will be ready for any further courses on optimization.

Module	Contents	Contact Hours
01	The Laplace transform: Definition and properties (without proofs); all standard transform methods for elementary functions including hyperbolic functions; Heaviside unit step function, Dirac delta function; the error function; evaluation of integrals using Laplace transforms; inverse Laplace transforms using partial fractions and H(t-a); convolution (no proof).	**07**
02	Matrices: Eigen values and eigens paces 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 -	**07**

	v are given; Milne-Thomson method; cross-ratio (no proofs); conformal mappings; images of straight lines and circles.	
04	Complex Integration Cauchy's integral formula; poles and residues; Cauchy's residue theorem; applications to evaluate real integrals of trigonometric functions; integrals in the upper half plane; the argument principle.	**06**
05	Statistics: (No theory questions expected in this module) Mean, median, variance, standard deviation; binomial, Poisson and normal distributions; correlation and regression between 2 variables.	**05**
06	Optimization (No theory). Non-linear programming: Lagrange multiplier method for 2 or 3 variables with at most 2 constraints; conditions on the Hessian matrix (no proof); Kuhn-Tucker conditions with at most 2 constraints.	**07**

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Mathematical Methods in Chemical Engineering, V.G. Jenson and G.V. Jeffreys, Academic Press, 1970
2. Laplace transforms, Murray Spiegel, Schaum's Outline Series, 1974
3. Complex variables, Murray Spiegel, Schaum's Outline Series, 1964
4. Linear Algebra, Murray Spiegel, Schaum's Outline Series, 1964
5. Probability and Statistics: Murray R. Spiegel, Schaum's Outline Series, 1965
6. Advanced Engineering Mathematics by *Erwin Kreyszig*, 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	Contact Hours.
1	**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	03
2	**Classification of Microorganisms:** • 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 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	08

3	**Microbial Nutrition:** • Nutritional requirements of microorganisms • Different types of media- Synthetic media, complex media Selective media, differential media, enrichment media.	05
4	**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	05
5	**Microbiological Techniques:** • Sterilization and disinfection techniques, • Principles and methods of sterilization. • Physical methods - autoclave, hot-air oven, pressure cooker, laminar airflow, filter sterilization. • Radiation methods – UV rays, gamma rays, ultrasonic methods. • Chemical methods - Use of alcohols, aldehydes, fumigants, phenols, halogens and hypochlorites. Phenol coefficient. • Isolation of pure culture techniques - Enrichment culturing, dilution plating, streak- plate, spread-plate and micromanipulator. • Preservation of microbial cultures - sub culturing, overlaying cultures with mineral oils, lyophilization, sand cultures, storage at low temperature.	09
6	**Antimicrobial Therapy:** • Antimicrobial sensitivity tests. • Agents used in treating infection: Antibacterial, antiviral, antiretroviral, antifungal, anti-protozoan & anti helminthes. • Resistance mechanism.	07
7	**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-chemical properties of soil, microbial community in soil, role of microorganisms in organic matter decomposition.	07

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Textbook of Microbiology ;R. Ananthnarayan, C. K. J. Panicker, Orient Longman 6th Edition (2003)
2. General Microbiology, R.Y. Stanier, J.L. Ingraham, M.L.Wheelis and P.R. Painter, Macmillian
3. Microbiology VI Edition, M.J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill Microbiology by Prescott
4. Microbiology: An Introduction (9th Ed.) by Tortora GJ, Funke BR, and Case CL, Pearson Education, 2008.
5. Industrial Microbiology, Casida, New Age International
6. Industrial Microbiology, Prescott and Dunn, C.B.S. Publishers Principles of Microbiology, R.M. Atlas, WMC. Brown Publisher.
7. Microbiology – Fundamentals and Application, 6th Ed. – Purohit, S.S. (Agrobios)
8. Textbook of Microbiology, P.Charkborthy
9. General Microbiology Vol. II by Powar and Daginawala Himalaya Publ. House 8th edition (2004)

Course Code	Course/Subject Name	Credits
BTC303	Cell Biology	4

Prerequisites:

- Knowledge of basic terminology of cell and cell organelles
- Knowledge of structure and function of prokaryotic and eukaryotic cell
- Knowledge of different compartments of cell organelle.
- Knowledge of cell division
- Basic knowledge of cell events like photosynthesis, respiration

Course Objectives:

- In this course, Students will explore the great diversity of all cellular form and function.
- Course emphasis is placed on the molecular mechanisms of cell metabolism, growth, division, and communication.
- This course is central to the cell biology and serves as the bridge between foundational courses in the cell and advanced courses in the complexity of sorting in the cell.

Course Outcome:

- By the end of the course students should be able to grasp the fundamentals in Understanding the molecular organization of the cells, function and structure of The different organelles including transport mechanisms for processes like; Protein sorting, cell communication and flow of information and transport across the unit membrane, cell signaling.
- Students will have good knowledge of cancer, its types and etiology. Students will be able to appreciate all basic concepts which he may encounter in future courses in biotechnology engineering.
- Students will be ready for application of these concepts in the field of research in biotechnology.

