Academic Handbook

B.Tech. Programme

Academic Affairs

(2013-2014)

NATIONAL INSTITUTE OF TECHNOLOGY GOA

Academic Hand Book

for

I year B.Tech Programme

Department of Humanities and Sciences

National Institute of Technology Goa

Farmagudi, Ponda, Goa - 403 401

Semester-wise Credit Distribution

Semester	Total Credits
I	24
II	23+1*
Total Credits	**47+1***

*** Physical Education**

FIRST YEAR COURSE DETAILS
I Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	MA100	Mathematics-I	4-0-0	4
2	PH100	Physics	3-0-0	3
3	ME100	Engineering Mechanics	3-0-0	3
4	CS100	Computer Programming and Problem solving	2-0-3	4
5	HU100	Professional Communication	2-0-2	3
6	ME101	Engineering Drawing	1-0-3	3
7	PH101	Physics Laboratory	0-0-3	2
		Total Credits		**22**

II Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	MA150	Mathematics-II	4-0-0	4
2	PH150	Material Science	3-0-0	3
3	CY150	Chemistry	3-0-0	3
4	ME150	Elements of Mechanical Engineering	2-0-0	2
5	EE151	Basic electrical science	3-0-0	3
6	ME151	Workshop Practices	0-0-3	2
7	CY151	Chemistry- Laboratory	0-0-3	2
8	EE152	Basic electrical scienceLab	0-0-3	2
9	PE150	Physical Education	1-0-0	1
		Total Credits		**22**

Detailed Syllabi of Courses

Subject Code **MA 100**	**Mathematics-I**	**Credits: 4 (4-0-0)** **Total hours: 56**
Course Prerequisites	10+2 level Mathematics	
Course Objectives	This course provides requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists. Important topics of applied mathematics, namely differential calculus, integral calculus, sequence and series and vector calculus.	
Course Outcome	At the end of this course the students are expected to learn, Importance of Mean value theorems and its applications, evaluation of multiple integrals, the powerful language of Vector calculus with physical understanding to deal with subjects such as Fluid Dynamics and Electromagnetic fields, convergence of sequence and series and Fourier series.	
Module 1	**Differential Calculus**	12 hours
Review of limits, continuity and differentiability; Mean value theorems, Taylor's and Maclaurin's theorems, Partial Differentiation, Total Differentiation, Euler's theorem and generalization, maxima and minima of functions of several variable, Lagrange's method of Multipliers; Change of variables – Jacobians.		
Module 2	**Integral Calculus**	10 hours
Fundamental theorem of Calculus, Improper integrals, applications to area, volume. Double and Triple integrals		
Module 3	**Vector Calculus**	14
Scalar and Vector fields; Vector Differentiation; directional derivative - Gradient of scalar field; Divergence and Curl of a vector field - Laplacian - Line and surface integrals; Green's theorem in plane; Gauss Divergence theorem; Stokes' theorem.		
Module 4	**Sequences and Series**	10 hours
Convergence of sequences and series, power series.		
Module 5	**Fourier series and Fourier Transforms**	10 hours
Fourier series: Periodic functions, Euler's formulae, Dirichlet's condition, Even and odd functions, Half Range Series, Parseval's identity. Fourier Transform		
Texts/References	1. G. B. Thomas and R. L. Finney, *Calculus and Analytic Geometry* (9th Edition), ISE Reprint, Addison-Wesley, 1998. 2. E. Kreyszig, *Advanced engineering mathematics* (8th Edition), John Wiley (1999).	

Subject Code PH 100	**Physics**	**Credits: 3 (3-0-0) Total hours: 45**
Course Prerequisites	10+2	
Course Objective s	To refurbish the understanding of fundamental physics and provide concepts of applied modern and advanced physics for equipping the student for a sound learning of engineering and technology principles.	
Course Outcome	1. Understanding basic concepts in Physics 2. Sound knowledge of the application aspects of modern physics in technology	
Module 1	**Dual nature of particle and waves**	8 hours
Representation of a wave, Phase and Group velocities, Black body radiation, Electromagnetic radiation, Dual nature of light and photoelectric effect, Properties of photons, X-Rays and X-Ray Diffraction, Compton effect, Matter waves, de-Broglie principles, Davisson and Germer experiment (basic ideas) to show the existence of matter waves,		
Module 2	**Quantum Mechanics**	12 hours
Limitations of classical mechanics, The wave equation, State functions, Normalization of wave functions, Schrödinger equation, Time dependent form, operators and expectation values, Time independent Schrödinger equation, Eigenvalues and Eigenfunctions, Applications of Schrödinger equation- Particle in a box, Finite potential well, Potential barrier and tunneling, Harmonic oscillator, Uncertainty principle, Energy and time form of uncertainty principle, explanation of zero point energy.		
Module 3	**Statistical Mechanics**	5 hours
Statistical analysis: Maxwell-Boltzman distribution function, Bose-Einstein distribution function, Fermi-Dirac distribution function, Quantum free electrons theory of metals		
Module 4	**Lasers, Fiber optics and Semiconductor photonic devices**	10 hours
Basics principles and action, Types of lasers, Characteristics of laser light. Fiber optics, Structure of an optical fiber, Principle of optical fiber communication. Semiconductor photonic devices: LED and Solar Cells		
Module 5	**Modern Energy sources**	10 hours
Nuclear reactions, Nuclear fission and fusion; Nuclear reactors, Breeder and fusion reactors. Superconductivity, Basic principles, Messiner effect, Magnetic levitation, Applications of superconductivity, Levitating trains. Solar energy, Wind and wave as energy resource. Elementary particles and their interaction, Leptons and Hardons, Quraks, History of Universe.		
Course Code PH101	**Physics Laboratory**	**Credits-2 (0-0-3)** 3 hours for week
List of Experiments		
1. Hall Effect 2. Photoelectric Effect 3. Helmholtz Resonator 4. Newton's Rings Experiment 5. Determination of Wavelength of He-Ne Laser 6. Determine the width of single slit based on Diffraction pattern 7. Determination of dispersive power of prism 8. Determination of Optical absorption coefficient of materials using lasers 9. Determination of Numerical aperture of an optical fiber		
Text /Reference	1. Franks S. Crawford, *Waves*, Tata Mc Graw Hills Publication	

Books	2. David Halliday, Robert Resnick, Walker Jearl, "*Fundamentals Of Physics"* Wiley India Pvt Ltd 3. S Rai Choudhury, Shobhit Mahajan, Arthur Beiser, Concepts of Modern Physics, 6th Edition, Tata McGraw - Hill Education (2009) 4. A. Goel, Wave Mechancs, Discovery Publishing House, 5. Optoelectronics and Photonics-Principles and Practices, Safa O.Kasap, Pearson publications 6. John W. Jewett, Raymond A. Serrway, *"Physics for Scientists and Engineers"*Brooks/Cole publisher. 7. Ajoy Ghatak, *Optics*, 5th Edition, Mc Graw Hills Publication 8. David Halliday, Robert Resnick, Walker Jearl *PRINCIPLES OF PHYSICS*, Willey India pvt. Ltd. 9. Hugh D. Young, Roger A. Freedman,A. Lewis Ford , *University Physics with Modern Physics, Willey India Pvt. Ltd.* 10. Elements of Solid state physics, M. Ali Omar : Pearson Publication 11. M. N. Avadhanulu, P. G. Krish Sagar, *"Engineering Physics"*S. Chand Publication. 12. V. Rajendran, A. Marikani ,*Materials Science,* Publisher Tata McGraw - Hill Education Publishers.

Subject Code ME 100	**Engineering Mechanics**	**Credits: 3** **Total hours: 44**
Course Prerequisites	10+2	
Course Objectives	To provide the students with a clear and thorough understanding of the theory and application of engineering mechanics covering both statics and dynamics	
Unit 1	**Fundamentals of mechanics**	6 hours
Idealizations of mechanics, vector and scalar quantities, equality and equivalence of vectors, laws of mechanics, Elements of vector algebra.Systems of forces: Position vector, moment of a force about a point, moment of a force about an axis, the couple and couple moment, couple moment as a free vector, moment of a couple about a line.Equivalent force systems:Translation of a force to a parallel position, resultant of a force system, simplest resultant of special force systems, distributed force systems.		
Unit 2	**Equations of equilibrium**	6 hours
Free body diagram, free bodies involving interior sections, general equations of equilibrium, problems of equilibrium, static indeterminacy. **Properties of surfaces:** First moment, centroid, second moments and the product of a plane area, transfer theorems, rotation of axes and polar moment of area, principal axes and concept of second order tensor transformation.		
Unit 3	**Kinematics of a particle**	8 hours
Introduction, general notions, differentiation of a vector with respect to time, velocity and acceleration calculations, rectangular components, velocity and acceleration in terms of cylindrical coordinates, simple kinematical relations and applications.		
Unit 4	**Particle Dynamics**	8 hours
Introduction, rectangular coordinates, rectilinear translation, Newton's law for rectangular coordinates, rectilinear translation, cylindrical coordinates, Newton's law for cylindrical coordinates.		
Unit 5	**Kinetics of Plane Motion of Rigid Bodies**	8 hours
Moment of momentum equations, Pure rotation of a rigid body of revolution about its axis, Pure rotation of slablike bodies. General plane motion of rigid bodies		
Unit 6	**Energy and momentum methods for a particle**	8 hours
Analysis for a single particle, conservative force field, conservation of mechanical energy, alternative form of work-energy equation, Linear momentum, impulse and momentum relations, moment of momentum, Method of momentum for particles.		
Text Books	1. Irving H. Shames, *Engineering Mechanics Statics And Dynamics*, Pearson,2005.	
Reference Books	1. Beer & Johnston, *Mechanics for Engineers*, McGraw – Hill, 2009. 2. Timoshenko, S.P., Young, D.H., Rao, J. V. *Engineering Mechanics*, McGraw-Hill, 2006. 3. Merian, J.L, Kraige, L.G. *Engineering Mechanics – Statics*, Wiley Publishers, 2002.	

Subject Code: CS 100	**Computer Programming and Problem Solving**	Credits: 2 (2-0-0) Total hours: 28
Course Prerequisites	Basic Mathematical Knowledge and logical thinking	
Course Objectives	The course is to make the students learn problem solving by writing algorithms, flow charts and coding the min C language. The course helps the students to write programs for solve Mathematical and Engineering problems.	
Course Outcome	**Enabling Knowledge:** Students will develop knowledge and experience with the use of the standard C programming language, good programming style, standards and practices in programming. **Problem Solving and Critical Analysis:** Students will further develop their capacity to analyze and solve computing problems; develop suitable algorithmic solutions which are the ncoded in the C programming language.	

Module 1	10 hours

Getting Started: Problem solving techniques, C standards. What is C, Getting Started with C, The C Character Set, Constants, Variables and Keywords, Types of C Constants, Rules for Constructing Integer, Real and Character Constants. Types of C Variables, Rules for Constructing Variable Names, C Keywords. The First C Program: Compilation and Execution, Receiving Input. Algorithms and flow charts. C Instructions: Type Declaration Instruction, Arithmetic Instruction, Integer and Float Conversions, Type Conversion in Assignments, Hierarchy of Operations, Associativity of Operators, Control Instructions in C.

The Decision Control Structure: Decisions! Decisions! : The if Statement, The if-else Statement, Nested if-elses, Forms of if. Use of Logical Operators: The else if Clause, The ! Operator, the Conditional Operators.

The Loop Control Structure: Loops: while Loop, for Loop, break statement, continue statement, do-while Loop.

The Case Control Structure: Decisions using switch, switch versus if-else Ladder, The goto Keyword.

Module 2	6 hours

Functions & Pointers: Basics of Functions, Value Passing, Scope rules of Functions, calling convention, Advanced Features of Functions. Introduction to Pointers, Pointer Notation, Recursion, Recursion and Stack, Pointers to Functions, Functions returning pointers, Functions with variable number of arguments.

Data Types Re-examine: Integers- long, short, signed, unsigned. Chars-signed, unsigned. Floats & Doubles. Storage Classes in C.

The C Preprocessor: Features of C Preprocessors, Macro Expansion, File Inclusion, Conditional Compilation, #if and #elif Directives, The Build Process.

Module 3	6 hours

Arrays: Basics of Arrays, Pointers & Arrays, Two Dimensional Arrays, Array of Pointers, Three Dimensional Arrays.

Strings: Basics of Strings, Pointers & Strings, Standard Library String Functions, Dynamic Allocation of memory, Two Dimensional Array of Characters, Array of pointers & Strings.

Structures & Unions: Basics, Declaration and Usage.

Console Input and Output: Formatting output for functions in the printf () family, Formatting input for functions in the scanf () family, Escape sequences.	
Module 4	6hours
File Processing: Opening and closing files, reading and writing sequential files, Using argc and argv **Operations on Bits**: Bitwise Operators, Hexadecimal Numbering System, Relation between Binary and Hex. **Mixed Features**: Enumerated Data type, Typedef, Typecasting, Bit Fields, The volatile Qualifier.	
Text Books	1. Joyce Farrell, *A guide to Programming Logic & Design*, Course Technology, Thomson learning, 2003. 2. Brian W. Kernighan & Dennis M. Ritchie, *The C Programming Language*, Prentice Hall Inc., 2001. 3. *C Programming: A Modern Approach* by K.N. King, 2nd Edition, W. W. Norton & Company
Reference Books	1. Byron S. Gottfried, *Program with C*, Schaum's Outline series. 2. Yashavanth Kanetkar, *Let us C*, BPB Publications. 3. Balagurusamy, *C Programming* – TMH, 2002

Subject Code CS 101	**Computer Programming and Problem Solving (Lab)**	**Credits: 2 (0-0-3)** **Total hours: 42**
Course Objectives	To enable students in developing programming skills using C language. To improve their logical ability and to apply these skills for solving problems in scientific, mathematical and business applications.	

List of experiments

1. Practice of DOS Commands,Exposure to Windows environment, practice of UNIX commands and vi editor.
2. Programs to demonstrate standard I/O functions
3. Practice of writing simple programs like arithmetic operations, simple, compound interests etc.
4. Programs to demonstrate decision, loop & case control structures, use of break and continue,etc.
5. Programs involving arrays
6. Programs involving pointers.
7. Programs involving functions, recursion,use of arrays with subscripts and pointers.
8. Programs using structures in C
9. Exercise on file handling

Reference books

1. Joyce Farrell, "A guide to Programming Logic & Design, Course Technology", Thomson learning, 2003.
2. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Prentice Hall Inc., 2001.
3. K.N. King, "C Programming: A Modern Approach", 2nd Edition, W. W. Norton & Company
4. Byron S. Gottfried, " Schaum's Outline Series on Programming with C"
5. YashavanthKanetkar, "Let us C", BPB Publications.

Subject Code: HU 100	**Professional Communication-I**	**Credits: 3 (3-0-2) Total hours: 45**
Course Prerequisite	Basic Knowledge of English (10+2 level)	
Course Objectives	This course aims at developing the four skills of Language Learning: Reading, Writing, Listening and Speaking. Also it inculcates the power of effective communication among the students.	
Course Outcome	At the end of this course, the students are expected to communicate effectively in English: be it written or be it oral.	
Module 1	**Principles of Communication**	12 hours
a.Verbal Communication: Oral, Written, Visual and Audio-Visual, b. Non-Verbal Communication: Kinesics, Proxemics, Chronemics, Chromatics and Haptics. C. Types of Written Communication, d. Channels, Process and Network of communication, e. Feedback-Types, f. Noise-Types, g. Listening-Types, h. Speaking-Pronunciation, Vocabulary, Stress Pattern i. Comprehension, j. Professional Presentation		
Module 2	**Listening and Speaking**	8 hours
Pronunciation, Word and Sentence Stress and Professional Presentation		
Module 3	**Elements of Effective Writing**	8 hours
Words, Phrases, Sentences, Paragraphs, Reading Comprehension, Precis		
Module 4	**Report Writing and Presentation**	10 hours
Types of Report: different topics will be given to students to prepare Business Reports and then they will be asked deliver verbal presentation based on the reports followed by question answer session		
Module 5	**Business Letters and Correspondences**	7 hours
Sales Letter, Letter of Enquiry, Letter of Order, Letter of Claim Adjustment, Letter of Recommendation, Letter of Promotion, Good News and Bad News Letter, Legal Letter, Application, Notice, Memo, Agenda, Minutes, (followed by tutorials)		
Text Books	1. Kaul, Asha. *Effective Business Communication*, New Delhi: Prentice Hall Pvt Ltd, 2007 2. Raman,Meenaakshi and Sangeeta Sharma, *Technical Communication*, IInd Ed,2012, New Delhi, OUP (with Video CD) 3. Krishna Mohan and Meenakshi Raman,*Advanced Communicative English*, 2011, New Delhi: TataMcGraw Hill. 4. Wren and Martin. *High School English Grammar and Composition*, New Delhi: S. Chand, 2011	
Reference Books	1. Rizvi, A.M. *Effective Technical Communication*, New Delhi: Tata Mc-Graw Hill, 2005 2. English Dailies, *Periodicals: India Today*, Outlook and Reader's Digest	

Subject Code ME 101	**Engineering Drawing**	**Credits: 3 (1-0-3)**
Course Prerequisites	10+2	
Course Objectives	• To express the novel ideas through an engineering language. • To improve the visualization skills. • Learn basic Auto Cad skills.	
Unit 1	**Introduction to Engineering Graphics**	4 hours
Drawing instruments and their use – Different types of lines - Lettering & dimensioning. Projection of points.		
Unit 2	**Orthographic Projections**	8 hours
Introduction to orthographic projections- Horizontal, vertical and profile planes – First angle and third angle projections.		
Unit 3	**Projection of lines**	8 hours
Projections of lines inclined to one of the reference planes. Projections of lines inclined to both the planes – True lengths of the lines and their angles of inclination with the reference planes – Traces of lines.		
Unit 4	**Projection of planes**	8 hours
Projection of plane lamina of geometric shapes inclined to one of the reference planes – inclined to both the planes, Traces of planes		
Unit 5	**Projection of solids**	8 hours
Projection of solids with axis parallel to one of the planes and parallel or perpendicular to the other plane-Projections with the axis inclined to one of the planes. Projections of solids with axis inclined to both the planes. Isometric projection.		
Unit 6	**Sections of Solids**	8 hours
Sections of cylinders, Sections of prisms.		
Unit 7	**Computer Aided Drafting.**	8 hours
Introduction to Auto CAD, Basic 2-D drawing, editing and viewing tools, Dimensioning. Orthographic and Isometric Projections.		
Text Books	1. Bhatt N D., *Engineering Drawing*, Charotar Publication, 2006.	
Reference Books	2. Gopalkrishna K R, *Engineering Graphics* (Ist angle projection), Subhas Publication, 2002. 3. Engineering Drawing and Design – Cencil Jensen, Jay D. Helsel, and Dennis R. Short, Tata McGraw Hills Publication, 2010.	