Module	Contents	Contact Hours
1	**Cytology:** • Developmental history of cytology: Origin of cell, Robert Hooke's Experiment, Cell theory, Miller's Experiment Properties & Types of cells: Prokaryotic & Eukaryotic cell • Structure and function of cells such as Viruses, Bacteria, Animal cells, Plant cells.	**05**
2	**Cell cycle & cell death:** • Cell cycle and its regulation: Cyclins, CDKs, Checkpoints • Cell division: Mitosis & Meiosis • Programmed cell death: Apoptosis, Extrinsic & Intrinsic pathway • Apoptosis vs. Necrosis	**05**
3	**Structural organization of cell and role of cell organelles in sorting and intracellular transport:**	**08**

	• Cell membrane: Function, Composition, Membrane proteins, Fluid Mosaic model, Electrical properties of membrane, Neurotransmission • Nucleus: Nuclear Envelop, Nuclear Pore Complex & its role in nucleocytoplasmic exchange • Overview of endomembrane system: secretory and endocytic pathway • Endoplasmic Reticulum: SER & RER, Protein synthesis on membrane bound and free ribosomes, Protein Glycosylation in ER & Golgi complex, Membrane biosynthesis in the ER • Golgi bodies: Movement of materials through the Golgi complex • Structure & function of Cell wall, Mitochondria, Lysosomes • Structure and function of cytoskeleton: (i)Microtubules – Structure & composition, MAPs, MTOCs, Dynamic properties of microtubules, Overview of motor proteins. (ii)Microfilaments – Structure, Assembly & disassembly. (iii)Intermediate filaments – Structure, Assembly & disassembly, Types and functions.	
4	**Transport across cell:** • Bulk transport: Exocytosis, Phagocytosis, Endocytosis – Pinocytosis & Receptor mediated endocytosis • Mechanism of transport of substances through membrane: (i) Active Transport – Ion pumps (ii) Passive Transport – Diffusion, Osmosis, Facilitated diffusion, Ion channels	**05**
5	**Cellular communication:** • General principles of cell communication: Types of adhesion, CAMs • Extracellular matrix: Components – Collagen, Proteoglycans, Fibronectin, Laminin • Interactions of cells with extracellular materials: Integrins, Focal Adhesions & Hemidesmosomes • Interactions of cells with other cells: Selectins, IgSF, Cadherins, Adherens junction, Desmosomes • Tight junctions • Gap junctions and plasmodesmata	**07**
6	**Cell Signaling:** • Types of intercellular signaling: Auto, Para & Endocrine • Overview of cellular signaling pathway • Various extracellular messengers and their receptors • Signal transduction by RTKs: Receptor dimerization, Protein kinase activation, Activation of downstream signaling pathways, Ending the response. Signaling by Insulin receptor	**05**

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Cell and Molecular biology: Concepts and Experiments, Gerald Karp, John Wiley and sons Inc, 6th Edition (2010)
2. Molecular Cell Biology, H. Lodish et. al., W.H. Freeman & Co Ltd, 5th Edition (2003)
3. Cell and Molecular Biology, DeRobertis; Lippincott Williams & Wilkins 8th Edition (2001)
4. Molecular Biology of the Cell and the Hypercell with CDROM; Alberts, Bray; Garland Publishing 1st Edition (1999)
5. Molecular Biology of the Cell with CDROM Alberts, Bruce; Johnson, Alexander; Lewis, Julian 4th Edition (2005).

Course Code	Course/Subject Name	Credits
BTC304	**Biochemistry**	**4**

Prerequisites:

- Knowledge of organic chemistry: functional groups and their reactions
- Knowledge of living cell and its components

Course Objectives:

- The major objective is to provide complete understanding of all the chemical processes associated with living cells at the molecular level.
- To ensure students have a strong grounding in structures and reactions of biomolecules.
- To introduce them to the metabolic pathways of the major biomolecules.
- To correlate biochemical processes with biotechnological applications.

Course outcomes:

- The students will be able to understand and analyze the correlation between biomolecules, their associated pathways and various biological processes underlying the living systems.

Module	Contents	Contact Hours
1	• 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	**10**
3	**Enzymes:** • Working of Enzymes • Concept of Activation energy and transition state • Factors affecting enzyme activity- pH, Temperature, Substrate & Enzyme Concentration	**05**
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	**15**

	• Amino acids- decarboxylation, deamination & transamination. Urea cycle; fate of amino acids (connection to TCA) • Electron Transport Chain • Photophosphorylation- Photosystems, reaction centers, pigments, cyclic and non-cyclic photophosphorylation, Z pathway	
6	**Bioenergetics:** • Laws of Thermodynamics • Concept of Enthalpy, Entropy • Energy rich compounds – ATP as energy currency	**05**

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. Nelson, D.L. and M.M. Cox, “Lehninger’s Principles of Biochemsitry”, 4th Edition, W.H. Freemen & Co., 2005.
2. Murray, R.K., et al “Harper’s Biochemistry”, 23rd Edition, Prentice Hall International, 1993
3. Lubert Stryer. 2007. Principles of Biochemistry. Freeman.
4. Voet and Voet. 2005. Biochemistry. Wiley.
5. D. Skoog, D. West, F.Holler, S. Crouch “Fundamentals of Analytical Chemistry” 8th Edition, 2004. Thomson Brooks/ Cole
6. David T. Plummer, An Introduction to practical biochemistry, Tata McGraw Publishing Company Ltd.

Course Code	Course/Subject Name	Credits
BTC305	**Unit Operations – I**	**3**

Prerequisites:

Basic knowledge in physics, units and dimensions and thermodynamics

Course Objectives:

- To impart the basic concepts of fluid statics and dynamics
- To study the basic equations of fluid flow.
- They should be comfortable with measurement of pressure or pressure drop.
- To enable students to determine viscosity using method such as Stokes Law.
- To study the different types of size reduction equipment used in Industries.
- To study about the metering and pumping of fluids.

Course Outcomes:

- The student will have a thorough grounding on measurement of pressure drop, velocity, flow rates etc. of fluids.
- They can select pumps and would be able to calculate power requirement for pumping as well as agitation operations.
- They will be able to operate certain flow measurement devices and size reduction equipment.

Module	Content	Contact Hours
1	**Introduction:** Classification of fluids, Rheological behavior of fluids & Newton's Law of viscosity. Effect of temperature & pressure on viscosity of fluids. **Fluid statics:** Pascal's law ,Hydrostatic equilibrium, Barometric equation and pressure measurement (problems)	**05**
2	**Fluid Dynamics:** Continuity Equation, Equation of motion, Euler's equation of motion, Bernoulli's equation (problems), Bernoulli's equation for compressible fluids (isothermal and adiabatic process) concept of Reynold's number, Laminar flow in pipes, Turbulent flow in pipes, velocity and shear stress distribution across pipe, Boundary layer formation and separation of boundary layer.	**07**
3	**Flow of Incompressible fluids:** Relationship between skin friction and wall shear, Fanning friction factor, friction factor law for smooth pipes, Form friction, effect of roughness, energy relationships, pipe fittings, major and minor losses in pipe flow. (problems) **Flow measurements:** Venturimeter, Orificemeter, Pitot tube, Rotameter. (problems) **Pumping:** Reciprocating pumps, Rotary pumps, centrifugal pumps (Characteristics, NPSH, and Cavitation) and blowers.	**08**
4	**Particle Size distribution:** Importance of particle size in reactions, particle size, shape and mass distributions,	**07**

	measurement and analysis, concept of average diameter. (problems) **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.	
5	**Size Reduction:** Factors affecting size reduction, comminution laws – Kick's law, Rittinger's law and Bond's law and their limitations. Crushing efficiency & power consumption (problems) **Size reduction equipment:** Grinder – Construction and operation of Hammer mill, Ball mill (problems), Ultrafine grinder – Fluid energy mill, Cutting machines: knife cutters.	**04**
6	**Sedimentation:** Free settling and Hindered settling, Stoke's law & Newton's law regimes of settling. Clarifiers and thickeners, flocculation, batch Sedimentation (Kynch theory), rate of sedimentation.	**04**

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

Text books

1. Dr. R. K. Bansal, "A Textbook of Fluid Mechanics & Hydraulic Machines", Laxmi Publications, 9th Edition, 2010.
2. R. S. Hiremath & A. Kulkarni. Mechanical Operations Vol. I.
3. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw Hill, Fourth Edition, 1984.
4. Narayanan C.M. & Bhattacharya B.C. "Mechanical operations for chemical engineers", Khanna.

References

1. Coulson, J.M., Richardson, J.F., "Chemical Engineering", Volume 2, Third Edition, Pergamon Press, 1977.
2. Badger and Bencharo, "Introduction to Chemical Engineering". TMH,
3. Fluid Mechanics and Hydraulics by Suresh Ukarande, Ane Books, 2012.

Course Code	Course/Subject Name	Credits
BTC306	**Process Calculations**	**4**

Prerequisites:

- Linear Algebra
- Differential Equation

Course Objectives:

- To study the laws regarding gas, liquid and vapor
- To develop understanding about material balance and energy balances
- To study the stoichiometry and thermodynamics of microbial growth and product formation

Course outcomes:

- The student will be able to understand basic application of various unit operations & unit processes to industrial &theoretical problems
- They will have a clear understanding of the various systems of units will be able to do the conversion of units of one system to another.
- They will be able to do basic calculations for biological systems & access the property data from appropriate sources.

Module	Content	Contact Hours
1	Units and dimensions: Systems of units, fundamental and derived units, unit conversions, dimensional homogeneity and dimensional analysis problems. Conversion of units Chemical arithmetic: Mole concept, atomic weight, molecular weight and equivalent weight- methods of determination. Chemical composition: Methods of expressing compositions of mixtures and solutions- mole percent, mass percent, volume percent, molarity, molality, normality etc. P-V-T behavior of pure liquids- Gas laws, real and ideal gases, equation of state, critical properties, properties of gas mixtures- Dalton's laws, Amagat's law-Average molecular weight and density problems. Biochemical stoichiometry: Limiting and excess reactants- conversion, degree of completion, selectivity, yield problems.	**07**
2	Fundamentals of material balances- Law of conservation of mass- Types of material balances, material balance with recycle bypass and purge streams	**07**
3	Material Balance for process involving chemical reaction, Calculations using Psychrometric chart; Humidity and saturation	**07**
4	Fundamentals of energy balances, Law of conservation of energy, Heat capacity, sensible heat, latent heat, calculation of enthalpy changes. General energy balance equation; Energy balance calculations with and without reactions, Energy	**07**

	balance for fermentation and downstream processing problems.	
5	Stoichiometry of microbial growth and product formation, Growth, Stoichiometry and elemental balances, respiratory quotient, degree of reduction, Yield and maintenance coefficients, Oxygen consumption in aerobic microbial cultures. Theoretical Oxygen demand- problems. Biochemical energetics: Metabolic reaction coupling, energetics of metabolic processes (respiration and biosynthesis). Transport across cell membranes, Thermodynamics of microbial growth, Heat generation in microbial cultures problems.	**07**

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each Module.