Subject Code MA 150	**Mathematics-II**	**Credits: 4 (4-0-0) Total hours: 56**
Course Prerequisites	Mathematics-I	
Course Objectives	This Mathematics course provides requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists. Important topics of applied mathematics, namely the linear algebra, ordinary differential equations, laplace transforms and Z transforms.	
Course Outcome	At the end of this course the students are expected to learn, 1. To acquire necessary background in matrix methods and Eigenvalue problems so as to appreciate their importance to engineering systems. 2. Basic skills in handling ordinary differential equations analytically and an understanding of how such equations are used in modeling. Students shall learn to solve systems of linear ordinary differential equations and using Laplace transforms and some basics of Z-transforms.	
Module 1	**Linear Algebra**	22 hours
Matrices: matrix operations -Addition, Scalar Multiplication, Multiplication, Transpose, Adjoint and their properties; System of linear equations and Gaussian Elimination, Determinants and their properties, Cramer's rule Vector Space: Subspaces, Linear Dependence/Independence, Basis dimension, Standard Basis of R^n,linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product spaces, Gram-Schmidt process, and orthonormal bases, Eigenvalues and eigenvectors, characteristic polynomials, eigenvalues of special matrices (orthogonal, unitary, hermitian, symmetric, skewsymmetric, normal). algebraic and geometric multiplicity, diagonalization by similarity transformations, spectral theorem for real symmetric matrices, application to quadratic forms.		
Module 2	**Ordinary Differential Equations**	20 hours
Introduction and Motivation to Differential Equations, First Order ODE y'=f(x,y)- geometrical Interpretation of solution, Equations reducible to separable form, Exact Equations, Integrating factor, Linear Equations and variation of constant, Orthogonal trajectories, Picard's Theorem for IVP (without proof) , examples on nonuniqueness. Second Order Linear differential equations: Linear dependence and Wronskians, Abel-Liouville formula. Linear ODE's with constant coefficients, the characteristic equations. Cauchy-Euler equations. Method of undetermined coefficients. Method of variation of parameters.		
Module 3	**Laplace Transformations and Z-Transforms**	14 hours
Laplace transform - Inverse Laplace transform - properties of Laplace transforms - Laplace transforms of unit step function, impulse function and periodic function - convolution theorem - Solution of ordinary differential equations with constant coefficients and system of linear differential equations with constant coefficients using Laplace transform and basic theory of Z-Transforms.		
Text/Reference	1. E. Kreyszig, *Advanced engineering mathematics* (8th Edition), John Wiley (1999). 2. W. E. Boyce and R. DiPrima, *Elementary Differential Equations* (8th Edition), John Wiley (2005). 3. G. Strang, *Linear algebra and its applications* (4th Edition), Thomson(2006). 4. R. K Jain and S.R.K. Iyengar, *Advanced Engineering Mathematics*,3rd edition, Narosa publications (2007)	

<table>
<tr><td>Subject Code
PH150</td><td colspan="2">Material Science</td><td>Credits: 3 (3-0-0)
Total hours: 46</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">Physics, Mathematics and Chemistry</td></tr>
<tr><td>Course Outcome</td><td colspan="3">Understanding the nature, properties and applications of materials.</td></tr>
<tr><td>Module 1</td><td colspan="2">Structure of Materials</td><td>6 hours</td></tr>
<tr><td colspan="4">Atomic structure and chemical bonding, Classification of solids, Periodicity in crystals, Crystal structure, Bravas lattices, Crystal systems, Crystallographic planes and Miller indices, Crystal structure analysis, Structure determination by X-ray diffraction, The Bragg law of X-ray diffraction, Crystal defects.</td></tr>
<tr><td>Module 2</td><td colspan="2">Conductors and Resistors</td><td>4 hours</td></tr>
<tr><td colspan="4">The resisistivity range, The free electron theory, Conduction by free electrons, Conductor and resistor materials, Superconducting materials.</td></tr>
<tr><td>Module 3</td><td colspan="2">Semiconductors and Dielectrics</td><td>12 hours</td></tr>
<tr><td colspan="4">Semiconductors: Energy gap in solids, Intrinsic semiconductor, Extrinsic semiconductors, Semiconductor materials, Fabrication of integrated circuits, Semiconductor devices, p-n Junction diode theory, Bipolar junction transistor. Dielectrics: Dielectric constant, Polarization, Field vector, Clussius-Mossotti equation, ferro-electric materials, Electrostriction, Piezoelectric effect, dielectric loss.</td></tr>
<tr><td>Module 4</td><td colspan="2">Magnetic Materials</td><td>6 hours</td></tr>
<tr><td colspan="4">Magnetic materials, Diamagnetic materials, Paramagnetic materials, Ferromagnetic materials, Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Soft & Hard Magnetic material and applications.</td></tr>
<tr><td>Module 5</td><td colspan="2">Superconductivity</td><td>6 hours</td></tr>
<tr><td colspan="4">Superconductivity, Meissner effect, London penetration depth, Isotope effect, The BCS theory, Type-I superconductor, Type-II superconductors, Josephson effect and applications</td></tr>
<tr><td>Module 6</td><td colspan="2">Advanced materials</td><td>12 hours</td></tr>
<tr><td colspan="4">Nanomaterials, Conducting Polymers, Meta materials, Fluorescent Materials. Principles of mesoscopic physics-size effect, Quantum confinement, and Coulomb blockade, Optical effects, Surface plasmon effects. Characterization techniques for nano size-SEM, AFM, TEM.</td></tr>
<tr><td>Text/ Reference Books</td><td colspan="3">1. William D. Callister, Jr, Materials science and engineering an introduction, John Wiley & Sons, Inc, 2007
2. V. Rajendran, A. Marikani ,Materials Science, Publisher Tata McGraw - Hill ducation Publishers.
3. S.L Kakani, Amit Kakani “Material Science” New age international Limited
Brain S. Mitchell “An Introduction to Materials for Engineering and science” Willey Interscience.
R. Balasubramanian, Materials Science and Engineering, Willey Interscience.
6. V. Raghavan, “Material Science and Engineering ” PHI Publication.
7. Edward M Purcell, “Electricity and Magnetism”
Julius Adams Stratton, “Electromagnetic Theory” Tata McGraw - Hill Education Publishers.
9. Ali Omar, “Elements of Solid State Physics” Addition Wesley,2000
10. Frederick J. Milford, John R. Reitz, Robert W. Christy, “Foundations of Electromagnetic Theory” Addison Wesley Longman Publishers.
11. John W. Jewett, Raymond A. Serway, “Physics for Scientists and Engineers”Brooks/Cole publishers.
12. T. Pradeep, “A Textbook of Nanoscience and Nanotechnology”, Tata McGraw</td></tr>
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	Hill Education 13. Hans-Eckhardt Schaefer, "*Nanoscience: The Science of the Small in Physics, Engineering, Chemistry, Biology and Medicine*" Springer

Subject Code CY150	**Chemistry**	**Credits: 3 (3-0-0)** **Total hours: 42**
Course Objectives	1. To understand the basic concepts in chemistry in compliance with the requirements for undergraduate engineering programme 2. To get familiarised with analytical instruments 3. To develop awareness on the basics and chemistry involved in electrochemical cells 4. To learn the methods for the development and characterization of polymers	
Module 1	**Organic Chemistry**	7 **hours**
Substitution reactions- SN1, SN2 reaction mechanisms, Factors affecting SN1 and SN2 reactions and stereochemistry, Elimination reactions- E1, E2 reaction mechanisms and factors affecting them, Stereo-selectivity of E1 and E2 reactions, Competition between substitutions and eliminations.		
Module 2	**Chemical Bonding**	**9 hours**
Ionic and covalent bonds; Valence bond theory (V.B.T) of covalency, VSEPR theory, Shapes of simple molecules, Molecular Orbital Theory (M.O.T), Non-covalent interactions- van der Waals and hydrogen bonding; Co-ordinate bond, Metallic bond, Crystal field theory-splitting of d orbital in tetrahedral, octahedral, and square planer complexes		
Module 3	**Instrumental Methods of Analysis**	**8 hours**
Colorimetry, UV-visible spectroscopy, Infra-red spectroscopy, Magnetic resonance spectroscopy, Qualitative and quantitative analysis, Conductometry and Potentiometry		
Module 4	**Water Technology**	**4 hours**
Hardness of water, Boiler troubles, Internal and external treatments, Desalination, Sewage water analysis- Dissolved oxygen (OD), Biological oxygen demand, Chemical oxygen demand and their determination, Sewage water treatment		
Module 5	**Electrochemical Cells**	8 **hours**
Nernst Equation, Energetics of cell reaction, Types of electrodes and their applications, Concentration cells, Primary and secondary cells, Fuel cells. Electroplating- Theory, Polarization, Decomposition potential, Overvoltage, Electroplating and Electroless plating of copper – PCB preparation		
Module 6	**High Polymers**	**6 hours**
Addition, Condensation and Coordination polymerization, Copolymerisation, Molecular weights and their determinations, Methods of polymerization, Tg & Tm and factors affecting them, Teflon, PMMA and UF		
Reference books	1) P. Y. Bruice, *Organic Chemistry*, 4th Edition, Prentice Hall, 2003 2) W. R. Robinson, J. D. Odom, H. F. Holtzclaw , *General Chemistry*, 10th Edition, AITBS Publishers, 2000 3) R. D. Madan, *Modern Inorganic Chemistry*, S. Chand & Company Ltd., 2012 4) G. Chatwal, S. Anand, *Instrumental Methods of Chemical Analysis*, S. D. Himalaya Publishing House, 2003 5) P. C. Jain, M. Jain, *Engineering Chemistry*, Dhanpat Rai & Sons, 15th edition,	

	2004 6) V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, *Polymer Science*, New Age International (P) Limited, 2005 7) O. G. Palanna, Engineering Chemistry, Tata McGraw Hill Publishing Co. Ltd., 2012 8) B. R. Puri, L. R. Sharma, M. S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co., 41st edition 2004 9) S. Rattan, *Comprehensive Engineering Chemistry*, S.K. Kataria & Sons, Delhi, 2011

Subject Code CY151	**Chemistry Laboratory**	**Credits: 2 (0-0-3)**

1. Estimation of Iron in hematite
2. Estimation of copper in brass
3. Determination of pKa and Ka of weak acid
4. Conductometric titration of strong acids with Strong base
5. Estimation of total chromium by colorimetry
6. Verification of Nernst Equation
7. Determination of coefficient of viscosity of a liquid
8. Determination of COD in a given water sample
9. Estimation of total hardness of water
10. Estimation of chloride content in water
11. Determination of percentage of composition by using Abbe's refractometer
12. Preparation of alkyl chloride from alcohol

Note: Any 8 experiments have to be done

Reference books	1) A. I. Vogel, *Text book of quantitative chemical analysis*, Prentice Hall, 2000 2) A. I. Vogel, *Text book of practical organic chemistry*, 5th edition, Prentice Hall ,1996 3) S. Rattan, *Experiments in applied chemistry*, 3rd edition, S. K. Kataria & Sons, 2011.

Subject Code ME150	**Elements of Mechanical Engineering**	**Credits: 2(2-0-0)**
Course Prerequisites	10+2	
Course Objectives	• To be able to use the Laws of Thermodynamics to estimate the efficiency of different components of power generating systems • To teach the basic mechanical	
Unit 1	**Introduction to Thermodynamics**	8 hours
Thermodynamics: Introduction and Basic Concepts, Application Areas of Thermodynamics, Systems and Control Volumes, Properties of a System, State and Equilibrium, Processes and Cycles, Temperature and the Zeroth Law of Thermodynamics, Pressure.		

Energy Conversion and General Energy Analysis: Forms of Energy, Energy Transfer by Heat, Energy Transfer by Work, the First Law of Thermodynamics.		
Unit 2	**Energy Analysis of Closed Systems**	8 hours
Moving Boundary Work, Energy Balance for Closed Systems, Specific Heats, Internal Energy, Enthalpy, and Specific Heats of Ideal Gases, Solids and Liquids. The Second Law of Thermodynamics: Thermal Energy Reservoirs, Heat Engines, Refrigerators and Heat Pumps, Perpetual-Motion Machines, Reversible and Irreversible Processes, the Carnot Cycle.		
Unit 3	**Basics of Solid Mechanics**	8 hours
Stress-Strain relationship, Shear force and Bending Moment Diagrams.		
Unit 4	**Manufacturing Process**	6 hours
Welding, Brazing and Soldering. Introduction to machine tools lathe and drilling machines.		
Text Books	1. Michael A. Boles, Yunus A. Cengel, Thermodynamics: *An Engineering Approach*, Tata McGraw Hill, 2011. 2. P. K. Nag, Engineering Thermodynamics, Tata McGraw Hill, 2005.	
Reference Books	1. Frank P. Incropera and David P. DeWitt, Fundamentals of Heat and Mass Transfer, Wiley Publication, 2006. 2. Ferdinand L. Singer, Strength of Materials, Harper and Row. 3. Elements of Workshop Technology, S. K. Hajra Choudhary, S. K. Bose, A. K. Hajra Choudhary, Media promoters and publishers pvt. ltd., 2007	

Subject Code EE151	**Basic Electrical Science**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To expose students to basic electric devices and components characteristics and techniques of analyzing them.	
Module 1	**DC circuit Analysis**	12 hours
Review of circuit elements, Voltage sources, Current sources, Ohm's Law, Kirchoff's Laws, Mesh and Node analysis of DC circuits,Source transformation, Star-Delta Transformation, Network theorems, Time domain analysis of RC, RL, RLC with DC excitation.		

Module 2	**Magnetic circuit Analysis and AC circuit Analysis**	12 hours
Electromagnetic Induction, Self and mutual inductances, Magnetic circuits. Fundamentals of A.C, Average and RMS values, Form and Peak factor, Concept of Phasors, Complex operator, Network theorems, Basic concepts of three phase circuits.		
Module 3	**Semiconductor Devices and Circuits**	14 hours
P-Njunction diode, Characteristics, Diode approximations, DC load line, AC equivalent circuits, Zener diodes Half-wave diode rectifier and Full-wave diode rectifier, Shunt capacitor filter, Ripple factor - Approximate analysis of capacitor filters, Power supply performance, Voltage regulators; Bipolar Junction transistor, Characteristics, DC Load line and Bias Point, Biasing circuit design, Amplifiers.		
Module 4	**Elements of Digital Electronics**	7 hours
Analog and Digital Signals, Introduction to Digital Electronics, Digital Logic Gates. Introduction to memory elements, SRAM, DRAM, ROM, PROM, EPROM, EEPROM.		
Text Books	1. Del Toro, *Electrical Engineering Fundamentals*, Pearson Education, 2002. 2. R.J. Smith, *Circuits, Devices and Systems: A First Course in Electrical Engineering*, Wiley-5th edition 3. William H. Hayt Jr., Jack E. Kemmerly, *Steven M. Durbin, Engineering Circuit Analysis*, TMH, 2002.	
Reference Books	1. A.S. Sedra& K.C Smith, *Microelectronic Circuits*, Oxford Univ. Press 1999.	

Subject Code EE152	**Basic Electrical Science(Lab)**	**Credits: 2 (0-0-3)** **Total hours: 45**
Course Objectives	To have hands on experience on principle of basic electronic passive and active components and their analysis.	
List of Experiments		
1. Verification of KVL and KCL circuit laws**.** 2. Designing and AC, Transient analysis of series and parallel RC,LC and RLC circuits . 3. Clipping , Clamping circuits & voltage multipliers with diodes. 4. Rectifiers with C, LC & CLC filters - half wave, full wave & Bridge.		

5. Network Theorem - Superposition, Thevenin, Norton and Maximum Power Transfer 6. Phasor Analysis of series and parallel RC,LC and RLC circuits. 7. BJT and JFET Characteristics. 8. Transistor as an Amplifier. 9. Digital Combinational Logic gates. 10. Memory Elements. 11. Soldering and PCB design practice.

Subject Code ME 151	**Workshop Practices**	**Credits: 2(0-0-3)**
Course Prerequisites	10+2	
Course Objectives	To impart knowledge and technical skills on basic manufacturing methods	
Module 1	**Mechanical Workshop**	36 hours
Carpentry: Demonstration of wood cutting machines, tools, and equipments, planning, chiseling, marking and sawing practice, Different joints Fitting: Demonstration of various tools and equipments used in fitting shop, chipping, filing, cutting, tapping, male and female joints, stepped joints Welding: Demonstration of various welding machines and equipments, Butt joint and Lap joint using electric arc welding Turning: Demonstration of lathe, drilling machines, grinding machines, milling machines.		
Reference Books	1. Elements of Workshop Technology, S. K. Hajra Choudhary, S. K. Bose, A. K. Hajra Choudhary, Media promoters and publishers pvt. ltd., 2007	

Subject Code-PE 150	**Physical Education**	**Credits: 1 (0-0-0)** **Total Hours: 16**
Objective: The particular topics will give an idea of minimum physical fitness required for maintain mental and physical health to become healthy in society. The contents will give relax and stress free from the hectic schedule of studies and job of students. The practical session of relaxation techniques will make students very fresh and active in daily life. Based on the topics, students will be ready for doing physical activity to maintain their health for better life without any kind of hypokinetic disease or lifestyle diseases presently seen in society.		
Module 1	**FITNESS**	4 hours

Definition and meaning of Physical fitness, Role and scope of physical fitness, Components of physical fitness, Types of physical fitness, Health related physical fitness, Skill related physical fitness, General and specific warming up. (Practical)		
Module 2	**SPORTS FOR TECHNICAL FIELD**	4 hours
Relaxing techniques, Stress management, Sports for relax, Benefits of Exercise-Psychological and Physiological aspects, Self Confidence and Motivation.		
Module 3	**ANATOMY AND PHYSIOLOGY**	4 hours
Basic anatomy, Exercise physiology, Body type, Sports Injury and prevention and their management.		
Module 4	**LIFESTYLE DISEASE AND SPORTS**	4 hours
Diet, Heart attack, Blood pressure, Cholesterol, Obesity, Stress		

References:

1. Mood, D, Musker, F and Rink, J. (1999). Sports and recreational activities. Boston: McGraw-Hill.
2. Rink, J.E. (1998). Teaching physical education for learning (3rd Ed.). Boston: McGraw-Hill.
3. Dey Swapan Kumar (2012). A Textbook of Sports and Exercise Physiology, New Delhi: Jaypee Brothers Medical Publications.ISBN: 9789350258736.
4. Nick Draper and Helen Marshall. (2013)Exercise Physiology: For Health and Sports Performance, Harlow/GB: Pearson Education Publication Limited. ISBN 13: 9780273778721 ISBN 10: 0273778722.
5. William D. McArdle, Frank I. Katch, Victor L. Katch. (2009)Exercise Physiology: Nutrition, Energy andHuman Performance. United States: Lippincott Williams and Wilkins ISBN: 1608318591.
6. Robert Weinberg and Daniel (2010) Gould Foundations of Sport and Exercise Psychology. USA: Human Kinetics ISBN: 0736083235.
7. Aidan.P.Moran (2012), Sport and Exercise Psychology A Critical Introduction, 2nd Edition, New york:Routledge, ISBN: 978041543430.

Academic Hand Book

for

Bachelor of Technology Programme

in

Computer Science and Engineering

National Institute of Technology Goa

Farmagudi, Ponda, Goa - 403 401

Semester-wise Credit Distribution

Semester	Total Credits
I	22
II	21+1
III	21
IV	20+1
V	21+3
VI	21
VII	21
VIII	18
Total Credits	**170**

I Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	MA100	Mathematics-I	4-0-0	4
2	PH100	Physics	3-0-0	3
3	ME100	Engineering Mechanics	3-0-0	3
4	CS100	Computer Programming andProblem Solving	2-0-3	4
5	HU100	Professional Communication	2-0-2	3
6	ME101	Engineering Drawing	1-0-3	3
7	PH101	Physics Laboratory	0-0-3	2
		Total Credits		**22**

II Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	MA150	Mathematics-II	4-0-0	4
2	PH150	Material Science	3-0-0	3
3	CY150	Chemistry	3-0-0	3
4	ME150	Elements of Mechanical Engineering	2-0-0	2
5	EE151	Basic Electrical Science	3-0-0	3
6	ME151	Workshop Practices	0-0-3	2
7	CY151	Chemistry Laboratory	0-0-3	2
8	EE152	Basic Electrical Science Lab	0-0-3	2
9	PE150	Physical Education	1-0-0	1
		Total Credits		**22**

III Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	CS200	Principles of Data Communications	3-1-0	4
2	CS201	Data Structures	3-1-0	4
3	CS202	Computer Organization and Architecture	3-1-0	4
4	CS203	Discrete Mathematics	3-1-0	4
5	MA200	Mathematics-III	3-0-0	3
6	CS204	Data Structures Laboratory	0-0-3	2
		Total Credits		**21**

IV Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	CS250	Digital Systems Design	3-0-0	3
2	HS250	Economics	3-0-0	3
3	CS251	Systems Programming	3-1-0	4
4	CS252	Object Oriented Programming	3-0-0	3
5	MA250	Mathematics-IV	3-0-0	3
6	CS253	Object Oriented Programming Laboratory	0-0-3	2
7	CS254	Digital Systems Laboratory	0-0-3	2
8	VE200	Value Education	1-0-0	1
		Total Credits		**21**

V Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	CS300	Operating Systems	3-1-0	4
2	CS301	Database Systems	3-1-0	4
3	CS302	Microprocessor and Microcontrollers	3-0-0	3
4	CS303	Theory of Computation	3-1-0	4
5	ES300	Environmental Studies	3-0-0	3
6	CS304	Operating Systems Laboratory	0-0-3	2
7	CS305	Database Systems Laboratory	0-0-3	2
8	CS306	Microprocessor and Microcontrollers Laboratory	0-0-3	2
		Total Credits		**24**

VI Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	CS350	Compiler Design	3-1-0	4
2	CS351	Design and Analysis of Algorithms	3-0-0	3
3	CS352	Software Engineering	3-0-0	3
4	CS353	Computer Networks	3-0-0	3
5	CS5** /HU501 and HU502	Elective-I	3-0-0	3
6	CS354	Compiler Design Laboratory	0-0-3	2
7	CS355	Networks Laboratory	0-0-3	2
8	CS356	Mini Project/Industrial training	0-0-3	1
		Total Credits		**21**

VII Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	CS400	Foundations of cryptography	3-1-0	4
2	CS401	Introduction to Machine Learning	3-0-0	3
3	CS5**	Elective-II	3-0-0	3
4	HS400	Management	3-0-0	3
5	CS402	Seminar	0-0-2	2
6	CS403	Security Laboratory	0-0-3	2
7	CS449	Major Project-I	0-0-4	4
		Total Credits		**21**

VIII Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	CS5**	Elective-III	3-0-0	3
2	CS5**	Elective- IV	3-0-0	3
3	CS5**	Elective- V	3-0-0	3
4	CS5**	Elective- VI	3-0-0	3
5	CS499	Major Project – II	0-0-6	6
		Total Credits		**18**

Subject Code CS 200	**Principles of Data Communication(PDC)**	**Credits: 4 (3-1-0)** **Total hours:56**
Course Objectives	This course provides an introduction to the field of data communications. The course covers the principles of data communications, transmission fundamentals: Signals, media, encoding and modulation, multiplexing, devices, error detection and correction, data link control and protocols, data transmission over networks - switching techniques and Local Area Network.	
Module 1		**12 Hours**
Introduction to communication signals, message, data, signal, mathematical models for basic communication, Fourier series, Fourier transform and signals, information spectrum, energy type and power type signals, Parseval's theorem, basic of analog filters.		
Module 2		**12 Hours**
Introduction to modulation, types of modulation, channel and noise effects in time domain and frequency domain, signals and spectra in amplitude, phase and frequency modulation; basic block diagram and analysis of AM/FM/PM demodulation/detection system.		
Module 3		**10 Hours**
Introduction to Information Theory and concepts in Digital data representation, sampling, Nyquist sampling theorem, filtering, pass band need for quantization, aliasing, and reconstruction filter, problem of quantization, quantizer design and noise.		
Module 4		**8 Hours**
Introduction to source coding, Shannon's first coding theorem, optimality of entropy based representation, Search for uniquely decodable code book and the kraft inequality, fixed vs. variable length codebook, Huffman coding, some other source coding algorithms - run length, Shannon-Fano, and introduction to Ziv–Lempel coding.		
Module 5		**10 Hours**
Errors in transmission/storage, need for forward error detection and control, need for feedback error detection and control, field, group and algebra of error control coding, minimum distance and distance distribution for error detection and correction, code word design using hamming algorithm, decoding and error detection - correction using syndrome, CRC and cyclic code.		
Module 6		**4 Hours**
Digital modulation concepts, architectures for receivers, communication network models, LAN, ethernet and IEEE 802.11 standards, resource allocation and performance issues in wired/wireless LAN.		
Reference books	(1) William Stallings, "Data and Computer Communications and Networking", 2nd Edition, TMH, 2002. (2) Behrouz A Forouzan, "Data Communications and Networking", 2nd edition, TMH, 2002. (3) Leon, Garcia and Widjaja , " Communication Networks", TMH, 2002.	