References

1. David M. Himmelblau. 1989. Basic Principles and Calculations in Chemical Engineering. Prentice Hall of India (P) Ltd.
2. 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
BTL301	**Microbiology Lab**	**1.5**

List of Experiments Suggested:

- Study of different equipments- Bunsen burner, water bath, Autoclave, Laminar air flow, Incubator, Hot air oven, Centrifuge, and Refrigerator.
- Study of Microscope- Compound Microscope & its parts. Use of oil Immersion objective.
- Preparation of medium -nutrients broth, nutrient agar, agar slant.
- Staining: Simple, Differential staining methods, Capsule, Endospore; Study of shape and arrangement of bacterial cells
- Isolation of microorganism by Pure Culture Techniques.
- Effect of disinfectants on microbial flora
- Isolation and identification of microorganisms from different sources – soil, water and milk
- Antibiotic sensitivity assay
- Effect of different parameters on bacterial growth (pH, temperature & UV irradiation)
- Culture of aerobic &anaerobic bacteria
- Effect of TDP & TDT on bacterial growth
- Filter paper disc methods for evaluation of antiseptics
- Study of growth curve of *E. coli*
- Bacterial colony counting using Haemocytometer

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL302	**Biochemistry Lab**	**1.5**

List of Experiments Suggested:

- Preparations of solutions –molar, normal, ppm, percent
- Study of pH meter and preparation of buffers
- Study of Beer and Lambert's Law and absorption maxima
- Glucose estimation by DNSA method
- Protein estimation by Biurette Test
- DNA estimation by DPA method
- RNA estimation by Orcinol method
- Estimation of Vitamin C by Iodometry
- Extraction and separation of plant pigment by paper chromatography
- TLC of Fatty acids
- Study of Enzyme Activity
- Estimation of Lipids

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL303	**Unit Operations - I Lab**	**1.0**

List of Experiments Suggested:

- Viscosity by Stoke's Law
- Venturimeter
- Orificemeter
- Flow through Helical coil
- Reynold's Apparatus.
- Bernoulli's apparatus
- Sieve analysis
- Screen effectiveness
- Major and Minor losses
- Ball mill
- Hammer mill
- Sedimentation
- Centrifugal pumps

University of Mumbai
Program Structure for B.E. Biotechnology (Revised 2016)
S.E. Semester IV (w.e.f 2017-2018)

Course code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BTC401	Applied Mathematics-IV	3	-	1	3	-	1	4
BTC402	Molecular Genetics	3	-	1	3	-	1	4
BTC403	Fermentation Technology	4	-	-	4	-	-	4
BTC404	Analytical Methods in Biotechnology	4	-	-	4	-	-	4
BTC405	Immunology and Immunotechnology	3	-	1	3	-	1	4
BTC406	Unit Operations-II	3	-	-	3	-	-	3
BTL401	Fermentation Technology Lab	-	3	-	-	1.5	-	1.5
BTL402	Analytical Methods in Biotechnology Lab	-	3	-	-	1.5	-	1.5
BTL403	Unit Operations-II Lab	-	2	-	-	1	-	1
	Total	20	8	3	20	4	3	27

Course code	Course Name	Examination Scheme								
		Theory					Term Work	Pract/ Oral	Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in hrs)				
		Test 1	Test 2	Avg						
BTC401	Applied Mathematics-IV	20	20	20	80	3	25	-	-	125
BTC402	Molecular Genetics	20	20	20	80	3	25	-	-	125
BTC403	Fermentation Technology	20	20	20	80	3	-	-	-	100
BTC404	Analytical Methods in Biotechnology	20	20	20	80	3	-	-	-	100
BTC405	Immunology and Immunotechnology	20	20	20	80	3	25	-	-	125
BTC406	Unit Operations-II	20	20	20	80	3	--	-	-	100
BTL401	Fermentation Technology Lab	-	-	-	-	3	--	25	-	25
BTL402	Analytical Methods in Biotechnology Lab	-	-	-	-	3	--	25	-	25
BTL403	Unit Operations-II Lab	-	-	-	-	-	--	-	25	25
	Total			120	480	-	75	50	25	750

Course Code	Course/Subject Name	Credits
BTC401	**Applied Mathematics IV**	**4**

Prerequisites:

- **Vector Calculus**:- Multiple Integral, Partial differentiation, basic knowledge of vectors and their products, Knowledge of spherical and cylindrical coordinate system.
- Partial Differential Equation:- Integration, 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 and Biotechnology processes.
- One can use vector formation and calculus together to describe and solve many problems in two/three dimension. The Fourier Transform and PDE module does the ground work for the techniques required to solve and find the answer for various physiochemical problems.

Course Outcomes:

- It is expected that the learner will develop the proactive approach towards the selection of methods to a solution of Chemical Engineering and Biotechnology problems coming across while studying higher level of the Course. (Example: Flow of Liquid through Pipes/Gases etc.)