Subject Code CS 201	**Data Structures (DS)**	Credits: 4 (3-1-0) Total hours:56
Course Objectives	Following this course, students will be able to: 1) Assess how the choice of data structures and algorithm design methods impacts the performance of programs. 2) Choose the appropriate data structure and algorithm design method for a specified application. 3) Solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, tournament trees, binary search trees, and graphs and writing programs for these solutions. 4) Solve problems using algorithm design methods such as the greedy method, divide and conquer, dynamic programming, backtracking, branch and bound and writing programs for these solutions.	
Module 1		**6 Hours**
Introduction to data structures and objectives, basic concepts Arrays: one dimensional, multi-dimensional, Elementary Operations.		
Module 2		**8 Hours**
Stacks: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching, Queues: Simple queue, circular queue, dequeue, elementary operations and applications.		
Module 3		**10 Hours**
Linked lists: Linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation.		
Module 4		**12 Hours**
Trees: Binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees like AVL tree and 2-3 tree and other operations and applications of trees.		
Module 5		**20 Hours**
Graphs: Representation, adjacency list, graph traversal, path matrix, spanning tree; introduction to algorithm analysis and design techniques, algorithms on sorting: Selection sort, bubble sort, quick sort, merge sort, heap sort, searching, linear and binary search.		
Reference books	(1) Alfred V Aho, John E Hopcroft, Jeffrey D. Ullman, "Data structures & algorithms", Addison Wesley. 2003 (2) Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, "Fundamentals of data structures and algorithms using C++", 2nd edition, Galgotia publications, 2006 (3) Michael T. Goodrich, Roberto Tamassia, "Data Structures and algorithms in Java", 4thEdition, John Wiley & Sons, Inc., 2010 (4) Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, "Introduction to algorithms", 2nd ed. MIT Press, 2003	

Subject Code CS 202	**Computer Organization and Architecture (COA)**	**Credits: 4 (3-1-0)** **Total hours:56**
Course Objectives	The course explores the hardware aspects of a computer system design.	

Module 1	**8 Hours**
Overview of Computer Architecture & Organization, contrast between computer architecture & organization, logical organization of computers; basic operational concepts, bus structures, performance, processor clock, basic performance equation, clock rate, performance measurement, Von Neumann machine, instruction format, execution cycle; instruction types and addressing modes.	
Module 2	**10 Hours**
Computer Arithmetic: representation of integers and real numbers, fixed point arithmetic, arithmetic and logical unit design, addition and subtraction of signed numbers, design of fast adders, multiplication of positive numbers, signed operand multiplication, fast multiplication, integer division, floating-point numbers and operations.	
Module 3	**8 Hours**
Basic Concepts of Memory System: Semiconductor RAM memories, ROM memories, speed, size, and cost, cache memories mapping functions, replacement algorithms, performance considerations, virtual memories, secondary storage.	
Module 4	**15 Hours**
Control Unit Design: Instruction sequencing, instruction interpretation, control memory, hardwired control, micro programmed control and micro programmed computers. I/O organization, bus control, Serial I/O (study of asynchronous and synchronous modes, USART & VART), parallel data transfer Program controlled: asynchronous, synchronous & interrupt driven modes, DMA mode, interrupt controller and DMA controller.	
Module 5	**15 Hours**
Organization of CPU: Single vs. multiple data path, ISA, control unit, instruction pipelining, trends in computer architecture, CISC, RISC, VLIW, introduction to ILP, pipeline hazards: structural, data and control, reducing the effects of hazards.	

Reference books	(1) Carl Hamacher, ZvonkoVranesic and SafwatZaky, "Computer organization", 5th Edition, Tata McGraw Hill, 2002. (2) J. P. Hayes, "Computer architecture and organization", 3rd Edition, McGraw Hill, 1998. (3) Patterson and Hennessy, "Computer architecture: A quantitative approach", Morgan Kaufmann, 2000. (4) Hwang and Briggs, "Computer architecture and parallel processing", McGraw Hill, 1985. (5) David A. Patterson& John L. Hennessy, "Computer organization and design", Morgan Kaufmann, 4th edition, 2012.

Subject Code CS 203	**Discrete Mathematics (DM)**	Credits: 4 (3-1-0) Total hours:56
Course Objectives	This course introduces basic concepts of combinatory, notion of proofs, concept of generating functions, recurrence relations.	
Module 1		**15 Hours**
Sets and Subsets, set operations and the laws of set theory, counting and Venn diagrams, a first word on probability, countable and uncountable sets. Fundamentals of Logic: Basic Connectives and truth tables, logic equivalence, the laws of logic, logical implication, rules of inference, proportional and predicate calculus the use of quantifiers, quantifiers, definitions and the proofs of theorems, normal forms, applications to artificial intelligence.		
Module 2		**10 Hours**
Properties of the Integers: Mathematical Induction, the well ordering principle, recursive definition.		
Module 3		**15 Hours**
Relations and Functions: Cartesian Products and Relations, functions, plain and one-to-one, onto functions, sterling numbers of the second kind, special functions, the pigeon-hole principle, function composition and inverse functions, properties of relations, computer recognition zero, one matrices and directed graphs, partial orders, Hasse diagrams, equivalence relations and partitions.		
Module 4		**10 Hours**
Groups: Definitions, examples, elementary properties, costs, normal subgroups, permutation groups, homeomorphisms, isomorphism, and cyclic groups, cosets and Lagrange's Theorem. Burnside's Theorem and simple applications.		
Module 5		**6 Hours**
Introduction to graph theory, trees, planarity, connectivity, traversability, shortest path and spanning tree, algorithms.		
Reference books	(1) J.P. Tremblay & R. Manohar, "Discrete mathematical structures with applications to computer science", Tata McGraw Hill, 2008. (2) C.L.Liu, "Elements of Discrete mathematics", 3rd ed. McGraw Hill, 2008 (3) Kenneth Rosen, "Discrete mathematics and its applications", TMH, 2011. (4) Jean Gallier, "Discrete mathematics", Springer, 2011. (5) Ralph P. Grimaldi, "Discrete and combinatorial mathematics: An applied introduction", Pearson, 2003.	

Subject Code **MA 200**	**Mathematics-III**	**Credits: 3** **Total hours 42**
Course Prerequisites	Mathematics-I & II	
Objectives	This Mathematics course provides requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists. Important topics of applied mathematics, namely complex analysis, power series solutions, Fourier series and transforms and partial differential equations.	
Module 1	**Complex Analysis**	18 hours
Complex Numbers, geometric representation, powers and roots of complex numbers, Functions of a complex variable, Analytic functions, Cauchy-Riemann equations; elementary functions, Conformal mapping (for linear transformation); Contours and contour integration, Cauchy's theorem, Cauchy integral formula; Power Series and properties, Taylor series, Laurent series, Zeros, singularities, poles, essential singularities, Residue theorem, Evaluation of real integrals and improper integrals.		
Module 2	**Power Series Solutions**	9 hours
Differential Equations Power Series Method - application to Legendre equation, Legendre Polynomials, Frobenious Method, Bessel equation, Properties of Bessel functions, Sturm- Liouville BVPs, Orthogonal functions.		
Module 3	**Partial Differential Equations**	15 hours
Introduction to PDE, basic concepts, second order PDE and classification, D'Alemberts formula and Duhamel's principle for one dimensional wave equation, Laplace's and Poisson's equations, Laplace, Wave, and Heat equations using separation of variables. Vibration of a circular membrane. Heat equation in the half space.		
Texts/References	1. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999). 2. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005). 3. R. V. Churchill and J. W. Brown, Complex variables and applications (7th Edition), McGraw-Hill (2003).	

Subject Code CS 204	**Data Structures Laboratory**	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	The course provides practical knowledge in implementing the standard data structures in C	

List of Experiments

(1) Implementation of array operations, Structures & Unions.
(2) Stacks, Queues, Circular Queues, Priority Queues, Multiple stacks and queues.
(3) Infix to postfix expression using stack
(4) Implementation of linked lists: stacks, queues, single linked lists.
(5) Implementation of polynomial operations. Doubly linked lists.
(6) Tree traversal: AVL tree implementation, application of trees.
(7) Implementation of Hash Table.
(8) Searching and sorting.
(9) Traversal of graph

Reference books

(1) Mark Allen Weiss, "Algorithms data structures and problem solving with C++", Addison Wesley, 1996.
(2) Seymour Lipschutz, G A VijayalalashmiPai, "Data structure", Schaum's outlines,TMH, 1986
(3) O.G. Kakde&P.S. Deshpandey, "Data structures and algorithms", ISTE/EXCEL books, 2004.
(4) Aho Alfred V., Hopperoft John E., UIlman Jeffrey D., "Data Structures and Algorithms",Addison Wesley, 1983.

Subject Code CS 250	**Digital Systems Design (DSD)**	Credits: 3 (3-0-0) Total hours:45
Course Objectives	To understand the working of digital systems. Hardware components of the computer can be studied in greater depth.	
Module 1		**10 Hours**
Number Systems And Boolean Algebra: Review of binary, octal & hexadecimal number systems, representation of signed numbers, floating point number representation BCD, ASCII, EBCDIC, excess 3 codes, gray code-error detecting & correcting codes. Boolean algebra: Postulates & theorems of boolean algebra, canonical forms, simplification of logic functions using Karnaugh map, Quine McCaskey method.		
Module 2		**8 Hours**
Combinational Logic Design: Logic gates, implementation of combinational logic functions, encoders & decoders, multiplexers &demultiplexers, code converters, comparator, half adder, full adder, parallel adder, binary adder, parity generator/checker, implementation of logical functions using multiplexers.		
Module 3		**11 Hours**
Sequential Logic Design-I : RS, JK, JK master, slave, D&T flip flops, level triggering and edge triggering, excitation tables, asynchronous & synchronous counters, modulus counters, shift register , Johnson counter, ring counter, timing waveforms, counter applications.		
Module 4		**8 Hours**
Sequential Logic Design-II: Basic models of sequential machines, concept of state table, state diagram, state reduction through partitioning & implementation of synchronous sequential circuits, Introduction to asynchronous sequential logic design.		
Module 5		**8 Hours**
Programmable Logic Devices: Semicustom design, introduction to PLD's, ROM, PAL, PLA, FPGA Architecture of PLD's: PAL 22V10, PLS 100/101, implementation of digital functions. Logic Families: RTL, DTL, TTL families, Schottky, clamped TTL, Emitter Coupled Logic (ECL), Integrated Injection Logic (IIL), MOS inverters, CMOS inverters, comparison of performance of various logic families.		
Reference books	(1) Alan B.Marcovitz, "Introduction to logic design", 3rd Edition, McGraw-Hill Professional, 2009. (2) Giovanni De Micheli, "Synthesis and optimization of digital circuits", Tata McGraw-Hill Education 2003. (3) Zvi Kohavi, Niraj K. Jha, "Switching and finite automata theory", 3rd Edition Cambridge University Press, 2011. (4) Douglas A. Pucknell &Kamran Shrayhian, "Basic VLSI design systems and circuits", Prentice Hall 2000. (5) ParagK.Lala, "Fault tolerant & fault testable hardware design", B.S publications, 2002.	

Subject Code HS 250	**Economics**	Credits: 3(3-0-0) Total hours: 45
Course Outcome	The fundamental objective of this course aims at providing a comprehensive perspective in the broad area of economics and its scenario. The course aspires to bring the students into the light of economic decision makings, and facilitates tohave grip in economic issues.	
Module 1	**Introduction to Economics**	2 hours
Constructing a Model, Optimization and Equilibrium in market demand and supply, Comparative statistics and asset allocation.		
Module 2	**Utility, Choice, Budget Constraint and Consumer Preference**	6 hours
Cardinal Utility, Constructing a Utility Function, Budget constraint in case of two goods, Shifting of budget line and impact of Taxes, Subsidies, and Rationing. Indifference curve, Marginal Rate of Substitution, Cardinal utility and utility function, Indifference curve from utility functions, Marginal Utility vs MRS		
Module 3	**Demand, Revealed Preference & Slutsky Equation**	6 hours
Normal and Inferior Goods, Income Offer Curves and Engel Curves, Perfect Substitute, complement and Cobb-Douglas Preferences, The Idea of Revealed Preference, From Revealed Preference to reference,Recovering Preferences, The Substitution Effect, The Income Effect, Rate of Change and change of Demand.		
Module 4	**Consumer Surplus, Market Demand & Equilibrium**	6 hours
Demand for a Discrete Good, Constructing Utility from DemandFrom, Change inConsumer's Surplus, Individual to Market Demand, The Inverse Demand Function, The Extensive and the Intensive Margin, Elasticity, Elasticity and Demand, Market Supply, Market equilibrium, Inverse Demand and Supply Curves		
Module 5	**Technology and Profit Maximization**	3 hours
Inputs and Outputs, Describing Technological Constraints, Properties of Technology, The Technical Rate of Substitution, Diminishing Technical Rate of Substitution, Returns to Scale, Profits, The Organization of Firms, The Organization of Firms, Short-Run Profit Maximization, Profit Maximization in the Long Run, Profit Maximization and Returns to Scale		
Module 6	**National Income Accounting**	2 hours
National Income and Related concepts, Nominal or real GDP, Methods of measuring NI.		
Module 7	**Determinants of Equilibrium Output and IS – LM Model**	8 hours
Aggregate demand and Equilibrium output, Consumption function and aggregate demand, Multiplier, Govt. sector, Budget and Full employment, Asset and Goods Market, Equilibrium and adjustment to equilibrium in IS – LM model		
Module 8	**Money and Fiscal policy and International Linkages**	8 hours
Monetary and fiscal policy, crowding out, composition of output and policy mix, Balance of Payment and Exchange rate, Balance of Trade and capital mobility, Mundell-Fleming model, Capital Mobility and fixed exchange rates		
Module 9	**Aggregate Demand, Supply and Growth**	4 hours
Aggregate demand and policies, Aggregate Supply, Fiscal and monetary policy under Alternative supply Assumption, The quantity theory and neutrality of Money.		
Text Books	Varian, Hal R.: Intermediate Microeconomics, W.W. Norton & Co., New work (ISBN: 0393978303) Koutsoyiannis, A.: Modern Microeconomics, 2nd ELBS/Palgrave Macmillan, London Rudiger Dornbusch and Stanley Fisher: Macroeconomics, McGraw Hill Barro Robert J. "Macroeconomics, New York, John Wiley	

Subject Code CS 251	**Systems Programming (SP)**	Credits: 4 (3-1-0) Total hours:56
Course Objectives	To understand the relationship between system software and machine architecture to design and implement assemblers, linkers and loaders.	
Module 1		**10 Hours**
Components of a programming system: Assemblers, loaders, macros, compilers, machine Structure: Memory, registers, data, instructions. Machine language: Address modification using instructions as data, address modification using index registers, looping Assembly language.		
Module 2		**15Hours**
Assemblers: Basic assembler functions with an example assembler, assembler algorithm and data structures, machine dependent assembler features, machine independent assembler features, one-pass assemblers, multi-pass assemblers, implementation example. Table processing: Searching and sorting.		
Module 3		**15 Hours**
Loaders and Linkers: Basic loader functions, design of an absolute loader, a simple bootstrap loader, machine dependent loader features, program linking, algorithms and data structures for lining, machine independent loader features, automatic library search, loader design options, dynamic linking and an implementation example.		
Module 4		**10 Hours**
Macro processors: Basic macro processor functions, macro definition and expansion, macro processor data structures and algorithms, implementation example, discussion of ANSI C macro language.		
Module 5		**6 Hours**
System Software Tools: Text editors, overview of the editing process, user interface, editor structure, interactive debugging systems, debugging functions and capabilities, relationship with other parts of the system.		
Reference books	(1) John J. Donovan, "Systems Programming", Tata McGraw-Hill Edition, 2009. (2) Leland L. Beck, D. Manjula, "System software: An introduction to systems programming", Pearson education, 3rd ed, 2007. (3) D.M. Dhamdhere, "Introduction to system software", Tata McGraw Hill Publications, 2002. (4) John R. Levine, "Linkers & Loaders", Morgan Kaufmann Publishers, 2000.	

Subject Code CS 252	**Object Oriented Programming (OOP)**	Credits: 3 (3-0-0) Total hours:45
Course Objectives	This course focuses on principles of object oriented programming paradigm. The course also includes practice of writing programs in C++ and Java.	

Module 1	**10 Hours**
Principles of OOP: Programming paradigms, basic concepts, benefits of OOP, applications of OOP Introduction to C++: History of C++, structure of C++, basic data types, type casting, type modifiers, operators and control structures, input and output statements in C++. Classes and objects: class specification, member function specification, scope resolution operator, access qualifiers, instance creation .Functions: Function prototyping, function components, passing parameters, call by reference, return by reference, inline functions, default arguments, overloaded function. Pointers: Array of objects, pointers to objects, this pointer, dynamic allocation operators, dynamic objects.	
Module 2	**10Hours**
Constructors: Constructors, parameterized constructors, overloaded constructors, constructors with default arguments, copy constructors, static class members and static objects. Operator overloading: Overloading unary and binary operator, overloading the operator using friend function, stream operator overloading and data conversion.	
Module 3	**8 Hours**
Inheritance: Defining derived classes, single inheritance, protected data with private inheritance, multiple inheritance, multi-level inheritance, hierarchical inheritance, hybrid inheritance, multi path inheritance, constructors in derived and base class, abstract classes, virtual function and dynamic polymorphism, virtual destructor.	
Module 4	**7 Hours**
Exception Handling: Principle of Exception handling, exception handling mechanism, multiple catch, nested try, rethrowing the exception. Streams in C++: Stream classes, formatted and unformatted data, manipulators, user defined manipulators, file streams, file pointer manipulation, file open and close. Templates: Template functions and Template classes.	
Module 5	**10 Hours**
Object oriented programming using Java: Introduction to Java, bytecode, virtual machines, basic data types, operators, control structures, classes and objects, using Javadoc, packages, arrays, strings, inheritance, interfaces, exception handling, multithreaded programming, Java streams, developing user interfaces in Java.	

Reference books	(1) BJarne Stroustrup, "The C++ Programming Language", Addison Wesley, 2004. (2) Stanley B Lippman, "The C++ Primer", Addison Wesley, 2005. (3) Ira Pohl, "Object oriented programming using C++", 2nd ed, Pearson Education India, 2003. (4) Patrick Naughton and Herbert Schildt, "Java 2: The Complete Reference", Fourth ed, McGraw Hill Professional 2001. (5) Paul. Deitel, Harvey Deitel, "Java: How to program", 8th Edition, PHI private limited, 2010.

Subject Code MA 250	**Mathematics-IV**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	This is a one semester course that covers elements of linear algebra from notion of vector spaces, norm, and basic topology and views the signal space model useful to model most real world observations. It aims at developing probabilistic models for Information processing and systems.	
Module 1		**15 Hours**
Signal Modeling: Review of vector spaces, linear data models, Eigen-decomposition & matrices, Fourier series and transforms, Some other transforms and applications to data representation.		
Module2		**10 Hours**
Motivating probability via measure theory and Borel-Field, Kolmogorov axioms, Bayes' theorem and applications, random variable, properties of CDF/PDF, inequalities & bounds, moment generating function & probability generating functions.		
Module 3		**10 Hours**
One function of one random variable, discrete and continuous random variables, Bernoulli, binomial, Poisson, geometric, uniform, exponential, Gaussian, statistical tests on surveys and sampling as experiments.		
Module 4		**10 Hours**
Computational models using randomness, information theory, pattern recognition, random sequences, random processes, measurements with random processes, types of random processes, detection and estimation (statistical inference models), Markov chains and discrete random processes, examples from communication networks		
Reference books	(1) Athanasios Papoulis, U. S. Unnikrishnan Pillai, "Probability, random variables and Stochastic processes", 4th ed, Tata McGraw-Hill Edition, 2002 (2) Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh "An introduction to probability and statistics", 2nd edition, Wiley series in probability and statistics, 1976. (3) Gilbert Strang, "Introduction to linear algebra", 3rd edition, Wellesley-Cambridge Press, 2005. (4) Sheldon M. Ross, "Stochastic Processes", 2nd edition, Wiley India Pvt. Limited, 2008. (5) Thomas M. Cover, Joy A. Thomas, "Elements of information theory", 2nd edition, Wiley-Interscience, 2006.	

Subject Code CS 253	**Object Oriented Programming Laboratory**	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	To understand the basic object oriented programming concepts (objects, classes and subclasses, methods) using C++ and Java.	