Module	Contents	Contact Hours
01	**Fourier Series** Expansion of functions in any interval (a, b). Half range expansion; Complex form; Parseval's identity theorem; Orthogonal and Orthonormal functions. NO PROOFS REQUIRED.	**09**
02	Fourier Integrals and Fourier Transform; sine & cosine Integrals, sine & cosine transforms, complex transforms. NO PROOFS REQUIRED.	**10**
03	**Partial Differential Equations** Elliptic, Parabolic & Hyperbolic Equations; Laplace's equation; One dimensional Heat & Wave Equation, Two Dimensional wave equation. (ONLY NUMERICAL PROBLEMS. NO PROOFS REQUIRED).	**10**
04	**Vector Integration** Green's Theorem in the plain; Conservative & Solenoidal Fields. Green's Theorem in the plain; Conservative, Gauss Divergence Theorem, Stokes' Theorem. (ONLY NUMERICAL PROBLEMS. NO PROOFS REQUIRED).	**10**

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Advanced Engineering Mathematics by *Erwin Kreyszig*, 9TH Edition, Wiley India.
2. Schuam's outline series in Fourier series.
3. Schuam's outline series in partial differential equations.
4. Partial differential equations Vol 1 by Rutherford Aris.

Course Code	Course/Subject Name	Credits
BTC402	Molecular Genetics	4

Prerequisites:

- Knowledge of Cell and its components
- Knowledge of Biomolecules and their functions
- Knowledge of Cellular Metabolism

Course Objective:

- Understand the Central Dogma of gene expression
- Explain the foundations of Mendelian genetics and chromosomal theory and apply these, with appropriate terminology, to contemporary concepts in genetics.
- Understand the redundant and universal qualities of the genetic code and how it is used to determine the amino acid sequence of a polypeptide.
- Describe the processes of transcription and translation in both prokaryotes and eukaryotes at the molecular level.
- Describe how prokaryotes control their gene expression through positive and negative regulatory mechanisms.

Course outcome:

- Students will get knowledge of molecular biology and genetics of Prokaryotic and eukaryotic organisms.
- Students will get insight on Replication, Transcription and translation processes in prokaryotes and eukaryotes, various mutations, their Repair mechanisms. Genetic syndromes.

Module	Contents	Contact Hours
01	**Structure of Nucleic Acid:** • DNA, RNA: mRNA,tRNA, rRNA, • Denaturation and Renaturation of DNA, • Tm, GC content from Tm, • Complexity of DNA, Cot curves • Satellite DNA: Repetitive DNA, SNP, STR	04
02	**Mendelism and its extensions** • Mendel's Laws , problems based on his laws • Linkage and Crossing Over • Multiple allelism • ABO blood group inheritance	06
03	**Cytogenetics** • International System for Human Chromosome Nomenclature • Mechanisms of numerical and structural chromosomal aberrations • Chromosomal and non-chromosomal basis of sex determination • Syndromes – Down's, Turner, Cri Du Chat, Klinfelter Transposons • Fluorescence in-situ hybridization technique and applications	04

04	**DNA Replication and Repair:** • Prokaryotic and Eukaryotic DNA replication mechanism - Enzymes and accessory proteins involved in DNA replication , • DNA Mutations: Types of Mutations and Mutagens • DNA Repair Mechanism – Excision, recombinational, SOS, Photo reactivation, Mis-match repair	06
05	**Transcription** • Relationship between Genes and Proteins • Prokaryotic transcription • Eukaryotic transcription: Eukaryotic RNA Polymerases, Transcription of protein coding genes, Production of mature mRNAs in Eukaryotes- 5' Modification , 3' Modification , Intron splicing, RNA Editing	05
06	**Translation** • The nature of Genetic Code • Synthesis of aminoacyl-tRNA, Ribosomal RNA genes • Mechanism of initiation, elongation and termination of • Translation in bacteria Co-and post-translational modifications of proteins	05
07	**Regulation of gene expression** • Operon theory • lac Operon: Structure, Regulation of Lac genes, Positive control of Lac Operon • trp Operon: Gene organization of the tryptophan biosynthetic genes, Regulation of the trp operon, attenuation • ara operon: structure and regulation of ara operon	05

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Molecular Biology; David Freifelder, Narosa Publishing House, 2nd edition (2004).
2. Microbial Genetics; David Freifelder, Narosa Publishing House, 2^{nd} edition (2004).
3. Principles of Gene Manipulations; S. B. Primrose, R. M. Twyman, R. W. old, Blackwell Science,6th Edition (2003)
4. Genetics: A molecular Approach, 2^{nd} edition; Peter J Russell
5. Gene VIII; Benjamin Lewin; Oxford Univ. Press, 8th edition (2004)
6. Cell and Molecular biology: Concepts and Experiments, Gerald Karp, John Wiley and sons Inc, 6^{th} Edition (2010)

Course Code	Course/Subject Name	Credits
BTC403	**Fermentation Technology**	**4**

Prerequisites:

- Knowledge of microbiology

Course Objectives: To gain broad knowledge on

- Role of microorganisms in fermentation
- The various fermentation technologies used
- Production of important products through fermentation

Course Outcomes:

- Appreciate the use of microorganisms for the production of value added commodities.
- Understand the working of a fermentation system.
- To describe key industrial bioprocesses, from the traditional to the recently evolved.
- Integrate biological and engineering principles involved in the production and recovery of commercial products.
- Develop critical thinking skills and learn to employ a quantitative, scientific approach towards conversion of biological materials to value added products.