List of experiments

(1) Simple programs in C++
(2) Matrix multiplication in C++
(3) Operator overloading exercises
(4) Matrix manipulation using dynamic memory allocation
(5) Overloading dynamic memory allocation operators
(6) Practice on templates
(7) Implementation of linked list using templates
(8) Implementation of sorting algorithms using templates
(9) Implementation of stack and queue using exception handling
(10) Inheritance based exercise
(11) File handling using streams
(12) Practice of Java programming
(13) File handling using Java streams
(14) Multithreaded programming using Java
(15) Developing graphical user interfaces using Java

Reference books

(1) BJarne Stroustrup, "The C++ Programming Language", Addison Wesley, 2004.
(2) Stanley B Lippman, "The C++ Primer", Addison Wesley, 2005.
(3) Ira Pohl, "Object oriented programming using C++", 2nd ed., Pearson Education India, 2003
(4) John R.Hubbard, "Schaum's Outline of Programming with C++", McGraw Hill Professional, 2003
(5) K.R.Venugopal, RajKumar Buyya, T.Ravishankar, "Mastering C++", Tata McGraw-Hill Publishing Company Limited, 2006
(6) E. Balagurusamy, "Object Oriented Programming with C++", Tata McGraw-Hill, 4th ed., 2008
(7) Patrick Naughton and Herbert Schildt, "Java 2: The Complete Reference", 4th ed., McGraw Hill Professional 2001
(8) Paul.Deitel, Harvey Deitel, "Java: How to program", 8th ed., Prentice Hall of India private limited, 2010

Subject Code CS 254	**Digital Systems Laboratory**	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	The course provides practical knowledge in designing the digital systems	

List of Experiments

(1) Simplification, realization of boolean expressions using logic gates/universal gates
(2) Realization of half/full adder & half/full subtractors using logic gates
(3) Realization of parallel adder/subtractors using 7483 chip, BCD to Excess-3code conversion & vice versa
(4) Realization of binary to gray code conversion & vice versa
(5) MUX/DEMUX – use of 74153,74139 for arithmetic circuits & code converter
(6) Realization of one/two bit comparator and study of 7485 magnitude comparator
(7) Use of a) Decoder chip to drive LED display & b) Priority encoder
(8) Truth table verification of flip-flops: i) JK Master Slave ii) T type iii) D type
(9) Realization of 3 bit counters as a sequential circuit & MOD-N counter design (7476,7490,74192,74193)
(10) Writing & testing of sequence generator

Reference books

(1) J. Bhasker, "A VHDL primer", 3rd edition, Addison Wesley Longmen, 1999.
(2) Douglas Perry, "VHDL: Programming by example", 4th ed. McGraw Hill International, 2002.
(3) Peter Ashenden, "The Designer Guide to VHDL",Morgan Kaufmann, 1998

Subject Code: VE200	**Value Education**	**Credits: 1 (1-0-0) Total hours: 14**
Course Prerequisite	General Awareness of the Society/ Environment we live in	
Course Objectives	It aims at Holistic Development	
Course Outcome	At the end, the students should be a complete human being in every respect	
Module 1	**Ethics in Engineering**	4 hours
Concepts of Values and Ethics, History and Purposes, Utilitarianism, Duties, Rights, Responsibility, Virtue, Honesty, Moral Autonomy, Obligations of Engineering Profession and moral Propriety		
Module 2	**Engineer's Moral responsibility**	3 hours
Engineer's Moral responsibility for Safety and Human Rights, Risk Assessment and Communication, Product Liability, Engineers-Employers Liaison, Whistle-Blowing and Its Moral Justification		
Module 3	**Computer Ethics**	3 hours
Social Impact of Computer, Gender-Issues and Privacy, Cyber Crime, Ethical use of Software		
Module 4	**Intellectual property**	4 hours
Definition, Types, Rights and Functions, Patents, Trademark, Grant of Patent in India, Surrender and Revocation of Patents, Compulsory Licensing, Acquisition of Inventions by the Government, Contents of draft application of Patents, WTO		
Texts:	1. Vinod V. Sople, *Managing Intellectual Property*: The Strategic Imperative, PHI,2006 2. Govindarajan, *Natarajan & Senthil Kumar, Engineering Ethics*, PHI 3. Robin Attfield, *A Theory of Value and Obligation, London*: Croomhelm, 1987 4. Jones and barlett, " *Cyber Ethics: Morality and Law in Cyber Space"*	
Reference	Case Studies from Newspapers	

Subject Code CS 300	Operating Systems (OS)	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	This course covers the objectives and functions of operating systems which include process management, memory management, disk scheduling, security and File Systems. At the end of the course student should be able to write application keeping concurrency and synchronization semaphores/monitors, shared memory, mutual exclusion Process scheduling services of an OS.	
Module 1		**10 Hours**
Introduction to OS, batch processing, multi-programming, interrupts, CPU scheduling, real time scheduling, concurrent processes, threads, multi-threading, inter process communication.		
Module 2		**10 Hours**
Mutual exclusion, Software solution, hardware solutions, atomic test and set, LL, swap instructions, monitors, deadlocks, avoidance, prevention and detection algorithms.		
Module 3		**14 Hours**
Memory management, fixed and variable paging, segmentation, virtual memory, virtual memory concept, demand paging, page replacement algorithms, trashing, and strategies to control trashing.		
Module 4		**12 Hours**
File Systems, disk scheduling algorithms, LOOK, C-LOOK, SCAN, C-SCAN, I/O Hardware, I/O buffering, RAID, performance evaluation.		
Module 5		**10 Hours**
Operating system security & protection, breaches, solutions, mechanisms, Inside attacks, outside attacks, case studies - the UNIX kernel and Microsoft Windows NT.		
Reference books	1) Peter B. Galvin, "Operating System Concepts", 8th Ed., TMH, 2012. 2) Andrew.S.Tanenbaum, "Modern Operating Systems", 3rd ed., PHI Learning, 2009. 3) Silberschartz& Galvin, Operating System Concepts, Addison Wesley, 5th ed., 1997. 4) MelinMilenkovic, "Operating Systems: Concepts and Design", McGraw Hill, New York, 2000.	

Subject Code CS 301	**Database Systems (DS)**	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	This course covers the relational database systems RDBS - the predominant system for business, scientific and engineering applications at present. The topics are reinforced using tools such as Oracle server in labs. The course includes entity-relation model, normalization, relational model, relational algebra, and data access queries as well as an introduction to SQL.	

Module 1	**12 Hours**
Introduction: An overview of database management system, database system vs file system, database system concept and architecture, data model schema and instances, data independence and database language and interfaces,(DDL,DML,DCL), overall database structure, database users. Data modeling using the Entity Relationship model: ER model concepts, notation for ER diagram, mapping constraints, keys, specialization, generalization, aggregation, reduction of an ER diagrams to tables, extended ER model, relationship of higher degree.	

Module 2	**14 Hours**
Relational data Model and Language: Relational data model concepts, integrity constraints, entity integrity, referential integrity, key constraints, domain constraints, relational algebra, relational calculus, tuple and domain calculus.Introduction on SQL: Characteristics of SQL, advantage of SQL, SQL data type and literals, types of SQL commands, SQL operators and their procedure, tables, views and indexes, queries and sub queries, aggregate functions, insert, update and delete operations, joins, unions, intersection, minus, cursors, triggers, procedures in SQL/PL SQL.	

Module 3	**18 Hours**
Data Base Design & Normalization: Functional dependencies, primary key, foreign key, candidate key, super key, normal forms, first, second, third normal forms, BCNF, 4th Normal form,5th normal form, loss less join decompositions, canonical cover, redundant cover, synthesis the set of relation , MVD, and JDs,inclusion dependence, transaction processing concept, transaction system, testing ofserializability, serializability of schedules, conflict & view serializable schedule, recoverability, Recovery from transaction failures, log based recovery, deadlock handling.	

Module 4	**12 Hours**
Concurrency Control Techniques: Concurrency control, locking techniques for concurrency control, 2PL, time stamping protocols for concurrency control, validation based protocol, multiple granularity, multi version schemes and recovery with concurrent transaction. Storage: Introduction, secondary storage devices, tertiary storage, buffering of blocks, structure of files, file organization, indexing and hashing, types of single level ordered indexes, multilevel indexes, dynamics multilevel indexes using B-trees and B+- Trees, database security.	

Reference books	(1) Korth, Silberschatz, "Database System Concepts", 4th ed., TMH, 2003. (2) Elmsari and Navathe, "Fundamentals of Database Systems", 4th ed., A. Wesley, 2004 (3) Raghu Ramakrishnan , Johannes Gehrke, " Database Management Systems", 3rd Edition, McGraw- Hill, 2003. (4) J D Ullman, "Principles of database systems", Computer Science Press, 2001.

Subject Code CS302	**Microprocessors and Microcontrollers (MPMC)**	Credits: 3(3-0-0) Total hours:45
Course Objectives	To introduce the student with knowledge about architecture, interfacing and programming with 8086 microprocessors and 8051 microcontrollers. It gives a brief introduction to ARM 7 and ARM 9 micro controllers. After studying this subject, the student should be able to design microprocessor/controller based system.	
Module 1		**12 Hours**
Introduction: History of microprocessors, basics of computer architecture, computer languages, CISC and RISC, 8085 programming model, architecture.		
Module2		**10 Hours**
Software architecture of the 8086 microprocessors, address space, data organization, registers, memory segmentation and addressing, stack, I/O space, Assembly language programming and program development, 8086 microprocessor architecture, min/max mode, coprocessor and multiprocessor configuration , hardware organization of address space, control signals and I/O interfaces.		
Module 3		**10 Hours**
Programmable interfacing devices, 8255A programmable parallel interface, 8279 programmable keyboard/display interface, 8254 programmable interval timer, 8259A programmable interrupt controller, direct memory access (DMA), 8237 DMA controller, serial I/O and data communication, standards in serial I/Os, serial I/O lines, 8251A programmable communication interfacing.		
Module 4		**13 Hours**
Intel 8051 microcontroller, CPU operation, memory space, software overview, peripheral overview, interrupt, timers parallel port inputs and outputs, serial port, low power special modes of operation, introduction to ARM processors , features of ARM 7 and 9 processors.		
Reference books	(1) Hall D.V., "Microprocessors and Interfacing", McGraw Hill, 1974. (2) Triebal W A & Singh A., "The 8088 and 8086 microprocessors", McGraw Hill, 2007. (3) Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D Mckinlay,"The 8051 microcontroller and embedded systems", 2nd edition, Pearson education, 2009. (4) Ramesh Gaonkar, "Microprocessor architecture programming and applications with 8085", 5th edition, Penram International Publishing, 2002	

Subject Code CS 303	**Theory of Computation (TOC)**	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	This course introduces models of computation: Regular languages models, Recursive and recursively enumerable sets models and context-free languages models.	
Module 1		**10 Hours**
Models of computation, classification, properties and equivalences, automata: Introduction to formal proof, additional forms of proof, inductive proofs, finite automata (FA), deterministic finite automata (DFA), non-deterministic finite automata (NFA), Finite Automata with Epsilon transitions.		
Module 2		**10Hours**
Regular expression and languages: Introduction to regular expression, building regular expression, converting DFA to a regular expression, converting regular expression to DFA, pumping lemma and its applications to prove languages not to be regular, closure properties of regular languages, minimization of automata.		
Module 3		**15 Hours**
Context free grammars (CFG) and languages: Definition, derivations, parse trees, ambiguity in grammars and languages, pushdown automata (PDA): Definition, Graphical notation, deterministic and nondeterministic, instantaneous descriptions of PDAs, language acceptance by final states and by empty stack, equivalence of the CFG and PDAs, pumping lemma for CFLs, closure properties of CFLs, decision problems for CFLs.		
Module 4		**15 Hours**
Turing machines: Introduction to Turing machines, instantaneous descriptions, language acceptance by Turing machines, Turing machine transition diagrams, Church-Turing hypothesis, Chomsky hierarchy, recursively enumerable sets, existence of non-recursively enumerable notion of undecidable problems, universality of Turing machine, separation of recursive and recursively enumerable classes, notion of reduction, undecidable problems of Turing machines.		
Module 5		**6 Hours**
Intractability: Notion of tractability/feasibility, the classes NP and co-NP, polynomial time many-one reduction, completeness under this reduction, NP-completeness of propositional satisfiability, other variants of satisfiability, NP-complete problems from other domains: graphs (clique, vertex cover, independent sets, Hamiltonian cycle), number problem (partition), set cover.		
Reference books	(1) J.E. Hopcroft and J.D. Ullman. "Introduction to Automata Theory, Languages of Computations", Addison-Wesley, 1979. (2) C. Papadimitriou and C. L. Lewis. "Elements of Theory of Computation", Prentice-Hall, 1981. (3) John. C. Martin, "Introduction to languages and the theory of computation", 3rd edition, TMH, 2003. (4) Peter Linz, "An introduction to formal language and automata", 3rd edition, Narosa publishing house, 2002. (5) John E. Hopcroft, Rajeev Motwani and Jeffery D. Ullman "Automata Theory, Languages, and Computation", 3rd Edition, Pearson Education, 2008. (6) Michael Sipser, "Introduction to the Theory of Computation", Books/Cole Thomson Learning, 2001.	

Subject Code CS 304	**Operating Systems Laboratory**	Credits: 2(0-0-3) Total hours: 42
Course Objectives	To understand the implementation of an operating system.	

List of experiments

(1) Linux based exercises to practice/simulate: scheduling, memory management algorithms.
(2) Implementation of various CPU scheduling algorithms (FCFS, SJF, Priority).
(3) Implementation of various page replacement algorithms (FIFO, Optimal, LRU).
(4) Concurrent programming; use of threads and processes, system calls (fork and v-fork).
(5) Implementation of Producer-Consumer problem, Bankers algorithm
(6) To simulate concept of semaphores.
(7) To simulate concept of inter process communication.
(8) Implementation of various memory allocation algorithms, (First fit, Best fit and Worst fit), Disk Scheduling algorithms (FCFS, SCAN, SSTF, C-SCAN)
(9) Kernel reconfiguration, devicone drivers and systems administration of different operating systems.
(10) Writing utilities and OS performance tuning.

Reference books

(1) Peter B. Galvin, "Operating System Concepts", 8th ed., TMH, 2012.
(2) Andrew.S.Tanenbaum, "Modern Operating Systems", 3rd ed., PHI Learning, 2009
(3) Silberschartz& Galvin, "Operating System Concepts", Addison Wesley, 5th ed., 1997.
(4) MelinMilenkovic, "Operating Systems: Concepts and Design", McGraw Hill, New York, 2000.

Subject Code CS 305	**Database Systems Laboratory**	Credits: 2 (0-0-3) Total hours:42
Course Objectives	To obtain working knowledge of a database management system and developing applications using the databases.	

List of experiments

(1) Defining schemas for applications.
(2) Creating tables, Renaming tables, Data constraints (Primary key, Foreign key, Not Null), Data insertion into a table.
(3) Grouping data, aggregate functions, Oracle functions (mathematical, character functions).
(4) Sub-queries, Set operations, Joins.
(5) Creation of databases, writing SQL and PL/SQL queries to retrieve information from the databases.
(6) Triggers & Cursors.
(7) Assignment in Design and Implementation of Database systems or packages for applications such as office automation, hotel management, hospital management;
(8) Deployment of Forms, Reports Normalization, Query Processing Algorithms in the above application project;
(9) Distributed data base Management, creating webpage interfaces for database applications using servlets.

Reference books	1) Ramez Elmasri, Shamkant B Navathe, "Fundamentals of database systems", 5th ed., 2003. 2) Avi Silberschatz, Henry korth and S. Sudarshan, "Database Systems Concepts", 5th Edition, TMH, 2005.

Subject Code CS 306	**Microprocessor and Microcontroller Laboratory**	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	To practice writing programs using microprocessor.	
List of experiments		
(1) 8085 and 8086 kit familiarization and basic experiments (2) Arithmetic operation of 16 bit binary numbers (3) Programming exercise : sorting ,searching and string (4) Interfacing with A/D and D/A converters (5) Interfacing with stepper motors (6) keyboard interfacing to 8086 (7) 8255 interface to 8086 (8) Assembly language programming of 8051 (9) Timer programming of 8051,using interrupts (10) LCD interfacing to 8051 –project		
Reference books	(1) ROM-BIOS service summary- Programmer's Guide to the IBM PC.	

Subject Code ES300	**Environmental Studies**	Credits: 3 (3-0-0) Total hours: 45
Course Objective	Understanding environment, its constituents, importance for living, ecosystem, human developmental activities vs environment, climate change, national and international environment related developments, need for public awareness, its protection and conservation activities.	

Module 1	**Hours : 2**
Multidisciplinary nature of environmental studies: Definition, scope and importance, Need for public awareness.	

Module 2	**Hours : 8**
Renewable and non-renewable Natural resources : Natural resources and associated problems; Forest resources : Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forest and tribal people; Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems; Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies; Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies; Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources, Case studies; Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.	

Module 3	**Hours : 10**
Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the Following ecosystem, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	

Module 4	**Hours : 12**
Biodiversity and its conservation: Introduction – Definition : genetic, species and ecosystem diversity, Bio geographical classification of India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-sports of biodiversity, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity, Eco-cultural heritage of India-various festivals related to Environment, Tradition of community conserved areas-Sacred forests, sacred tanks, sacred mountains, sacred rivers.	

Module 5	**Hours : 12**
National and International Environment related developments Environmental ethics : Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear, accidents and holocaust, Environment related Acts, Issues involved in enforcement of environmental legislation, Public awareness, Wasteland reclamation, Consumerism and waste products, UN Frame Convention Climate Change, Kyoto protocol, concept of carbon credits, latest CoP meet Agenda; Filed Work(equal to 5 lecture hours): Visit to a local area to document environmental assets river/forest/grassland/hill/mountain/sacred groves/sacred forests, Visit to a local polluted site-Urban/Rural/Industrial/Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hill slopes, etc.	

Reference books	1. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education (online book -UGC Website), Erach Bharucha,University Grants Commission , India. 2. Anil Agarwal, Dying Wisdom, Publisher: Centre for Science and Environment, Edi:1st,1997 ISBN-13 9788186906200; ISBN-10 8186906207 3. R. Rajagopalan, Environmental Studies from Crisis to Cure, Oxford IBH Pub., 2005. 4. Benny Joseph, Environmental Science and Engineering, Tata McGraw Hill, 2006. 5. Erach Bharucha, Text Book for Environmental Studies, Pub., Universities Press, 2005. 6. Masters, Gilbert M., Introduction to Environmental Engineering and Sciences, Prentice Hall India, 1991

Subject Code CS 350	Compiler Design (CD)	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	Describe the steps and algorithms used by language translators, Recognize the underlying formal models such as finite state automata, push-down automata and their connection to language definition through regular expressions and grammars, Discuss the effectiveness of optimization.	
Module 1		**10 Hours**
Introduction to compiler design, Model of a Compilers, Translators, Interpreters, Assemblers, Languages, Computer Architecture vs Compiler Design, Lexical analyzer, Regular expressions and finite automata.		
Module2		**8 Hours**
Introduction to context free grammars, BNF notation, Syntax Analysis.		
Module 3		**14 Hours**
Parsing Techniques: Top-down parsing and Bottom-up parsing, general parsing strategies, brute force approach, recursive descent parser and algorithms, simple LL(1) grammar, bottom-up parsing-handle of a right sentential form, shift reduce parsers, operator precedence parsers, LR, SLR, Canonical LR, LALR grammar and parsers, error recover strategies for different parsing techniques.		
Module 4		**14 Hours**
Symbol table, syntax-directed translation schemes, intermediate code generation, translation schemes for programming language constructs, runtime storage allocation.		
Module 5		**10 Hours**
Code generation and instruction selection: Issues, basic blocks and flow graphs, register allocation, DAG representation of programs, code generation from DAG, peep hole optimization, code generator generators, specifications of machine. Code optimization, source of optimizations, optimization of basic blocks, loops, global dataflow analysis, solution to iterative dataflow equations.		
Reference books	1) Alfred V. Aho, Ravi Sethi & Jeffrey D. Ullman, "Compilers; Principles, Techniques & Tools", Addison- Wesley Publication, 2001. 2) William A. Barrett et.al, "Compiler Construction, Theory and Practice", Galgotia 2000 3) Holub A.I., "Compiler Design in C", Prentice Hall India.2000.	

Subject Code CS 351	**Design and Analysis of Algorithms (DAA)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To study paradigms and approaches used to analyze and design algorithms and to appreciate the impact of algorithm design in practice.	

Module 1	**10 Hours**
Models of computation, RAM model, big Oh, big Omega, asymptotic analysis, recurrence relations, probabilistic analysis, linearity of expectations, worst and average case analysis of sorting and searching algorithms, hashing algorithms, lower bound proofs for the above problems, amortized analysis, aggregate, accounting and potential methods, analysis of Knuth-Morris-Pratt algorithms, amortized weight balanced trees.	
Module2	**11 Hours**
Problem Solving, Divide & Conquer, Strassens algorithm, O(n)_ median finding algorithm, dynamic programming, combinatorial search, matrix chain multiplication, optimal binary search trees, Floyd Warshall algorithm, CYK algorithm, Greedy, set of intervals, Huffman coding, Knapsack, Kruskal& Prims algorithm for MST, back tracking, branch & bound, traveling salesman problem	
Module 3	**8 Hours**
Computing Algorithms, Simple Numerical algorithms, B trees, Fibonacci Heaps, Data Structure for disjoint sets.	
Module 4	**8 Hours**
Efficient Graph algorithms based on DFS, BFS, topological sort, pattern matching & string/ text algorithms, shortest path, flow, cuts. Efficient algorithms for matrix inversion and LUP decomposition, Modular arithmetic.	
Module 5	**8 Hours**
Complexity classes, P, NP, Co-NP, NP Hard & NP complete problems. Search / decision, SAT, Cooks theorem, NP Completeness for clique, vertex cover, TSP, set covering &subset sum, approximation algorithms.	