Module	Contents	Contact Hours
01	**Introduction to fermentation** History and development of fermentation, general requirements of the fermentation, range of fermentation processes, parts of a fermentation process- upstream and downstream processing, aerobic and anaerobic fermentation, solid state and submerged fermentation.	**04**
02	**Introduction to Microbial Growth Kinetics** Batch culture (Quantifying cell concentration, Growth patterns and Kinetics), Continuous culture, Comparison of batch and continuous cultures in industrial processes, Fed batch culture, Examples of use of fed batch cultures.	**05**
03	**Isolation, preservation and improvement of industrial microorganisms** • Isolation methods utilizing selection of the desired characteristics • Isolation methods not utilizing selection of the desired characteristics • The preservation of industrially important microorganisms • Improvement of industrial microorganisms	**07**
	• The selection of induced mutants synthesizing improved levels of products • The use of rDNA techniques	
04	**Regulatory Mechanisms controlling the catabolic and**	**03**

	anabolic pathways of microbes Induction, carbon catabolite repression, crab tree effect, feedback inhibition and repression	
05	**Media for industrial fermentations & sterilization** Introduction, Typical media, Energy sources, Carbon sources, Nitrogen sources, Buffers, Oxygen requirements, Antifoams, Medium optimization, Medium sterilization: The design of batch sterilization processes, The design of continuous sterilization processes, Sterilization of the fermenter, feeds and air, Filter sterilization	06
06	**The development of inocula for industrial fermentations** The development of inocula for yeast , bacterial and fungal processes, The aseptic inoculation of plant fermenters	04
07	**Aeration and agitation** The oxygen requirements and supply of industrial fermentations, Determination of KLa, Factors affecting KLa values, The balance between oxygen supply and demand	04
08	**Design of fermenter** Basic function of a fermenter for microbial or animal cell culture, body construction, various parts of a fermenter	04
09	**Important products through Fermentation** Organic acids: citric and acetic acid; enzymes : amylase, protease, lipase; antibiotics: penicillin; vitamins: vitB12; aminoacids: lysine, Glutamic acid ; organic solvents: ethanol, acetone butanol; alcoholic breverages: wine, beer; biomass : bakers yeast; biofertilizers; biopesticides; biosurfactant; steroid transformation; biopolymers	08

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Principles of Fermentation Technology – Stanbury P.F., Whitaker A, Hall S. J.
2. Bioprocess Engineering: Basic concepts – Shuler M.L., Kargi F. (PHI)
3. Bioprocess Engineering Principles – Doran Pauline M. (Elsevier Pub.)
4. Biotechnology: A textbook of Industrial Microbiology- Cruger, W. and A. Cruger
5. Introduction to Biochemical Engineering - DG Rao, 2005, Tata McGraw-Hill, New Delhi

Course Code	Course/Subject Name	Credits
BTC404	**Analytical Methods In Biotechnology**	**4**

Pre-requisites:
- Basic knowledge of Physical and Analytical Chemistry
- Knowledge of various types of spectra
- Knowledge of Biomolecules and their properties

Course Objective:
- To study the various analytical techniques used in Biotechnology.

Course outcomes:
- The students will be capable of handling different instruments in the laboratory.
- They would be able to compare different separation techniques and use them effectively in research work

Module	Contents	Contact Hours
01	**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, Chromato focussing, Size exclusion chromatography. Gas Chromatography, HPLC: Principle & Components: pumping systems, detectors systems Applications	**12**
03	**Electro kinetic methods of separation:** Electrophoresis: General principle and application, factors affecting electrophoresis – voltage, current, resistance, buffer, composition, concentration, pH. Agarose Gel electrophoresis SDS-PAGE – Native and denaturing gels, gradient gels, discontinuous buffer system Two dimensional gel electrophoresis Isoelectric focusing Capillary electrophoresis	**09**

	☐ Immuno electrophoresis	
04	**Spectroscopy:** ☐ Spectroscopic Techniques; Beers Lamberts law, molar and extinction coefficient, limitations of Beers Lamberts law ☐ Visible and UV Spectrophotometry; Principles, Instrumentation and applications	**08**
05	**Radio isotopic techniques:** ☐ Use of radioisotopes in life sciences, radioactive labelling, principle and application of tracer techniques ☐ Detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger-Muller and Scintillation counters, Autoradiography ☐ Applications	**08**

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Wilson K and Goulding K.H., A biologist's guide to Principles and Techniques of Practical Biochemistry.
2. Willard and Merrit, Instrumental Methods and Analysis
3. Ewing GW, Instrumental Methods of Chemical analysis.
4. Robert. M. Silverstein et al, Spectrometric identification of Organic Compounds, 7th Edition, 1981.
5. Vogel's, Text Book of Quantitative Chemical Analysis, 6th Edition, 2004.
6. John A. Adamovic, Chromatographic Analysis of Pharmaceuticals, 2nd Edition.
7. Raymond P. W. Scott, Techniques and Practice of Chromatography –Vol. 70.
8. Sethi P.D, Dilip Charegaonkar, Chromatography –2nd Edition.
9. Niessen W. M. A., Van Der Greef J, Liquid Chromatography– Mass Spectrometry, Vol. 58.
10. Kalsi. P.K, Spectroscopy of Organic Compounds.
11. Hanes, Gel Electrophoresis of Proteins- A Practical Approach,
12. Hamilton R. J. and Sewell P. A, Introduction to High Performance Liquid Chromatography
13. Gordon M. Message, Practical aspects of Gas Chromatography and Mass Spectrometry, John Wiley and Sons, New York. 1984
14. Chapman J.M and G. Ayrey, The use of radioactive isotopes in the life sciences, George Allen and Unwin Ltd., London.
15. Biophysical chemistry by Upadhyay, Upadhyay and Nath, Himalaya publication house.