Reference books	(1) Aho, Hopcroft and Ullman "The design and analysis of Computer Algorithms", Addison Weseley. (2) Horowitz and Sahni, "Fundamentals of Computer Algorithms", Galgotia Publications, 2000. (3) Baase S., "Computer Algorithms: Introduction to Design and Analysis", Addison Wesley. 2000 (4) Donald E. Knuth, "Art of Computer Programming, Volume 1: Fundamental Algorithms", 3rd Edition, Addison Wesley, 2000 (5) Corman, Leiserson and Rivest " Introduction to Algorithm", Prentice Hall India, 3rd Edition, 2010 (6) AnanyLevtin, "Introduction to Design and Analysis of Algorithms", Pearson, 2003.

Subject Code CS 352	Software Engineering (SE)	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	Following this course, students will be able to: 1) Define software engineering and explain its importance, 2) Discuss the concepts of software products and software processes, 3) Explain the importance of process visibility, 4) Introduce the notion of professional responsibility. This course covers the basic concepts of software engineering, life cycle models and system engineering, concepts & principles of software coding, design and testing. Improvement in design languages & reusable code. Participatory design & debugging. Specification of interface & mock up to confirm specifications. To introduce ethical & Professional issues & to explain why they are of concern to software engineers & experience working in a team.	

Module 1	**6 Hours**
Introduction to software engineering and its objectives, S/W myths, generic view of process, S/W engineering paradigm, verification, validation.	
Module 2	**11 Hours**
Life cycle models, system engineering, requirements engineering, business process engineering, analysis concepts, design process and concepts, modular design, design heuristic, architectural design, data design, user interface designs, real time software design, data acquisition system, monitoring and control system.	
Module 3	**14 Hours**
Taxonomy of software testing, types of S/W test, black box testing, testing boundary conditions, structural testing, test coverage criteria based on data flow mechanisms, regression testing, unit testing, integration testing, validation testing, system testing and debugging.	
Module 4	**14 Hours**
Software implementation techniques measures and measurements, software cost estimation, function point models, COCOMO model, error tracking, software configuration management, program evolution dynamics, software maintenance, project planning, risk management, CASE tools.	

Reference books	(1) R.S. Pressman, "Software Engineering", McGraw-Hill, 2002 (2) PankajJalote, "An Integrated Approach to software Engineering", Narosa Pub., 2002. (3) Ian Sommerville, "Software Engineering", 5th ed., Addison-Wesley Publication House, 1997. (4) Bell Morry and Pugh. "Software Engineering Approach", Prentice Hall. 2001 (5) K. C. Shet, "Software Engineering & Quality Assurance", BPB Publications, New Delhi. (6) Waman S. Jawadekar, "Software Engineering, Principles and Practice", Tata McGraw Hill.

Subject Code CS 353	**Computer Networks (CN)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	This course focuses on understanding the design of computer networks, assimilating hubs into a personal network.	

Module 1	**6 Hours**
Introduction to Computer Networks,Overview of OSI reference model. Topology design,Problems and protocols, Practical local area network design and implementation. IEEE LAN Standards, Logical Link Control protocols, HDLC, ALOHA, SLOTTED ALOHA, FDDI, Client Server model and related softwares. Computer Networks and Internet, Network edge, network core, Network Access, Delay and Loss.	
Module 2	**17 Hours**
Transport layer services, UDP, TCP, New transport layer protocols, congestion control and resource allocation, new versions of TCP, network layer services, routing, IP, routing in internet, router, IPV6, multicast routing.	
Module 3	**9 Hours**
Link layer services, error detection and correction, multiple access protocols, ARP, Ethernet, hubs, bridges, switches, wireless links, mobility, PPP, ATM, MPLS, VLAN.	
Module 4	**13 Hours**
Multimedia networking, streaming stored audio and video, real-time protocols, security, Cryptography, authentication, integrity, key distribution, network management, Firewalls, Brief functioning of upper layers, E-mail and other application.	

Reference books	(1) J. F. Kurose and K. W. Ross, "Computer Networking: A Top-Down Approach Featuring Internet", 3/e, Pearson Education, 2005. (2) Peterson L.L. & Davie B.S., "Computer Networks, A systems approach", 3/E, Harcourt Asia, 2003. (3) Andrew. S. Tanenbaum, "Computer Networks", Prentice Hall of India, 5th Edn, 2002. (4) Fred Halsall, "Data Communications, Computer networking on OSI", Addison Wesley Publishing Co., 2nd Edition, 2002. (5) William Stallings, "Data & Computer Communications", 2nd Edition, Maxwell, MacMillan International Edn. 2003. (6) Behrouz A. Forouzan, "Data Communications & Networks", third edition, Tata McGraw Hill.

Subject Code CS 354	**Compiler Design Laboratory**	Credits: 2(0-0-3) Total hours: 42
Course Objectives	To obtain the practice of writing compilers.	

List of experiments

(1) Introduction to Flex/Lex& Bison/Yacc tools, Lexing and tokenizing Programs
(2) Implementing an alternative grammars for infix expressions
(3) Parsing and parse trees
(4) Type checking
(5) Intermediate code generation
(6) Simple optimization (constant folding, etc.)
(7) Relations
(8) Control flow
(9) Functions
(10) Building a minicompiler (possibly subsets of Standard Compilers like PASCAL or other languages) and executing Simple problems to demonstrate the Compiler capabilities

Reference books	1) Holub A.I., "Compiler Design in C", Prentice Hall India.2000. 2) W. Appel, "Modern Compiler Implementation in C" , Cambridge University Press, 1998. 3) V. Aho, M. S. Lam, R. Sethi, J. D. Ullman, "Compilers- Principles, Techniques & Tools", 2/e, Pearson Education, 2007.

Subject Code CS 355	**Networks Laboratory**	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	To provide students with a theoretical and practical base in computer networks issues.	

List of experiments

(1) Implementation of basic Client Server program using TCP and UDP Socket
(2) Exercises comprising simulation of various protocols and performance study
(3) TCP/IP Level Programming Problems
(4) Implementing fully concurrent application with a TCP server acting as a directory server and client programs allowing concurrent connection and message transfer (Eg. Chat sytem).
(5) Routing Algorithms and internetworking
(6) Experiments with open source firewall/proxy packages like iptables,ufw, squid etc
(7) Experiments with Emulator like Netkit, Emulabetc
(8) Experiments with Simulator like NS2, NCTU NS etc

Reference books	1) W. Richard Stevens, Bill Fenner and Andrew M. Rudoff, "UNIX Network Programming", PHI. 2) Kris Jamsa, Ken Cope, "Internet Programming", Galgotia 3) Elliotte Rusty Harold, "Java Network Programming", 3rd Edition, O'Reilly, 2004.

Subject Code CS 356	**Mini Project/Industrial Training**	Credits: 1(0-0-2)
Course Objectives	Students are expected to undergo hands on training on a real problem under the guidance of a faculty/ an expert from industry. The problem domain should be relevant to Computer Science and Engineering applications.	

Subject Code CS 400	**Foundation of Cryptography (FC)**	**Credits: 4 (3-1-0)** **Total hours: 56**
Course Objectives	The purpose of the course is to familiarize the students to the arithmetic topics that have been at the centre of interest in applications of number theory, particularly in cryptography. It also includes familiarizing the students with cryptography, cryptographic protocols and the latest elliptic curve systems.	
Module 1		**13 Hours**
Mathematical preliminaries: Number theory and algebra, finite fields.		
Module 2		**9 Hours**
Symmetric key encryption: Stream ciphers and block ciphers.		
Module 3		**12 Hours**
Public key cryptography, digital signatures, attacks, hash functions, authentication schemes, key exchange algorithm, public key infrastructure.		
Module 4		**10 Hours**
Identification schemes, interactive proofs, commitment protocols, zero knowledge proofs, non-interactive proofs.		
Module 5		**12 Hours**
Secret sharing schemes, digital cash, electronic voting, elliptic curve, elliptic curve cryptosystems, identity based encryption.		
Reference books	(1)Neal Koblitz, "Number theory and cryptography", Springer, 2007. (2)Hans Delfs, Helmut Knebl, "Introduction to Cryptography: Principles and Applications", Springer. (3)Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone, "Handbook of Applied Cryptography", CRC Press, 1996. (4)Stinson Douglas R, "Cryptography Theory and Practice", CRC press, 2005. (5)Rudolf Lidl, Herald Niederreiter, "Introduction to Finite Fields and their Applications", Cambridge University Press. (6)Ivan Niven, Herbert S. Zukerman, Hugh L.Montgomery, "An Introduction to the Theory of Numbers", John Wiley, 1991. (7)Husten, "Topics in Algebra", John Wiley, 1975. (8)Lide and Niderriten, "Finite Fields", Cambridge University press, 1984. (9)Birchoff and Maclan, "Modern Algebra". (10) Relevant Research Papers	

Subject Code CS 401	**Introduction to Machine Learning (IML)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To develop framework for representation, classification and processing of information using various mathematical approaches with real architectures based in statistics, and modern algorithms [Genetic, Neural networks]	
Module 1		**8 Hours**
Basic test on Linear algebra and review of algorithms, Introduction to pattern classification, learning theory, Lloyd-max algorithm and quantization with Kraft inequality, entropy as minimum word length		
Module 2		**15 Hours**
Bayesian decision theory, classifiers, discriminant functions, decision surfaces. Error probabilities in statistical decision, non-parametric techniques in pattern classification, order statistics, windowing,		
Module 3		**15 Hours**
KNN, linear discriminants, non-metric methods, grammar based methods, dictionary and the Lempel-Ziv estimation, mixtures, clusters data description and clustering, component analysis – PCA, ICA, architectures and performance analysis of pattern classification		
Module 4		**7 Hours**
Database systems, search & complexity, distributed, parallel and randomized processing environments, selected topics and research papers from PAMI, PY, KBS, IFS, for seminar and assignments.		
Reference books	(1) Luciano Da Costa, Roberto Cesar Jr. – "Shape analysis and classification: theory and practice ", CRC Press, 2001 (2) T Hastie, R Tibshirani, J Friedman – "The elements of statistical learning: Data mining, Inference and Prediction", Springer-verlag, 2009 (3) K. Fukunaga – "Introduction to statistical pattern recognition", Academic press (4) Yu Xinjie, Mitsuo Gen – "Introduction to Evolutionary Algorithms", Springer (5) Richard O. Duda, Peter E. Hart and David G. Stork "Pattern Classification" , Wiley, 2007 (6) Christopher M. Bishop "Pattern Recognition and Machine Learning", Springer, 2006	

Subject Code HS 400	**Management**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Outcome	Develops the ability to understand and analyze the broad aspect of management and its financial dynamism	
Module 1	**Principles of Accounting**	5 hours
Accounting Cycle, Assumptions, Classifications of Accounts- Journal, Cash Book, Ledger, Final Accounts-Manufacturing Account, Trading Account, P & L Account, Balance Sheet.		
Module 2	**Financial Statement Analysis**	5 hours
Balance sheet, Profit and Loss Account, Economic vs Accounting Profit, Changes in Financial Position, Funds flow and cash flow statement.		
Module 3	**Ratio Analysis**	6 hours
Nature of Ratio Analysis, Liquidity Ratio, Leverage Ratio, Activity Ratio, Profitability Ratio, DuPont Analysis, Comparative statement and Trend Analysis, Inter-firm Analysis.		
Module 4	**Working Capital**	6 hours
Concept of working Capital, Operating and Cash conversion Cycle, Permanent and Variable working Capital, Balance working capital position and Issues.		
Module 5	**Time Value of Money**	5 hours
Time preference for money, Future value, Annuity, Perpetuity, Sinking fund factor, Present value, Annuity, Perpetuity, capital recovery factor, Multiple period Compounding.		
Module 6	**Capital Budgeting**	8 hours
Nature and type of Investment decision, Net Present value, (NPV), Internal Rate of Return (IRR), Payback period, Profitability Index, Nature and Behavior of Cost, Breakeven point, multiple products analysis, decision points.		
Module 7	**Financial System**	6 hours
Introduction to Indian Financial System, Financial Institutions and Financial Markets.		
Module 8	**Industrial Engineering & Project Management**	4 hours
Work Study, Time Study, Industrial Psychology, Project Management (PERT, CPM)		
Text Books	I.M Pandey, *Financial Management*, 10th edition, Vikish Publication Brealey Y Myers, *Principles of Corporate Finance*, McGraw-Hill Rajiv and Anil: *Financial Management*, 2nd Edition, Oxford University Press L.M Bhole: *Financial Institutions and Markets*, Tata McGrow-hill	

Subject Code CS 402	**Seminar**	**Credits: 2 (0-0-2)**
Course Objectives	Students will have to choose a topic in Computer Science and related areas, current trends or industry practices, prepare a write up, and present it along with a suitable demonstration.	

Subject Code CS 403	**Security Laboratory**	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	To study the number-theoretic and cryptographic algorithms. To have practical hands on experience with the number theoretic algorithms and cryptographic algorithms. To learn the usage of the number theoretic library packages in supplement with the C programming language.	

List of experiments

1. Euclidean algorithm for finding the Greatest Common Divisor of two large integers.
2. Extended Euclidean algorithm for finding the GCD of two large integers.
3. Binary Euclidean algorithm to find the GCD of two large integers.
4. Computing the Multiplicative inverses in Z_n. Z_n is defined as *the integers modulo n.*Z_n $= \{0, 1,2,...,n-1\}$. Given a ϵ Z_n. Find the multiplicative inverse of a.
5. Write a program to find the modular inverse of the matrix if it exists.
6. Repeated square and multiply algorithm for modular exponentiation in Z_n.
7. Determining the order of a group element.
8. Finding a generator of a cyclic group.
9. Chinese remainder method
10. Pollard's rho algorithm for factoring integers.
11. Pollard's p-1 algorithm for factoring integers.
12. Fermat's factorization method
13. Congruence of squares. Finding a congruence of squares modulo n to factor n.
14. Fermat primality test
15. Solovay-Strassen probabilistic primality test
16. Miller-Rabin probabilistic primality test
17. Lucas-Lehmer primality test for Mersenne numbers
18. AKS primality test
19. DES Symmetric key algorithm
20. RSA public key algorithm, Elgamal Cryptosystem, Subset sum, Secret Sharing scheme.

Reference books	(1) Hand Book of Applied Cryptography by Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone (2) (It is freely available: One of the source links: http://www.cacr.math.uwaterloo.ca/hac/) (3) PARI C Library: http://pari.math.u-bordeaux.fr/ (4) The C Programming Language by Brian W. Kernighan, Dennis M. Ritchie (5) Any Library packages for multi-precision arithmetic.

Elective Subjects

Subject Code **CS 500**	**Object Oriented Analysis and Design (OOAD)**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To apply an iterative process such as the Unified Process & Analyze software requirements and document them using Use Cases. Perform software analysis and record the results using UML notation. Discuss how object oriented software development affects testing and quality.	
Module 1		**8 Hours**
An overview of object oriented systems development, object basics, object oriented systems development life cycle.		
Module 2		**13 Hours**
Rumbaugh methodology , Booch methodology , Jacobson methodology , patterns, frameworks, unified approach, unified modeling language , use case , class diagram , interactive diagram , package diagram , collaboration diagram , state diagram , activity diagram.		
Module 3		**12 Hours**
Identifying use cases, object analysis, classification, identifying object relationships, attributes and methods, design axioms, designing classes, access layer, object storage, and object interoperability.		
Module 4		**12 Hours**
Designing interface objects, software quality assurance, system usability, measuring, user satisfaction, mini project.		
Reference books	(1) Ali Bah rami, "Object Oriented Systems Development", Tata McGraw-Hill, 1999. (2) Martin Fowler, "UML Distilled", 2nd ed., PHI/Pearson Education, 2002. (3) Stephen R. Schach, "Introduction to Object Oriented Analysis and Design", Tata McGraw-Hill, 2003. (4) James Rumbaugh, Ivar Jacobson, Grady Booch "The Unified Modeling Language Reference Manual", Addison Wesley, 1999. (5) Hans-Erik Eriksson, Magnus Penker, Brain Lyons, David Fado, "UML Toolkit", OMG Press Wiley Publishing Inc., 2004.	

Subject Code CS 501	**Advanced Data Structures (ADS)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	Advanced Data Structures is about using mathematical objects like trees and graphs to represent computational problems. It aims at the usage of some sophisticated algorithms and methods of analysis.	
Module 1		**9 Hours**
Introduction: Algorithms, algorithms as a technology, analyzing algorithms, designing algorithms, asymptotic notations, standard notations, common functions, recurrences, substitution method, master method. Sorting and order statistics: Merge sort, quick sort, heap sort, sorting in linear time, Median and order statistics.		
Module 2		**9 Hours**
Data structures: Elementary data structures, linked lists, stacks, queues, hash tables, direct address tables, hash tables, hash functions, open addressing, search trees , binary search trees, red-black Trees, splay trees. Advanced Data structures: B – Trees, binomial heaps, fibonacci heaps, data structures for disjoint sets. Suffix Trees-Tries-Text compression, text similarity testing-range trees, priority search trees, quad trees and k-d trees.		
Module 3		**9 Hours**
Graph Algorithms: Elementary graph algorithms, representation of graphs, BFS, DFS, topological sort, strongly connected components, minimum spanning trees, the algorithms of Kruskal and Prim's. Single-source shortest paths: Bellman-ford algorithm, single source shortest paths in DAG's, Dijkstra's algorithm, all-pair shortest paths, matrix multiplication, Floyd-Warshall algorithm. Maximum flow: Flow networks, the Ford-Fulkerson method, maximum bipartite matching.		
Module 4		**9 Hours**
Advanced design and analysis techniques: Greedy algorithms, an activity, selection problem, elements of greedy strategy, Huffman codes. Dynamic programming: Matrix chain multiplication, elements of dynamic programming, optimal binary search trees.		
Module 5		**9 Hours**
String Matching: The naïve string matching algorithm, Rabin-Karp algorithm, Knuth-Morris-Pratt algorithm. NP-Completeness: Polynomial time, Verification, NP-Completeness and reducibility, NP-Completeness proofs, NP-Complete problems.		
Reference books	(1) Thomas Cormen, Charles E Leiserson and Ronald D River, "Introduction to Algorithms", PHI, 2001. (2) Mark Allen Weiss, Algorithms, "Data Structures and Problem Solving with C++", Addison Wesley, 2002. (3) M.T.Goodrich and R.Tomassia,"Algorithm design: Foundations,analysis and internet examples", John Wiley and sons. (4) EllisHorowitz, Satraj Sahni and S.Rajasekaran, "Fundamentals of computer algorithms",Galgotia publications pvt. Ltd. (5) R.C.T.Lee, S.S.Tseng, R.C.Chang and T.Tsai, "Introduction to design and analysis of algorithms: A strategic approach", McGraw Hill.	