Course Code	Course/Subject Name	Credits
BTC405	**Immunology and Immunotechnology**	**4**

Prerequisites:
- Knowledge of anatomy and physiology of human body
- Knowledge of blood components and blood cells
- Knowledge of lymphatic system
- Knowledge of principle of immune response and vaccine
- Knowledge of history and basic terminology in immunology

Objectives
- To learn about various basic terminology in immunology
- To have knowledge of immune system in detail
- To describe the interaction of antigens and antibodies in antibody mediated and cell-mediated immune responses.
- To make familiar with the techniques involved in antigen and antibody reactions
- To understand the concepts and principle of immunoassay techniques in routine diagnosis, research
- To learn principle and types of vaccines

Outcomes:
- Student can define innate and adaptive immunity
- Student can define the characteristics of antigens
- Student can define the characteristics of antibodies
- Student can describe cellular cooperation in antibody and cell mediated immune responses
- Student can define antigen antibody interaction
- Student can describe Production of Monoclonal Antibodies and Recombinant Vaccines.

Module	Contents	Contact Hours
01	**Introduction to immune system**	**06**
	Innate and adaptive immunity	
	Cells and organs of the immune system	
	Primary and secondary immune responses;	
	Cell mediated and humoral response	
02	**Antigens & Antibodies**	**04**
	Antigens	
	Antibodies and T cell receptors: Antigens, Structure and function of immunoglobulin,	
	B and T cell receptors	
03	**Generation and regulation of immune responses**	**08**
	Antigen processing and presentation	
	MHC-restriction; Cytokines	
	T Cell Maturation, activation and Differentiation 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	
04	**Antigen-antibody Reactions**	**07**
	Strength of Antigen-Antibody Reactions	
	In Vivo Antigen-Antibody Reactions, In Vitro Antigen-Antibody Reactions	
	Precipitation (In Fluid and In Gel Immuno electrophoresis),	
	Agglutination (Heamagglutination, Bacterial agglutination, Passive agglutination and Agglutination Inhibition).	
	Radio immuno Assay (RIA)	
	Enzyme Linked Immunosorbant Assay (ELISA),	
	Western Blot	
	• Immune Fluorescence Immunoprecipitation	
05	**Disorders of Human Immune System**	**06**
	Primary and secondary immunodeficiency; Autoimmune	
	disorders; Hypersensitive reactions; Cytokine related diseases	
06	**Production of Monoclonal Antibodies and Recombinant Vaccines.**	**05**
	Monoclonal antibody, polyclonal antibody. Production of	
	Monoclonal antibodies - Definition, production, applications.	
	Vaccines - Definition, recombinant vector vaccines, DNA vaccines ,Multivalent subunit vaccines, minicell vaccines, conjugate vaccines	

Term work

Term work shall consist of minimum **eight** tutorials from entire syllabus which are to be given at regular intervals Batch wise.

Tutorials: 20 marks
Attendance: 05 marks
Total: 25 marks

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.

- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Essential Immunology: Ivan Roitt.
2. Kuby Immunology: Golds by, Kindt and Osborne.
3. Immunology: Roitt, Brostoff, Mole.
4. Introductory Immunology : Huw Davies

Course Code	Course/Subject Name	Credits
BTC406	**Unit Operation - II**	**3**

Pre-requisites:

- An understanding of differential equations and basic physical concepts, units and dimensions

Course Objectives:

- To study the basics of Heat and Mass Transfer
- To develop understanding about the application of Heat and Mass transfer in Bio processing.
- To calculate the size of heat transfer equipments, for a known quantity of raw material.
- To apply energy balance.
- To understand the role of diffusion, drying &distillation in the processes. To apply material balance.
- To design equipments in which heat &mass transfer occurs.

Course outcomes:

- The student will be able to understand basic application of various unit operations &unit processes to industrial &theoretical problems
- They will have a clear understanding of the theories of Heat and Mass transfer which are used for modeling.
- They will be able to do design the fermenter and Bioreactors using the models developed.