Subject Code CS 502	**Advanced Computer Architecture (ACA)**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To understand concepts of parallel processing and design choices of implementing parallel execution within a single processor (pipeline, VLIW, and superscalar) and multiprocessor systems. To gain knowledge of the state of the art research topics on advanced computing systems	
Module 1		**9 Hours**
Parallel Computer Models: The state of computing, classification of parallel computers, multiprocessors and multicomputer, multi vector and SIMD computers. Program and network properties: Conditions of parallelism, data and resource dependences, hardware and software parallelism, program partitioning and scheduling, grain size and latency, program flow mechanisms, control flow versus inter connects, hierarchical bus systems, crossbar switch and multiport memory, multistage and combining network.		
Module 2		**9 Hours**
Advanced Processors: Advanced processor technology, instruction-set architectures, CISC scalar processors, RISC scalar processors, superscalar processors, VLIW architectures, vector and symbolic processors.		
Module 3		**9 Hours**
Pipelining: Linear pipeline processor, nonlinear pipeline processor, instruction pipeline design, mechanisms for instruction pipelining, dynamic instruction scheduling, branch handling techniques, branch prediction, arithmetic pipeline design, computer arithmetic principles, static arithmetic pipeline, multifunctional arithmetic pipelining		
Module 4		**9 Hours**
Multi Processors: Multiprocessor system interconnect, cache coherence and synchronization mechanisms, message-passing mechanism, scalable, multi-threaded and dataflow architectures: latency-hiding techniques, principles of multithreading, scalable and multithreaded architecture, dataflow and hybrid architectures.		
Module 5		**9 Hours**
Parallel Models, languages and compilers: Latency-Hiding techniques environment, synchronization and multiprocessing modes, shared variable program structures, message passing programming development		
Reference books	(1) Dezso Sima, Terence Fountain, Peter Kacsuk, "Advanced computer architectures: A design space approach" , Addison Wesley. (2) K.Hwang and F.A. Briggs, "Computer architecture and parallel processing", McGraw Hill Publications (3) K. Hwang, "Advanced computer architecture-parallelism, scalability, programmability" , McGraw Hill. (4) J. Hennesy and D. Patterson, "Computer architecture –A quantitative approach", Morgan Kaufmann, 200.3	

Subject Code CS503	**Advanced Microprocessors (AMP)**	Credits:3 (3-0-0) Total hours:45
Course Objectives	To thoroughly understand the internal operation, layout and underlying design principles of modern systems containing advanced microprocessors. Throughout the semester, the Intel family of microprocessors will be the baseline used to illustrate the particular concepts.	
Module 1		**9 Hours**
80186 Architecture, enhancements of 80186,80286 architecture, real and virtual addressing modes, 80386 architecture, special registers, memory management, memory paging mechanism, 80486 architecture, enhancements, cache memory, comparison of microprocessors (8086, 80186, 80286, 80386, 80486).		
Module 2		**10 Hours**
Pentium microprocessor architecture, special Pentium registers, Pentium memory management, new Pentium instructions, Pentium pro microprocessor architecture, special features, Pentium II microprocessor architecture, Pentium II microprocessor architecture, Pentium III architecture, Pentium IV architecture, comparison of Pentium processors.		
Module 3		**10 Hours**
PowerPC620, Instruction fetching, branch prediction, fetching, speculation, instruction dispatching dispatch stalls, instruction execution, issue stalls, execution parallelism, instruction completion, Basics of P6 micro architecture, Pipelining, out of order core pipeline, Memory subsystem.		
Module 4		**8 Hours**
Intel I960, Intel IA32, MIPS R8000, MIPS R10000 , Motorola 88110, Ultra SPARC processor-SPARC version 8 , SPARC version, DSP processors.		
Module 5		**8 Hours**
Functional Units & Interconnection, new generation mother boards 286 to Pentium 4bus interface-ISA- EISA- VESA- PCI- PCIX, peripheral interfaces and controller, memory and I/O port addresses.		
Reference books	(1) B.B.Brey, "The Intel Microprocessor 8086/8088 /80186/80188, 80286, 80386, 80486 Pentium, Pentium Pro, PII, PIII & IV Archietecture, Programming & Interfacing", Pearson Education , 2004. (2) John Paul Shen, Mikko H.Lipasti, "Modern Processor Design", Tata Mcgraw Hill,2006 (3) Douglas V.Hall, "Microprocessors and Interfacing", Tata McGraw Hill, IIEdition 2006 (4) Mohamed Rafiquzzaman, "Microprocessors and Microcomputer BasedSystem Design", II Edition, CRC Press, 2007	

Subject Code CS 504	**Principles of Programming Languages (PPL)**	Credits: 3 (3-0-0) Total hours:45
Course Objectives	The basic thrust of this course will be on learning the distinctive techniques in the different paradigms and what semantic and compiling issues come up in the various languages considered. The course introduces Imperative Languages, functional programming, declarative programming and semantics of object-oriented programming.	
Module 1		**12 Hours**
Imperative and object-oriented programming, role of types, static and dynamic type checking, scope rules, grouping data and operations, information hiding and abstract data types, objects, inheritance, polymorphism, templates.		
Module 2		**12 Hours**
Functional programming, expressions and lists, evaluation, types, type systems, values and operations, function declarations, lexical scope, lists and programming with lists, polymorphic functions, higher order and curried functions, abstract data types.		
Module 3		**12 Hours**
Logic programming, review of predicate logic, clausal-form logic, logic as a programming language, unification algorithm, abstract interpreter for logic programs, semantics of logic programs, programming in prolog.		
Module 4		**9 Hours**
Lambda calculus and semantic environment and rules.		
Reference books	(1) Kenneth C. Louden, "Programming Languages: Principles and Practice", 2nd ed., Thomson 2003. (2) Carlo Ghezzi, Mehdi Jazayeri, "Programming Language Concepts", 3rd ed., John Wiley & Sons, 1997. (3) Ravi Sethi, "Programming Languages: Concepts and Constructs", 2nd ed., Pearson Education Asia.	

Subject Code CS505	Data Warehousing and Data Mining (DWDM)	Credits: 3 (3-0-0) Total hours:45
Course Objectives	Following this course, students will be able to 1) Learn the concepts of database technology, 2) Understand data mining principles and techniques, 3) Discover interesting patterns from large amounts of data to analyze and extract patterns to solve problems, make predictions of outcomes. 4) Evaluate systematically supervised and unsupervised models and algorithms with respect to their accuracy, 5) Design and implement of a data-mining application using sample, realistic data sets and modern tools.	

Module 1	**9 Hours**
Introduction to data warehousing, building a data warehouse, mapping the data warehouse to a multiprocessor architecture, OLAP technology for data mining, data warehouse, multidimensional data model, data warehouse architecture, data warehouse implementation, OLAP guidelines, multidimensional versus multi relational OLAP, categories of tools, DBMS schemas for decision support data extraction, cleanup and transformation tools for metadata, development of data cube technology, from data warehousing to data mining, data generalization, efficient methods for data cube computation, further development of data cube and OLAP Technology, attribute-oriented induction.	
Module 2	**12 Hours**
Introduction to data mining tasks, objectives (classification, clustering, association rules, sequential patterns, regression, deviation detection).	
Module 3	**8 Hours**
Data and preprocessing (data cleaning, feature selection, dimensionality reduction).	
Module 4	**8 Hours**
Classification (decision-tree based approach, rule-based approach, instance-based classifiers, Bayesian Approach: Naive and Bayesian networks, classification model evaluation).	
Module 5	**8 Hours**
Clustering (partitional methods, hierarchical methods, graph-based methods, density-based methods, cluster validation methods), anomaly/outlier detection (introduction to various types of outliers, statistical-based, density-based and other methods for outlier detection).	

Reference books	**(1)** Jiawei Han and Micheline Kamber, "Data mining: Concepts and techniques"**,** 2nd ed., Morgan Kaufmann publishers. (2) Raph Kimball," Data warehouse toolkit", John Wiley & Sons Publications (3) Michael. J. Berry, Gordon Linoff, "Data mining techniques: Marketing, sales, customer support", John Wiley & Sons.

Subject Code CS 506	**Advanced Database Systems (ADBS)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To develop an appreciation of emerging database trends as they apply to semi-structured data, the internet, and object-oriented databases. To explain the process of DB Query processing and evaluation.	
Module 1		**11 Hours**
Distributed database concepts, overview of client-server architecture and its relationship to distributed databases, concurrency control heterogeneity issues, persistent programming languages, object identity and its implementation, clustering, indexing, client server object bases, cache coherence.		
Module 2		**11 Hours**
Parallel databases: Parallel architectures, performance measures, shared nothing/shared disk/shared memory based architectures, data partitioning, intra-operator parallelism, pipelining, scheduling, load balancing, query processing- index based, query optimization: cost estimation, query optimization: algorithms, online query processing and optimization, XML, DTD, XPath, XML indexing, adaptive query processing.		
Module 3		**11 Hours**
Advanced transaction models: Save points, sagas, nested transactions, multi-level transactions, Recovery, multilevel recovery, shared disk systems, distributed systems 2PC, 3PC, replication and hot spares, data storage, security and privacy- multidimensional k- anonymity, data stream management.		
Module 4		**12 Hours**
Models of spatial data: Conceptual data models for spatial databases (e.g. pictogram enhanced ERDs), logical data models for spatial databases: raster model (map algebra), vector model, spatial query languages, need for spatial operators and relations, SQL3 and ADT. spatial operators, OGIS queries.		
Reference books	(1) AviSilberschatz, Henry Korth, and S. Sudarshan, " Database system concepts", 5th ed., McGraw Hill, 2005. (2) S. Shekhar and S. Chawla, "Spatial databases: A tour, Prentice Hall", 2003. (3) Ralf HartmutGuting, Markus Schneider, "Moving objects databases", Morgan Kaufman, 2005. (4) R. Elmasri and S. Navathe, "Fundamentals of database systems", Benjamin-Cummings,5th ed., 2007. (5) Raghu Ramakrishnan, "Database management systems", McGraw-Hill, 2000. (6) Ceri S and Pelagatti G, "Distributed databases principles and systems", 2nd ed., Mc-Graw Hill, 1999.	

Subject Code CS 507	E-Commerce (EC)	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To provide principles of e-commerce from a business perspective.	
Module 1		**12 Hours**
Infrastructure and tools for e-commerce, current trends in e-commerce applications development, the business of internet commerce, enterprise level e-commerce.		
Module 2		**12 Hours**
Security and encryption, electronic payment systems, search engines, intelligent agents in e-commerce, on-line auctions, data mining for e-commerce.		
Module 3		**12 Hours**
Web metrics, recommended systems, knowledge management, mobile e-commerce, legal, ethical and social issues.		
Module 4		**9 Hours**
Seminars and mini projects.		
Reference books	(1) Henry Chan et al., "E-Commerce-Fundamental and applications", John Wiley & Sons 2002.. (2) G. Winfield Treese and Lawrence C.S., "Designing Systems for Internet Commerce", Pearson Education, LPE, 2002 (3) Fensel, Dieter, Brodie M.L., "Ontologies: A Silver Bullet for Knowledge Management and ECommerce", Allied Publishers, 2004 (4) Zimmermann, Olaf Tomlinson, Mark R.: Peuser, Stefan, "Perspectives on Web Services", Allied Publilshers, 2004	

Subject Code CS 508	**Advanced Operating Systems (AOS)**	Credits: 3(3-0-0) Total hours: 45
Course Objectives	To provide comprehensive and up-to-date coverage of the major developments in distributed operating system, multi-processor operating system and database operating system.	
Module 1		**9 Hours**
Architectures of distributed systems , system architecture types, issues in distributed OS, communication networks, primitives, theoretical foundations, inherent limitations of a distributed system, lamp ports logical clocks, vector clocks, casual ordering of messages, global state, cuts of a distributed computation, termination detection, distributed mutual exclusion.		
Module 2		**9 Hours**
Distributed deadlock detection, introduction, deadlock handling strategies in distributed systems, issues in deadlock detection and resolution, control organizations for distributed deadlock detection, centralized, distributed and hierarchical deadlock detection algorithms , agreement protocols.		
Module 3		**12Hours**
Distributed shared memory, architecture, algorithms for implementing DSM, memory coherence and protocols, design issues, distributed scheduling, issues in load distributing, components of a load distributing algorithm, stability, load distributing algorithm, performance comparison, selecting a suitable load sharing algorithm, requirements for load distributing, task migration and associated issues. Failure recovery and Fault tolerance: Introduction, basic concepts, classification of failures, backward and forward error recovery, recovery in concurrent systems, consistent set of check points, synchronous and asynchronous check pointing and recovery, check pointing for distributed database systems, recovery in replicated distributed databases.		
Module 4		**8 Hours**
Protection and security, preliminaries, the access matrix model and its implementations, safety in matrix model, advanced models of protection. Cryptography basics,multiple encryption and authentication in distributed systems.		
Module 5		**7 Hours**
Multiprocessor OS, database OS, database systems, a concurrency control model, problem, serializability theory, distributed database systems, concurrency control algorithms.		
Reference books	(1) MukeshSinghal Niranjan, Shivorothri G., "Advanced Concepts in Operating systems" (2) Andrew S. Tanenbaum, "Distributed Operating systems" (3) Doreen L. Galli, "Distributed operating systems - concepts and practice", Prentice-Hall 2000. (4) A Silberschatz, "Applied Operating systems Concepts", Wiley 2000 (5) Lubemir F. Bic& Alan C. Shaw, "Operating systems Principles", Pearson Education, 2003.	

Subject Code CS 509	Cyber Laws & Intellectual Property Right (CLIPR)	Credits:3 (3-0-0) Total hours: 45
Course Objectives	To introduce the cyber world, intellectual property law and cyber law in general to explain about the various facets of cyber-crimes, to enhance the understanding of problems arising out of online transactions and provoke them to find solutions, to clarify the Intellectual Property issues in the cyber space and the growth and development of the law in this regard and to educate about the regulation of cyber space at national and international level.	
Module 1		**12 Hours**
Cyber laws and IT act; the rights the various parties have with respect to creating, modifying, using, and distribution, storing and copying digital data..		
Module 2		**12 Hours**
Concurrent responsibilities and potential liabilities, intellectual property issues connected with use and management of digital data, the similar act of other countries.		
Module 3		**12 Hours**
Computer crime, computer fraud, hacking.		
Module 4		**9 Hours**
Unauthorized modification of information, privacy, computer pornography harassment.		
Reference books	(1) D. Brainbridge, "Introduction to computer law", 5th ed., Pearson Education,2004. (2) P. Duggal, "Cyber law: the Indian perspective", 2005.	

Subject Code CS 510	**Information Theory (IT)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	This course aims at developing contents from Information theory formulating its mathematical structure towards design, representation and performance limits associated with the problems in information systems.	
Module 1		**15 Hours**
Over view of probability theory & statistics, analysis and discrete mathematics, measure of information using probability, digitization and Shannon's model for information storage/transmission		
Module 2		**10 Hours**
Discrete entropy and the law of large numbers, bounds on typicality, properties of entropy – rate characterization, conditional, relative, joint entropy, mutual information, source coding theorem (loss less for DMS), existence of minimum information, entropy as divergence, entropy rates of various families, entropy rate of Markov sources, comments on complexity		
Module 3		**10 Hours**
Source coding for DMS: Existence of good source codes, optimality criterion, Huffman coding and competitive optimality, greedy algorithm via min-max constraint, Shannon-Fano coding, run length coding, rate-distortion function and data compression of speech or image (case study), dictionary and entropy rates		
Module 4		**10 Hours**
Entropy rate for reliability analysis, Burg's theorem and entropy maximization, error and information rates for unreliable communication, Shannon-McMillan-Brieman theorem, information theory and betting, stock market (the log-optimal portfolio), special topics : algorithms in database development, learning theory, distributed processing/source coding, information theory in machine learning		
Reference books	(1) T. Cover, J Thomas, "Elements of information theory", Wiley Press (2) R. G. Gallager, "Information theory and reliable communication", Cambridge Press (3) A Rohatgi, MdEhsanes Saleh, "Introduction to probability, statistics", Wiley (4) Relevant Literature pointed in the Class from IEEE Transactions Information Theory	

Subject Code CS511	**Optimization Techniques in Computing (OT)**	**Credits: 3 (3-0-0)** **Total hours:45**
Course Objectives	The main goal of this course is to provide the students with a background, foundation, and insight into the several dimensions of Optimization Techniques.	
Module 1		**15 Hours**
Basic OR techniques, requirements, networks, design, role and methods, unconstrained optimization methods- Newton like methods, conjugate direction methods.		
Module 2		**15 Hours**
Constrained optimization: Linear programming, theory of constrained optimization, Non-linear programming. Databases, compilers, optimization and performance in web computing, internet application.		
Module 3		**15 Hours**
Performance measurement tools, case studies, Implementation of an optimization technique for Computer Science applications		
Reference books	(1) K Kanth, "Introduction to computer system performance evaluation", McGraw Hill, 1992 (2) David K Smith, "Network optimization in practice", ellise, Horrwood publications, 1982 (3) R. Fletcher, "Practical methods of optimization", 2nd Edition, Wiley.2000.	

Subject Code CS 512	**Soft Computing (SC)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	The course explores the soft computing approaches to consider uncertainty that is inherent in pattern analysis tasks.	
Module 1		**8 Hours**
Biological neuron, nerve structure and synapse, artificial neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory.		
Module 2		**8 Hours**
Architecture: Perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning rule co-efficient, back propagation algorithm, factors affecting back propagation training, applications.		
Module 3		**10 Hours**
Basic concepts of fuzzy logic, fuzzy sets and crisp sets, fuzzy set theory and operations, properties of fuzzy sets, fuzzy and crisp relations, fuzzy to crisp conversion.		
Module 4		**9 Hours**
Membership functions, interference in fuzzy logic, fuzzy if-then rules, fuzzy implications and fuzzy algorithms, fuzzyfication and defuzzificataion, fuzzy controller, industrial applications		
Module 5		**10 Hours**
Genetic algorithm(GA):Basic concepts, working principle, procedures of GA, flow chart of GA, genetic representations(encoding), initialization and selection, genetic operators, mutation, generational cycle, applications.		
Reference books	(1) Satish Kumar, "Neural networks: A classroom approach" , III edition (2) J. S. R. Lang, C. T. Sun and E. Mizutaju "Neuro-Fuzzy and soft computing", Pearson Education (3) C. -T. Liu and C.S. George Lee "Neural fuzzy System: A neuro fuzzy synergism to intelligent system", PH 1996 (4) V. Kecman "Learning and soft computing" MIT press 2001 (5) A Ghosh, S. Dehuri and S. Ghosh(eds), "Multi-objective evolutionary algorithms for knowledge discovery from databases", Springer 2008 (6) S. Bandyopadhyay and S.K. Pal, "Classification and learning using genetic algorithms: applications in bioinformatics and web intelligence", , Springer-Verlag, 2007 (7) S. Rajsekaran& G.A. VijayalakshmiPai, "Neural networks, fuzzy logic and genetic algorithm:synthesis and applications" Prentice Hall of India, 2003	

Subject Code CS513	**Applied Algorithms (AA)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	The course provides an overview of some of the essential numerical techniques which are commonly used in the scientific enterprise.	
Module 1		**15 Hours**
Sequential algorithms: Algorithm design techniques; stable marriage problem, stable matching problem analysis and representative problems. greedy algorithms, interval scheduling, scheduling with deadlines and profits, 1/2 approximation for knapsack. Data compression: Huffman code, (KT4.8) LZ77, gzip.		
Module 2		**11 Hours**
String Matching algorithms: Rabin-Karp algorithm, Knuth Morris pratt algorithm. Parallel algorithms: Designing parallel algorithms; combinatorial algorithms.		
Module 3		**10 Hours**
Network flows: Bellman ford algorithm. divide-and-conquer, closest points problem. external memory algorithms, online algorithms.		
Module 4		**9 Hours**
Graph Algorithms, internet algorithms and security- cryptography algorithms. basics of randomized algorithms. basics of approximation algorithms.		
Reference books	(1) Alfred V Aho, John E Hopcroft, Jeffery D Ullman, "Data structure and algorithms", Addison Wesley , 1993 (2) J. Kleinberg, E. Tardos, "Algorithm design". Pearson Education, Addison Wesley, 2006." (3) Michael Jay Quinn, "Designing efficient algorithms for parallel computers", McGraw Hill 1997. (4) Rajeev Motwani, PrabhakarRaghavan, "Randomized algorithms", Cambridge University Press,1995. (5) R. E. Tarjan, "Data structures and network algorithms", SIAM, 1983. (6) Vijay V. Vazirani, "Approximation algorithms", Springer, 2001.	

Subject Code CS514	Network Management(NM)	Credits: 3 (3-0-0) Total hours: 45

Course Objectives	To appreciate the need for interoperable network management, understand general concepts and architecture behind standards based network management. Understand advanced information processing techniques such as distributed object technologies, software agents and internet technologies used for network management

Module 1	**11 Hours**
Data communications and network management overview: Goals, architecture and perspectives, review of information network and technology.	
Module 2	**11 Hours**
SNMP and network management- basic foundations: Standards, models and languages, network management organization and information models, communication and functional models.	
Module 3	**11 Hours**
Network Management tools, systems and engineering and applications, management of heterogeneous network with intelligent agents, network security management, internet management (IEEE communication May, Oct.03).	
Module 4	**12 Hours**
Broadband network management, wired and optical networks management, QoS in IP network, basic methods & theory for survivable network design & operation, network planning, network management standards.	

Reference books	(1) M. Subramanian, "Network management: principles and practice", Adison-Wesley, 2000. (2) James F. Kurose and Keith W. Rose, "Computer networking", Pearson Education, LPE, 2003 (3) J. Burke, "Network management concepts and practice, A Hands-on approach", Pearson Education, 2000. (4) Larry L. Peterson and Bruce S. Davie, "Computer networks, a system approach", 3rd edition, Elsevier.

Subject Code CS515	Software Architecture (SA)	Credits: 3 (3-0-0) Total hours:45
Course Objectives	Complex software systems require abstraction and analysis at an architectural level of abstraction. In this course we study, typical software system structures.	
Module 1		**15 Hours**
Typical software system structures (architectural styles), techniques for designing and implementing these structures.		
Module 2		**10 Hours**
Models for characterizing and reasoning about architectures, and tools architectural modelling. Role of architecture in Software engineering;		
Module 3		**10 Hours**
Enterprise Architectures, Zachman's Framework; Architectural Styles, Design Patterns;		
Module 4		**10 Hours**
Architecture Description Languages; Product-line architectures; Component based development.		
Reference books	(1) Frank Buschmann, RegineMeunier, Hans Rohnert, Peter Sommerlad, MiachelStal, Douglas Schmidt, "Pattern oriented software architecture", Volumes 1 &2, Wiley (2) Len Bass, Paul Clements, Rick Katzman, Ken Bass, "Software architecture in practice".2nd ed. Addison-Wesley Professional 2003 (3) George T. Heineman, William T. Councill, "Component based software engineering", Addison-Wesley, 2001 (4) Kurt Wallnau, Scott Hissam and Robert Seacord, "Building systems from commercial components", Addison-Wesley 2002	

Subject Code **CS 516**	**Cyber Laws & Security Standards(CLSS)**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To acquire critical understanding in cyber law, the emerging social & intellectual property issues explore legal & policy developments in various countries to regulate cyber space & to develop competencies for dealing fraud & deceptions using cyber space.	
Module 1		**15 Hours**
Perimeter barrier standards, cyber laws, cyber security issues, FGIB cyber security proposals.		
Module 2		**15 Hours**
NRIC cyber security recovery best practices, creation of new practices.		
Module 3		**15 Hours**
NRIC physical security practices.		
Reference books	(1) www. Bell-labs.com/user/krauscher/nric/#intraduction%20TO%20NRIC (2) Hacking exposed scambrey mcclure, kartz tata-mcgrawhill	

Subject Code CS 517	**Wireless Networks & Systems (WNS)**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To provide students with the knowledge and skills necessary to securely design, deploy and manage enterprise-wide wireless local area networks and to test the security of wireless networks for weaknesses.	
Module 1		**11 Hours**
Introduction to network resilience problems and solutions, wireless beyond 3G, performance modeling of (wireless) networks and formal methods.		
Module 2		**11 Hours**
Network design algorithms & network design using network processors, wireless ad-hoc networks, security issues in control, management, routing and other areas of networks		
Module 3		**11 Hours**
Distributed control in (wireless) network and middleware, distributed mobile computing.		
Module 4		**12 Hours**
Embedded systems in mobile/wireless/network systems, hardware & software design/development issues, standardization in wireless/mobile network systems.		
Reference books	(1) Theodore S. Rappaport, "wireless communications – principles & practices",2nd ed, Pearson Education, 2002 (2) Boucher N., "Cellular radio handbook", Quantum Publishing, 1991 (3) Feng& Leonidas, "Wireless sensor networks", Elsevier India, 2005	

Subject Code CS 518	**Web Engineering(WE)**	**Credits: 3(3-0-0)** **Total hours: 45**
Course Objectives	To apply the concepts, principles, and methods of Web engineering to Web applications development	
Module 1		**10 Hours**
Web Engineering Fundamentals: Requirements specification and analysis, web-based systems development methodologies and techniques, migration of legacy systems to web environments.		
Module 2		**10 Hours**
Web-application development: Web-based real-time applications development, testing, verification and validation, quality assessment, control and assurance, configuration and project management.		
Module 3		**10 Hours**
Web metrics: generating metrics for estimation of development efforts, performance specification and evaluation, update and maintenance.		
Module 4		**15 Hours**
User-centric development: Development models, teams, staffing, integration with legacy systems, human and cultural aspects, user-centric development, user modeling and user involvement and feedback, end-user application development.		
Reference books	(1) Journal of Web Engineering, Rinton Press, IEEE & ACM Publications (2) Cato and John, " User centered web design", Pearson Education, 2001	

Subject Code CS 519	**Software Project Management (SPM)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	This course introduces project management as it relates to the software life cycle. Different software life cycle models and the project management activities in each phase of the life cycle are studied. Project planning activities are introduced, including effort estimation & the use of software metrics. Risk analysis and resource allocation and project scheduling. The course concludes with a project monitoring & control, project contracts & team organization.	
Module 1		**11 Hours**
Introduction, project definition, contract management, activities covered by software project management.		
Module 2		**11 Hours**
Overview of Project planning, stepwise project planning, life cycle phases, artifacts of the process, model based software architectures, workflows of the process, check points of the process.		
Module 3		**11 Hours**
Software management disciplines, iterative process planning, project organizations & responsibilities, process automation, project control & process instrumentation, tailoring the process.		
Module 4		**12Hours**
Modern project profiles, next generation software economics, modern process transitions, the state of practice in software project management, the COCOMO cost estimation model, change of metrics		
Reference books	(1) K. Conway, "Software project management: From concept to development", IDG Books, 2001. (2) I. Jacobson, G.Booch, J.Rumbaugh, "The unified software development" Process, Addison Wesley, 1999. (3) Stephan H.Kin, "Metric and models in software quality engineering", Addison Wesley 1995. (4) Walker Royce, "Software Project Management", Addison Wesley,1998. (5) Pankaj Jalote, "Software Project Management in Practice", Pearson Education Inc. Delhi, 2002	

Subject Code CS520	Advanced Compilers (AC)	Credits: 3 (3-0-0) Total hours:45
Course Objectives	Complex software systems require abstraction and analysis at an architectural level of abstraction. In this course we study, typical software system structures.	
Module 1		**10Hours**
Overview of compiler design, optimizing compilers, graph structures for control flow analysis of programs, data flow analysis of programs, static single assignment form, data dependence of program, program dependence graph.		
Module 2		**10 Hours**
Scalar optimization, loop optimizations,register allocation, instruction scheduling, local methods, graph colouring, code scheduling software pipelining, inter procedural dataflow analysis, optimizing for memory hierarchies.		
Module 3		**9Hours**
High performance systems, scalar, vector, multiprocessor, SIMD, message passing architectures. sequential and parallel loops, data dependence use-def chains.		
Module 4		**16Hours**
Dependence system, GCD test, Banerjee's Inequality, exact algorithm, vectorization, concurrentization, array region analysis, loop restructuring transformations		
Reference books	(1) Robert "Building an Optimizing Compiler Morgan",Digital Press, 1998. (2) M. Wolfe, "High Performance Compilers for Parallel Computing", Addison-Wesley, 1996. (3) Steven S. Muchnick, "Advanced Compiler Design and Implementation", Morgan Kaufmann Publishers, 1997. (4) R. Allen and K. Kennedy, "Optimizing Compilers for Modern Architectures", Morgan Kaufmann Publishers, 2003. (5) A. Appel,Press, "Modern Compiler Implementation in C", 1998. (6) A. Aho, M. Lam, R. Sethi and J. Ullman "Compilers: Principles, Techniques, and Tools", 2007. (7) Steven S. Muchnick, "Advanced Compiler Design and Implementation", Morgan Kaufmann, Elsevier Science, 2003 (8) Michael Wolfe, "High Performance Compilers for Parallel Computing", Addison Wesley, 1995.	

Subject Code CS 521	**Computer Vision (CV)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	The objective of this course is to understand the basic issues in computer vision and major approaches that address them. Even though Computer Vision is being used for many practical applications today, it is still not a solved problem. Hence, definitive solutions are available only rarely.	
Module 1		**11 Hours**
Introduction and overview, pinhole cameras, radiometry terminology. Sources, shadows and shading: Local shading models- point, line and area sources; photometric stereo. Color: Physics of color; human color perception, Representing color; A model for image color; surface color from image color.		
Module 2		**12 Hours**
Linear filters: Linear filters and convolution; shift invariant linear systems- discrete convolution, continuous convolution, edge effects in discrete convolution; Spatial frequency and Fourier transforms; Sampling and aliasing; filters as templates; Normalized correlations and finding patterns. Edge detection: Noise; estimating derivatives; detecting edges. Texture: Representing texture; Analysis using oriented pyramid; Applications; Shape from texture. The geometry and views: Two views.		
Module 3		**11 Hours**
Stereopsis: Reconstruction; human stereo; Binocular fusion; using color camera.		
Module 4		**11 Hours**
Segmentation by clustering: Human vision, applications, segmentation by graph theoretic clustering. Segmentation by fitting a model, Hough transform; fitting lines, fitting curves;		
Reference books	(1) David A Forsynth and Jean Ponce, "Computer vision- A modern approach", Pearson education series, 2003. (2) Milan Sonka, Vaclav Hlavac and Roger Boyle , "Digital image processing and computer vision", Cengagelearning, 2008. (3) Schalkoff R. J., "Digital image processing and computer vision", John Wiley, 2004. (4) Sonka M., Hlavac V., Boyle R., "Image processing analysis and machine design". PWS Publishers (5) Ballard D., Brown C., "Computer vision", Prentice Hall	

Subject Code CS522	**Artificial Intelligence (AI)**	Credits: 3 (3-0-0) Total hours:45
Course Objectives	The course objective is to introduce problems in search, logic, and game playing, more complex problems in first-order predicate logic, inference, knowledge bases, planning, and reasoning systems.	
Module 1		**15 Hours**
Introduction to artificial intelligence,architecture of AI & KBCS systems, design issues and AI techniques; problem solving, knowledge based reasoning, logic, inference, knowledge based systems, reasoning with uncertain information; state space search, heuristic search.		
Module 2		**10 Hours**
Planning and making decisions, learning, distributed AI, communication, web based agents. introduction &design of expert systems, various applications;		
Module 3		**10 Hours**
Negotiating agents, artificial intelligence applications and programming. introduction to fuzzy logic systems, natural language processing;		
Module 4		**10 Hours**
Heuristic search techniques, knowledge based systems. problem solving by search; uninformed search, informed ("heuristic") search, constrained satisfaction problems, adversarial search,		
Reference books	(1) Nilson, "Artificial intelligence : A new synthesis", Morgan Kaufmann Publishers, 2001. (2) Charniak and Mcdermott, "Introduction to artificial intelligence", Addison-Wesley, 1985. (3) S. Russel and P. Norvig, "Artificial intelligence - A modern approach", Prentice Hall, 1995. (4) Deepak Khemani, "A first course in artificial intelligence", Tata McGraw Hill,2013. (5) Ginsburg, "Essentials of artificial intelligence", Morgan Kaufmann, 1993. (6) George F. Luger, "Artificial intelligence", Pearson Education, 2001. (7) Edwin wise, "Hands on AI with Java", McGraw Hill, 2004	

subject Code CS523	Multimedia & Virtual Reality (MVR)	Credits: 3 (3-0-0) Total hours:45
Course Objectives	To provide basic knowledge of multimedia and overview of the tools & taxonomy of multimedia authoring, including data representation for images, video & audio. To understand data compression & multimedia communication & retrieval	
Module 1		**11Hours**
Introduction to multimedia technology and its applications, multimedia hardware and software essentials. multimedia graphics fundamentals. multimedia audio - sound card fundamentals		
Module 2		**12Hours**
MIDI fundamentals: digital video production techniques, image processing - digital image fundamentals, digital image development and editing, computer animation techniques, animation software. multimedia file formats – growth pace of multimedia in IT industry.		
Module 3		**11Hours**
Concepts of virtual reality and its effectiveness in real time applications, virtual reality tools, introduction to scientific visualization and virtual reality, hardware requirements, sound, animation techniques, VR on flight simulation.		
Module 4		**11Hours**
VR on CAD / CAM processing : Virtual banks, compression and decompression techniques, CASE study of multimedia workstations		
Reference books	(1)The Winn L. Rosch "Multimedia Bibble", SAMS Publishing (2)D. P. Kothari & Anshu, "Hypermedia: From multimedia to V. R." , PHI, 2004.	

Subject Code CS524	Software Quality Assurance (SQA)	Credits: 3 (3-0-0) Total hours:45
Course Objectives	The course will introduce the basics of software quality assurance. Further, the issues, processes, and techniques in software quality assurance are discussed. The course will train the students to apply quality assurance techniques in different activities of software development and maintenance.	
Module 1		**15 Hours**
Introduction to software quality, software defects, reasons of poor quality, quality laggards, project management approaches, cost and economics of SQA, quality measurements, evaluation, role, maturity in development, life cycle, models, maintenance issues, specification.		
Module 2		**10 Hours**
Software requirements and SQA, requirements defects, writing quality requirements, quality attributes of requirements document, software design model and software design defects		
Module 3		**10 Hours**
Quality design concepts, programming and SQA, SQA reviews, software inspections, software testing: WBT techniques, BBT techniques, testing strategies, debugging, test planning, automated software testing, test cases, responsibilities of testers		
Module 4		**10 Hours**
SQA and SCM, SCM plan and SQA plan, process assurance, process management and improvement, introduction to quality metrics, a process model of software quality assurance.testing, mechanisms, verification and validation.cost estimation, tools, debugging, simulators, ISO 9000 standards, quality assurance.		
Reference books	(1) Capers Jones, "Software quality: Analysis and guidelines for success", International Thomson Computer Press. 1997. (2) Capers Jones, "Software assessments, benchmarks, and best practices", Addison-Wesley Professional, 2000. (3) Pankaj Jalote, "An integrated approach to software engineering", Narosa Publication, 1995. (4) John J Marciniack, (Ed), "Encyclopedia of software engineering", John Wiley and Sons,1994. (5) Isabel Evans, "Achieving software quality through team work", Allied Publishers, 2004. (6) Mordechai Ben, Menachem, Garry S. Marliss, "Software quality producing practical, consistent software", Thomson Learning. (7) James F. Peters, Witold Pedrycz, "Software engineering, an engineering approach" WSE, Wiley.	

Subject Code CS 525	**Protocol Engineering(PE)**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	Characterize protocol engineering. Compare and contrast various Internet protocols such as TCP/IP, DNS, DHCP, LDAP, and IPsec.	
Module 1		**11 Hours**
Review of Communication Network: Overview of computer network protocol, OSI reference model, Basic design concept: Protocol as a system, life cycle model, architectural design phase,top down approach ,bottom up approach ,separation of concern.		
Module 2		**11 Hours**
Requirement specification: service specification service data unit service elements, communication mode, Protocol architecture:Basic protocol concept, protocol layer, protocol entity, protocol element protocol data unit.		
Module 3		**11 Hours**
Protocol structuring, design and specification protocol structuring, the users of pdu service structuring, generic protocol function, five elements of protocol specification, rules of design, specification language, message sequence chart, petri net finite state machine		
Module 4		**12 Hours**
Protocol Data Format: Abstract Syntax format design principles, ASN.1, ASN.1 record structure ASN.1 encoding rule, XML Syntax, DTD and XML schemas example, Case of protocol data format customer information: XML-based customer information, ASN.1 binary-encoded based XML schema and ASN.1 cooperation.		
Reference books	(1) Web sites, IEEE, ISO and ITU-T sites. (2) P. Venkatram & S. S. Manavi, "Protocol Engineering", PHI, 2004.	

Subject Code CS 526	**Software Testing (ST)**	**Credits: 3(3-0-0)** **Total hours: 45**
Course Objectives	To discuss the distinctions between validation tests and defect testing. To describe strategies for generating system test cases.To gain the techniques and skills on how to use modern software testing tools to support software testing projects.	
Module 1		**9 Hours**
Testing as an engineering activity, role of process in software quality, testing as aprocess, basic definitions, software testing principles, the tester's role in asoftware development organization, origins of defects, defect classes, the defectrepository and test design, defect examples, developer / tester support fordeveloping a defect repository.		
Module 2		**9 Hours**
Introduction to testing design strategies, the smarter tester, test case designstrategies, using black box approach to test case design, random testing, equivalence class partitioning, boundary value analysis, other black box testdesign approaches, black box testing and cots, using white box approach to testdesign, test adequacy criteria, coverage and control flow graphs, covering codelogic, paths, their role in white box based test design – additional white box test design approaches, evaluating test adequacy criteria.		
Module 3		**9 Hours**
The need for levels of testing, unit test, unit test planning, designing the unittests, the class as a testable unit, the test harness, running the unit tests andrecording results,integration tests, designing integration tests, integration testplanning, system test, the different types, regression testing, alpha, beta andacceptance tests.		
Module 4		**9 Hours**
Basic concepts, testing and debugging goals and policies, test planning, testplan components, test plan attachments, locating test items, reporting testresults, the role of three groups in test planning and policy development, processand the engineering disciplines, introducing the test specialist, skills needed by atest specialist, building a testing group.		
Module 5		**9 Hours**
Defining terms, measurements and milestones for controlling and monitoring, status meetings, reports and control issues, criteria for test completion, scm, types of reviews, developing a review program, components of review plans, reporting review results.		
Reference books	(1) Glenford J. Myers, "The art of software testing", John Wiley & Sons, 1979. (2) Boris Beizer, Black "Testing: Techniques for functional testing of software and systems", John Wiley & Sons, 1995. (3) William Perry, "Software testing: Effective methods for software testing", John Wiley, 1995. (4) Cem Kaner, Jack Falk, Hung Quoc Nguyen, "Testing computer software", 2nd Ed, Intl. Thomson Computer Press, 1993. (5) Ilene Burnstein, "Practical software testing", Springer International Edition,2003.	

Subject Code CS 527	**Mobile Communications (MC)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To understand the issues involved in mobile communication system design & analysis.	
Module 1		**8 Hours**
Introduction to cellular mobile systems: A basic cellular system, performance criteria, uniqueness of mobile radio environment, operation of cellular systems, planning and cellular systems, analog & digital cellular systems.		
Module 2		**8 Hours**
Elements of cellular radio system design:General description of the problem, concept of frequency channels, co-channel interference reduction factor, desired c/i from a normal case in an omnidirectional antenna system, cell splitting, consideration of the components of cellular systems.		
Module 3		**10 Hours**
Interference:Introduction to Co-channel interference, real time Co-channel interference, Co-channelmeasurement, design of antenna system, antenna parameters and their effects, diversity receiver, non Co-channel interference - different types.		
Module 4		**9 Hours**
Cell coverage for signal and traffic:General introduction, obtaining the mobile point- to - point model, propagation over water or flat open area, foliage loss, propagation in near in distance, long distance propagation, point - to - point predication model - characteristics, cell site, antenna heights and signal coverage cells, mobile - to - mobile propagation.		
Module 5		**10 Hours**
Mobile communications by satellite service systems in operation, INMARSAT, MSAT, LEO mobile satellite services		
Reference books	(1)Lee W.C.Y., "Mobile cellular telecommunications", McGraw Hill, 1995. (2) Mazda F., "Telecommunications engineering" Reference book, Butterworth, 1993. (3) Gibson J.D., "Mobile communication hand book", CRC press, U.S.A., 1996. (4)Macario R.C.V., "Cellular radio", Macmillan, 1993. (5) Bud Bates, "Wireless networked Communication", McGraw Hill, 1991. (6)Dr. KamiloFeher, “Wireless digital communication”, PHI.	

Subject Code CS528	Information Security(IS)	Credits: 3 (3-0-0) Total hours:45
Course Objectives	To provide extensive, detailed and critical understanding of the concepts, issues, principles and theories of computer network security. also the course focuses on application and operating system security , web security mobile application security.	
Module 1		**9Hours**
Security properties, threat models, examples; control hijacking attacks and defences.		
Module 2		**9 Hours**
Tools for robust code, exploitation techniques and fuzzing, dealing with legacy code, least privilege, access control		
Module 3		**9 Hours**
Operating system security, cryptography overview, basic web security model		
Module 4		**9 Hours**
Web application security; session management and user authentication, HTTPS: goals and pitfalls		
Module 5		**9 Hours**
Mobile platform security models: Android, iOS, mobile threats and malware, the trusted computing architecture		
Reference books	(1) Matt Bishop, "Computer security, arts & science", Pearson Education, 2003. (2) Pceprzyk et.al. "Fundamentals of computer security", Allied Publishers, 2004. (3) Derek Atkins and 9 others, "Internet security" Techmedia 2nd edition, 1997. (4) Michael Howard and David LeBlane, "Writing Secure Code, Microsoft, WP Publishers. (5) Dave Aitel, "How hackers look for bugs" (6) Charlie Miller, "Real world fuzzing"	

Subject Code CS529	Network Security(NS)	Credits: 3 (3-0-0) Total hours:45
Course Objectives	To provide extensive, detailed and critical understanding of the concepts, issues, principles and theories of network security.	
Module 1		**15 Hours**
Introduction to network security and associated techniques, Firewall design principles: Packet filtering, Gateways: Circuit-level gateways; application-level gateways,		
Module 2		**10 Hours**
Firewall Configurations, Intrusion Control: Detection; Anomaly-Based IDS Intrusion Recovery; Vulnerability Scanners; Login, Audit, and Sniffers,		
Module 3		**10 Hours**
Communication Security Network Access Layer;- Internet Layer - Transport Layer;		
Module 4		**10 Hours**
Application Layer - Message Security Risk Analysis, Policies, Procedures and Enforcement. Special Topics : DOS Mitigation ,VPNs Special Topics: Viruses, SPAM. Network protocols and vulnerabilities, Network defenses, Denial of service attacks, Malware,		
Reference books	(1) C. Kaufman, R. Perlman, M. Speciner, "Network security: Private communication in a public world", Prentice Hall, 2002. (2) William Stallings, "Network security essentials", 2/e, Pearson Education, 2003.	

Subject Code CS 530	**Parallel Algorithms (PA)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To introduce techniques for the design of efficient parallel algorithms and their implementation.	
Module 1		**10 Hours**
Parallel processing, parallel models, performance of parallel algorithms, complexity measure for parallel algorithms.		
Module 2		**11Hours**
Techniques for designing parallel algorithms, pointer jumping technique, divide and conquer, partitioning strategy, pipelining, accelerated cascading, symmetry breaking.		
Module 3		**12Hours**
Lists and trees, list ranking, Euler-tour technique, Tree contraction, computation of tree functions, merging, parallel sorting algorithms. parallel combinatorial algorithms: permutations with and without repetitions combinations, derangements. parallel searching algorithms: maximum/minimum, median, K-th largest/smallest element.		
Module 4		**12Hours**
Parallel graph algorithms, parallel graph search &, tree traversal algorithms, parallel algorithms for connectivity problems, parallel algorithms for path problems., Ear decomposition, Polynomial and matrix computations, General dense matrices.		
Reference books	(1) Jaja, J. "An introduction to parallel algorithms", Addison- Wesley, Reading, MA, 1992. (2) Gibbons A., W.Rytter, "Efficient parallel algorithms", Cambridge university Press; Cambridge, 1988 (3) H. Sparkias and A. Gibbon, "Lecture notes on parallel computation", Cambridge University Press, 1993. (4) K. Hwang and F. A. Briggs, "Computer architecture and parallel processing", McGraw Hill Inc., 1985. (5) S. Akl., "Design and analysis of parallel algorithms", Prentice Hall Inc, 1992.	