Module	Contents	Contact Hours
01	Introduction: Various modes of heat transfer Viz. Conduction, Convection and Radiation.	**07**
	Conduction: Fouriers law, Steady state unidirectional heat flow through single and multiple layer slabs, Cylinders and spheres for constant and variable thermal conductivity.	
	Insulation: Properties of insulation materials, Types of insulation, Critical and Optimum thickness of insulation	
	Extended Surfaces: Fins – Types of fins, Derivation of fin efficiency for longitudinal fins, Fin effectiveness. Elementary treatment of unsteady state heat conduction. Problems	
02	Convection: Individual and overall heat transfer coefficient, LMTD, LMTD correction factor.	**08**
	Dimensionless numbers, - Dimensional analysis, Empirical correlation for forced and natural convection.	
	Analogy between momentum and heat transfer – Reynolds, Coulburn and Prandtl analogies. Problems	
	Heat Transfer with Phase Change: Boiling phenomena, Nucleate and film boiling, Condensation – Film and Drop wise condensation, Nusselts equations.	
03	Radiation: Properties and definitions, Absorptivity, Reflectivity, Emissive power and intensity of radiation, Black body radiation,	**08**

	Gray body radiation,	
	Stefen – Boltzmann law, Wien's displacement law, Kirchoffs law, View factors, Radiation between surfaces- different shapes, Radiation involving gases and vapours, Radiation shields.	
	Heat Transfer Equipment: Double pipe heat exchangers, Shell and tube heat exchangers – Types of shell and tube heat exchangers, Condenser – types of condensers. Design of heat exchanger.	
	Evaporators: Types of evaporators, performance of tubular evaporator – Evaporator capacity, Evaporator economy, Multiple effect evaporator	
04	Diffusion: Molecular diffusion in fluids, Diffusion coefficient, Flick's Law of diffusion, Dependence of diffusion coefficient on temperature, pressure and composition, Diffusion in multi-component gas mixtures. Diffusion in solids: Molecular, Knudsen &surface diffusion Inter- phase mass transfer, Mass transfer coefficients ,Diffusion between phases , Equilibrium solubility of gases in liquids, Mass Transfer theories, Mass transfer in fluidized beds , flow past solids and boundary layers, Simultaneous heat and mass transfer.	**07**
05	Mass Transfer in Bioprocess Operations: Role of Diffusion in Bio processing, Oxygen Uptake in Cell Culture, Factors affecting cellular oxygen demand, oxygen transfer from gas bubble to cell, oxygen transfer in fermenters, sparging stirring and medium properties, anti foaming agents, temperature, gas pressure and oxygen partial pressure, presence of cells, measuring dissolved oxygen concentration, estimating oxygen solubility, effect of oxygen partial pressure, effect of temperature, effect of solutes, mass transfer correlations, measurement of kLa, oxygen balance method, dynamic method, sulphite oxidation method, oxygen transfer in large vessels.	**05**

Assessment

Internal:

- Assessment consists of average of two tests which should be conducted at proper interval.

End Semester Theory Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on entire syllabus wherein sub questions can be asked.
- Remaining questions will be randomly selected from all the modules. Weightage of marks should be proportional to number of hours assigned to each Module

References

1. Robert E Treybal, Mass Transfer Operations, McGraw Hill Third Edition
2. Diffusion: Mass Transfer in Fluid System (Cambridge series in Chemical Engineering) by E.L.Cussler"

3. McCabe & Smith, Unit Operations in Chemical Engineering, 6th Edition, McGraw Hall, 2001.
4. Coulson and Richardson, Chemical Engineering Vol I, 4th Edition, Pergmon
5. Press, 1998.
6. Badger & Banchero, Introduction to Chemical Engineering, TMH 6th Reprint, 1998.
7. Doran P.M, Bioprocess Engineering Principles, Academic Press
8. Bailey G.E and Ollis D.F, Bioprocess Engineering Fundamentals McGraw Hill
9. Shuler M.L and Kargi F, Bioprocess Engineering- Basic Concepts, Pearson Education
10. Blanch H.W and Clark D.S, Biochemical Engineering Marcel Dekker Inc.

Course Code	Course/Subject Name	Credits
BTL401	**Fermentation Technology Lab**	**1.5**

List of Experiments Suggested:

- Alcohol production by baker's yeast
- Isolation and preservation of microorganism of commercial importance
- Cell immobilization technique by immobilizing yeast cells in calcium alginate beads.
- Production of citric acid by A.niger
- Hydrolysis of sucrose by immobilized yeast cells
- Determination of cell mass by different methods (dry weight method, density method and haemocytometer method)
- Estimation of carbohydrates from fermentation media.
- Production of amylase
- Isolation of auxotrophic mutants of industrially important microorganisms
- Study of substrate utilization kinetics of the organism
- Study the set up of various types of bioreactors
- Introduction to fermentor.

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL402	**Analytical Methods In Biotechnology Lab**	**1.5**

List of Experiments Suggested:

- Chromatography of amino acids and sugars
- Agarose gel electrophoresis
- SDS-PAGE, Native PAGE
- Iso-electric Focussing
- Centrifugation
- Density gradient Centrifugation
- Affinity chromatography
- Ion exchange chromatography
- Gel filtration chromatography
- UV-Visible spectrophotometer
- Thin Layer Chromatography
- Paper Chromatography

Practical Examination

- Duration for practical examination would be the same as assigned to the respective lab per week.
- A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.

Course Code	Course/Subject Name	Credits
BTL403	**Unit Operations - II Lab**	**1**

List of Experiments Suggested:

- Plate type H.E
- Natural convection
- Forced convection
- Critical Heat flux
- Emissivity
- Heat transfer through composite wall
- Shell & Tube H.E
- k of insulating material
- Vapor-liquid equilibrium
- Diffusivity of a liquid
- Diffusion through porous solids
- Determination of Mass transfer coefficients in Gas Liquid 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