Subject Code CS531	**Distributed Algorithms(DA)**	Credits: 3 (3-0-0) Total hours:45
Course Objectives	To introduce the main algorithmic techniques in the framework of distributed models of computing; to define the most significant complexity parameters and the computational limits of parallelism and concurrency.	
Module 1		**9 Hours**
Distributed Algorithms: models and complexity measures. Modeling: Synchronous network model, asynchronous system model,asynchronous shared memory model, asynchronous network model. partially synchronous system model.		
Module 2		**9 Hours**
Leader election in synchronous ring: Basic algorithm, non-comparison based algorithm, time slice and variablespeeds algorithm. Lower bounds on the algorithms. Leader election in a general network.		
Module 3		**9 Hours**
Distributed consensus with process failures: Algorithms for stopping failures, algorithms for byzantine failures. approximate agreement.		
Module 4		**9 Hours**
Consensus: Agreement using read/write shared memory. Basic asynchronous network algorithms: Leader election in a ring algorithms, leader election in arbitrary network.		
Module 5		**9 Hours**
Synchonizers, safe synchronizer implementations. algorithm tolerating process failures. adding logical time to asynchronous networks. applications. termination detection for diffusing algorithms. The chandylamport algorithms, mutual exclusion , general resource allocation algorithms .		
Reference books	1. Nancy & Lynch, Distributed Algorithms, Harcour Asia, 2001.	

Subject Code CS 532	**Web Services & Cloud Computing (WSCC)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To standardize a framework applications to communicate over the internet & to get a general idea about the models of web services. To understand the emerging area of "cloud computing" and how it relates to traditional models of computing. To understand how well-known algorithms such as Page Rank and inverted index construction can be expressed in the Map-Reduce framework. To gain competence in Ajax as a vehicle for delivering highly-interactive Web applications.	
Module 1		**11 Hours**
Basic concepts, enabling infrastructure, core functionality and standards.		
Module 2		**12 Hours**
Service semantics, web service composition, service development and recent research trends.		
Module 3		**11 Hours**
Introduction to cloud computing, cloud computing delivery models.		
Module 4		**11 Hours**
Open Source and Industry case Studies of cloud, Map Reduce, Apache VCL, Amazon, IBM and Eucalyptus, Hadoop, Security issues in cloud		
Reference books	(1) Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi, Mastering Cloud Computing, International Edition: Morgan Kaufmann, 2013. (2) AlonsoG.,Casati F., Kuno H., Machiraju V., "Web Services – Concepts, Architectures and Applications Series: Data- Centric Systems and Applications"PHI 2004. (3) SanjivaWeerawarana, Francisco Curbera, Frank Leymann et al, "Web Services Platform Architecture: SOAP, WSDL, WS-Policy, WS-Addressing, WS-BPEL, WS-Reliable Messaging and more", Prentice Hall Publication, 2005. (4) Thomas Erl, "Service oriented Architecture: Concepts, Technology and Design", Prentice Hall Publication, 2005. (5) R. Allen Wyke et-al, "XML Programming", WR Publishers, (6) Richard Monson-Haefel , "Web Services", , Pearson (LPE), 2005. (7) "Cloud Application Architectures" by George Reese, O'Reilly Publications, 2009. (8) "Cloud Security and Privacy", Tim Mather, SubraKumaraswamy, O'Reilly, 2009. (9) The Hadoop – Definitive Guide, Tom White, O'Reilly, 2009.	

Subject Code CS533	**Computer Security Audit and Assurance (CSAA)**	Credits: 3 (3-0-0) Total hours:45
Course Objectives	To introduce students to the concepts of Information Assurance and how to secure such information using appropriate systems and technologies, presenting introductory aspects on computer audit including auditing information systems auditing computerized systems, auditing applications etc. Also, to introduce students to the key management and Public Key Infrastructure.	
Module 1		**10 Hours**
Security policy frameworks;practices and procedures, business practice disclosures. Information Systems in Global Context · Threats to Information Systems · Security Considerations in Mobile and Wireless Computing · Information Security Management in Organizations · Building Blocks of Information Security · Information Security Risk Analysis · Overview of Physical Security for Information Systems · Perimeter Security for Physical Protection · Biometrics Controls for Security · Biometrics-based Security: Issues and Challenges · Network Security in Perspective.		
Module 2		**15 Hours**
·Networking and Digital Communication Fundamentals · Cryptography and Encryption · Intrusion Detection for Securing the Networks · Firewalls for Network Protection · Virtual Private Networks for Security · Security of Wireless Networks · Business Applications Security: An EAI Perspective · Security of Electronic Mail Systems · Security of Databases · Security of Operating Systems · Security Models, Frameworks, Standards and Methodologies · ISO 17799/ISO 27001 · Systems Security Engineering Capability Maturity Model - The SSE-CMM · COBIT, COSO-ERM and SAS 70.		
Module 3		**10 Hours**
· Information Security: Other Models and Methodologies · Laws and Legal Framework for Information Security · Security Metrics · Privacy - Fundamental Concepts and Principles · Privacy - Business Challenges · Privacy - Technological Impacts · Web Services and Privacy · Staffing the Security Function · Business Continuity and Disaster Recovery Planning. Policy authority and practices, information security practices, personal and physical security practices, operation management practices .		
Module 4		**10 Hours**
· Auditing for Security · Privacy Best Practices in Organizations · Asset Management · Ethical Issues and Intellectual Property Concerns for InfoSec Professionals. PKI's and key management schemes, key generation, key storage, backup, recovery and distribution. XML frameworks for security policy specification, certificate management life cycle.		
Reference books	(1)W K Brotby, Information security management metrics, CRC press 2009. (2)Nina Godbole, Information systems security: security management, metrics, frameworks and best practices, John Wiley and sons Ltd. 2009.	

Subject Code CS534	Big Data Analysis (BDA)	Credits: 3(3-0-0) Total hours: 45
Course Objectives	This course covers the object oriented programming concepts using C++.	
Module 1		**15 Hours**
Overview of big data, stages of analytical evolution, state of the practice in analytics, the data scientist.		
Module 2		**10Hours**
Big data analytics in industry verticals, data analytics lifecycle, operationalizing basic data analytic methods using R, advanced analytics - analytics for unstructured data - map reduce and Hadoop, the Hadoop ecosystem, in-database analytics.		
Module 3		**10 Hours**
Data Visualization Techniques, Stream Computing Challenges, Systems architecture, Main memory data management techniques, energy-efficient data processing, benchmarking.		
Module 4		**10 Hours**
Security and Privacy, Failover and reliability.		
Reference books	(1) Bill Franks, Taming, "The big data tidal wave", 1st ed., Wiley, 2012 (2)Frank J. Ohlhorst, "Big data analytics", 1st ed., Wiley, 2012.	

Subject Code	Business Intelligence (BI)	Credits: 3 (3-0-0)
CS 535		Total hours:45
Course Objectives	Explore the concepts of business intelligence/business analytics through readings, creation of Wikis and Blogs relevant to the course. To develop and apply critical thinking, problem-solving and decision-making skills .	
Module 1		**15 Hours**
Overview of managerial, strategic and technical issues associated with business intelligence and data warehouse, analytics and DSS.		
Module 2		**15 Hours**
Design, implementation and utilization, data as the basis for decision making, business reporting and visualization.		
Module 3		**15 Hours**
Data warehouse architecture, OLAP, data cubes, Reporting tools, Balance Scorecard, dash board design, and implementation. Case studies.		
Reference books	(1) Efraim Turban, Ramesh Sharda, Jay Aronson, David King, "Decision support and business intelligence systems", 9th ed., Pearson Education, 2009. (2) David Loshin, "Business Intelligence - The Savy Manager's Guide Getting Onboard with Emerging IT", Morgan Kaufmann Publishers, 2009.	

Subject Code CS 536	Secure Software Engineering (SSE)	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	This course focuses on secure software engineering process and details the secure programming and software security.	
Module 1		**15Hours**
Definition of software security, threats and vulnerabilities, risk management, security requirements.		
Module 2		**10Hours**
Principles of secure design and patterns, secure programming, validation of the data.		
Module 3		**10Hours**
Secure usage of cryptography, code reviews and static analysis.		
Module 4		**10Hours**
Secure testing, creating a software security programs.		
Reference books	(1) Julia H Allen, Sean J Barnum, Robert J Ellison, Gary McGraw, Nancy M Read, "Software Security Engineering: A Guide to Project Managers", Addison Wesley, 2008. (2) Ross J Anderson, "Security Engineering: A Guide to Building Dependable Distributed Systems", Wiley, 2008. (3) Howard M and LeBlanc D, "Writing Secure Code", Microsoft Press, 2003.	

Subject Code CS 537	**Computer Graphics (CG)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To have an introduction to computer graphics to develop abilities to comprehend contemporary issues and address them.	

Module 1	**6 Hours**
Introduction to graphics hardware devices, display devices, primitive operations, the display-file interpreter, display file structure, and graphics file formats. text mode graphics function, graphic mode graphics functions shapes, colors, co-ordinate systems, applications of computer graphics.	

Module 2	**11 Hours**
Basic concepts in line drawing, line drawing algorithms: DDAalgorithms, Bresenham's algorithm Circle generating algorithms: DDA circle drawing algorithm, Bresenham's circle drawing algorithm, midpoint circle algorithm, polygons, types of polygons, polygon representation, entering polygons, inside –outside test, polygon filling: Flood fill, scan-line algorithm.	

Module 3	**13 Hours**
2D transformation: scaling, Reflection, shearing, Rotation, Translation, Rotation about an arbitrary point. 3D Transformation: scaling, rotation, translation, rotation about arbitrary axis. Viewing transformation, normalization, transformation. Line clipping: Cohen-Sutherland, Line clipping algorithm, midpoint subdivision algorithm Polygon clipping: Sutherland–Hodgeman Polygon clipping algorithm.	

Module 4	**15 Hours**
Curve generation: arc generation using DDA algorithm. Interpolation, B-Spline, Bezier curves. Fractals: Hilbert's Curve, Koch curve, Fractal lines, Fractal Surfaces. Raster scan display, Random scan display Need for graphics standards, Graphics standards, Advantages of Graphics standards, Hazards of Graphics standards. Graphical user interface Open GL: What is Open GL, How OpenGL works, Open GL and animation, Graphical processors: GPUs.	

Reference books	(1) Ronald Hearn &MPauline Baker, "Computer graphics", 2nd ed., PES, 2003. (2) James D. Foley, Andrews van Dam, Steven K Feimer, John F Hughes, "Computer graphics principles and practice", 2nd ed., Addison Wesley, 1996. (3) William Newman and Robert Sproull, "Principles of Interactive Computer Graphics", Tata McGraw-Hill,1973.

Subject Code CS 538	Graph Theory (GT)	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	This is an introductory course about properties and applications of graphs. It aims at the usage of graph theoretic methods for modeling problems and proofs in discrete mathematics.	

Module 1	**12 Hours**
Definitions, pictorial representation of a graph, isomorphic graphs, sub graphs, matrix representations of graphs, degree of a vertex, special graphs, complements, larger graphs from smaller graphs, connected graphs and shortest paths, walks, trails, paths, cycles, connected graphs, cut-vertices and cut-edges, blocks, connectivity, weighted graphs and shortest paths, weighted graphs, Dijkstra's shortest path algorithm, Floyd-Warshall shortest path algorithm.	
Module2	**12 Hours**
Trees, Definitions and characterizations, number of trees, Cayley's formula, minimum spanning trees, Kruskal's algorithm, Prim's algorithm, bipartite graphs, Eulerian graphs, Fleury's algorithm, Chinese Postman problem.	
Module 3	**12 Hours**
Hamilton Graphs, necessary conditions and sufficient conditions, independent sets, coverings and matchings, matchings in bipartite graphs, Hall's theorem, Konig's theorem, perfect matching's in graphs, vertex Colorings, basic definitions, cliques and chromatic number, greedy coloring algorithm.	
Module 4	**9 Hours**
Edge colorings, Gupta-Vizing theorem, class-1 and class-2 graphs, edge-coloring of bipartite, graphs, planar graphs, basic concepts, Euler's formula and its consequences, characterizations of planar graphs, 5-color-theorem, directed graphs, directed walks, paths and cycles, Eulerian and Hamilton digraphs.	

Reference books	(1) Adrian Bondy, U. S. R. Murty, "Graph Theory", Springer, 2008. (2) Reinhard Diestel, "Graph Theory", 3rd edition, Springer, 2000. (3) Douglas B. West, "Introduction to Graph Theory", Prentice Hall, 1996 (4) Jonathon L. Gross, "Combinatorial methods with computer applications", Chapman & Hall /CRC press, 2008

Subject Code CS 539	**Distributed Computing Systems (DCS)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	This course covers abstractions and implementation techniques for the design of distributed systems. It focuses on server design, network programming, naming, storage systems, security, and fault tolerance.	
Module 1		**9 Hours**
Introduction Distributed Systems and applications, Distributed vs parallel systems, models of distributed systems, Message Passing mechanisms IPC and RPC.		
Module2		**11 Hours**
Clock synchronization, physical & logical clocks, vector clocks, verifying clock algorithms, mutual exclusion using time stamp, election algorithms, Distributed mutual exclusion using time stamps, token & quorums, centralized & distributed algorithms, proof of correctness & complexity, drinking philosophers problem, Implementation & performance evaluation of DME Algorithms.		
Module 3		**13 Hours**
Leader election algorithms, global states, global predicates, termination detection, Control of distributed computation, disjunctive predicates, performance evaluation of leader election algorithms on simulated environments.		
Module 4		**12 Hours**
Distributed File Systems and Services, Shared data, Synchronization Transaction and Concurrency Control. Distributed databases, Name service, Timing & Coordination, Replication, Security and Fault Tolerance.		
Reference books	(1) Vijay K Garg "Elements of Distributed Computing", Wiley & Sons, 2002 (2) Pradeep Sinha, "Distributed Operating Systems- Concepts and Design", PHI,2000 (3) A.S. Tanenbaum and M.V. Steen, "Distributed Systems – Principles and Paradigms", PHI.2003 (4) George Couloris, Jean Dollimore & Time Kindberg, "Distributed Systems: Concepts & Design", 2nd Edition, Addison Wesley 2003. (5) V. Rajaraman, C. Siva Ram Murthy, "Parallel, Computers Architecture & Programming", PHI. (6) Khemkalyani and Singal, "Distributed Computing" (7) Nancy Lynch , "Distributed Algorithm" (8) Singal and Shivaratri, "Ditributed OS"	

Subject Code: HU 501& HU 502	**Professional Communication-II and Language Lab**	**Credits: 4 (2-0-3) Total hours: 56**
Course Prerequisite	Knowledge of English	
Course Objectives	This course aims at Personality Development	
Course Outcome	At the end, the students should possess a Saleable Image with employability skills	
Module 1	**Principles of Soft Skills and Practice**	12 hours
Definition of Soft Skills and Personality, Attitude, Dress Code, Body Language, Individual and Group Behaviour, Personality Test, C.V Writing and the difference between CV & Resume		
Module 2	**Group Discussion, Extempore, JAM and Survey**	16 hours
Topics: Is Cloning Ethical, Shopping Mall vs Retailer, Should Animals be used for Drug-Test, Effects of Advertisement on Youth, Google vs Social Networking Sites, Newspaper is the thing of Past, Diversity in Indian Culture, Gender Discrimination, Who is Smarter: Human Beings or Computer and so on		
Module 3	**Interview**	14 hours
Types of Interview, Interview Ethics, Questions and Mock-Interview Sessions		
Module 4	**Business Presentation and Seminars**	14 hours
Business Presentation and Students' Seminar		
Texts:	1.W.B. Martin, *Ethics in Engineering* Tata McGraw Hill, India 2. Patnaik,Priyadarshi, *Group Discussion and Interview Skills*, New Delhi: CUP, (Video CD) 3..Downes, Colm, *Cambridge English for Job Hunting*,2009, New Delhi,CUP (2 Audio CDs)	
Reference	TV News (Headlines Today, ND TV and BBC), Chat-Shows on TV, Magazines like India Today, Outlook, The Week and English Dailies. Reader's Digest for Expressive Skill, English Films & English Comics	

Academic Hand Book

for

Bachelor of Technology Programme

in

Electronics and Communication Engineering

National Institute of Technology Goa

Farmagudi, Ponda, Goa - 403 401

Programme Structure Summary

Institute-wide Categories of the Courses

The Bachelor of Technology (B.Tech.) program at National Institute of Technology Goa (NIT Goa) will have 170 credits as the lower limit for the award of degree. These courses are grouped in a number of categories as shown below:

S.N.	Category	Credits	Remarks
1.	Basic Sciences (BS)	27	Mathematics - 14 Credits Physics - 8 Credits Chemistry - 5 Credits
2.	Basic Engineering Sciences (ES)	14	Engineering Mechanics - 3 Credits Mechanical Engineering - 2 Credits Basic Electrical Science - 5 Credits Computer Programming - 4 Credits
3.	Humanities and Languages (HL)	9	Professional Communication - 3 Credits Economics - 3 Credits Management - 3 Credits
4.	Technical Arts (TA)	5	Engineering Drawing - 3 Credits Workshop - 2 Credits
5.	Professional Theory and Practice (PT)	110	
6.	Others (*Not counted for final CGPA)	5*	Environmental Studies - 3 Credits Physical Education - 1 Credits Value Education - 1 Credits
Total Credits		**170**	**165 credits are counted for CGPA**

Semester-wise Distribution of the Courses

Semester I (Structure Common to All Branches)				
Course Code	**SI. No.**	**Course Name**	**Total Credits** (L-T-P)	**Credits**
MA100	1	Mathematics-I*	4(4-0-0)	4
PH100	2	Physics*	3(3-0-0)	3
ME100	3	Engineering Mechanics*	3(3-0-0)	3
CS100	4	Computer Programming and Problem Solving	4(2-0-3)	4
HU100	5	Professional Communication*	3(2-0-2)	3
ME101	6	Engineering Drawing*	3(1-0-3)	3
PH101	7	Physics Laboratory*	2(0-0-3)	2
Total Credits				**22**

Semester II (Structure Common to All Branches)				
Course Code	**SI. No.**	**Course Name**	**Total Credits** (L-T-P)	**Credits**
MA150	1	Mathematics-II*	4(4-0-0)	4
PH150	2	Material Science*	3(3-0-0)	3
CY150	3	Chemistry*	3(3-0-0)	3
ME150	4	Elements of Mechanical Engineering *	2(2-0-0)	2
EE150	5	Basic Electrical Science	3(3-0-0)	3
ME151	6	Workshop Practices*	2(0-0-3)	2
CY151	7	Chemistry- Laboratory*	2(0-0-3)	2
EE151	8	Basic Electrical Science Laboratory	2(0-0-3)	2
PE150	9	Physical Education	1(1-0-0)	1
Total Credits				**22**

***The course contents can be found under syllabus details of First year B. Tech programme.**

Semester III				
Course Code	**SI. No.**	**Course Name**	**Total Credits** (L-T-P)	**Credits**
EC201	1	Analog Electronics	3(3-0-0)	3
EC202	2	Signals and Systems	4(3-1-0)	4
EC203	3	Network Theory and Synthesis	4(3-1-0)	4
EC204	4	Electromagnetic Theory	4(3-1-0)	4
MA200	5	Mathematics –III	3(3-0-0)	3
EC205	6	Analog Electronics Laboratory	2(0-0-3)	2
EC206	7	Signals and Systems Laboratory	2(0-0-3)	2
Total Credits				**22**

Semester IV				
Course Code	**SI. No.**	**Course Name**	**Total Credits** (L-T-P)	**Credits**
EC251	1	Digital Electronics	3(3-0-0)	3
EC252	2	Communication Engineering	4(3-1-0)	4
EC253	3	Devices	4(3-1-0)	4
HU250	4	Economics	3(3-0-0)	3
MA250	5	Mathematics-IV (Probability, Statistics and Random Processes)	3(3-0-0)	3
EC254	6	Digital Electronics Laboratory	2(0-0-3)	2
EC255	7	Communication Engineering Laboratory	2(0-0-3)	2
VE200	8	Value Education	1(0-0-2)	1
Total Credits				**22**

Semester V				
Course Code	**SI. No.**	**Course Name**	**Total Credits** (L-T-P)	**Credits**
ES300	1	Environmental Studies	3(3-0-0)	3
EC301	2	Data Structures and Algorithm	4(3-1-0)	4
EC302	3	Control System	4(3-1-0)	4
EC303	4	Digital Signal Processing	4(3-1-0)	4
EC304	5	Microprocessor and Microcontroller	3(3-0-0)	3
EC305	6	Digital Signal Processing Laboratory	2(0-0-3)	2
EC306	7	Microprocessor and Microcontroller Laboratory	2(0-0-3)	2
Total Credits				**22**

Semester VI				
Course Code	**SI. No.**	**Course Name**	**Total Credits** (L-T-P)	**Credits**
EC351	1	Wireless Communication	4(3-1-0)	4
EC352	2	Linear Integrated Circuits	3(3-0-0)	3
EC353	3	Digital Communication	4(3-1-0)	4
EC354	4	Communication Network	3(3-0-0)	3
EC4XX	5	Elective I	3(3-0-0)	3
EC355	6	Linear Integrated Circuits Laboratory	2(0-0-3)	2
EC356	7	Digital Communication Laboratory	2(0-0-3)	2
EC399	8	Mini Project/Industrial Training	1(0-0-2)	1
Total Credits				**22**

Semester VII				
Course Code	**SI. No.**	**Course Name**	**Total Credits** (L-T-P)	**Credits**
EC401	1	VLSI Circuit Design	3(3-0-0)	3
HS400	2	Management	3(3-0-0)	3
EC402	3	Information Theory and Coding	3(3-0-0)	3
EC4XX	4	Elective II	3(3-0-0)	3
EC403	5	VLSI Design Laboratory	2(0-0-3)	2
EC448	6	Seminar	2(0-0-3)	2
EC449	7	Major Project	4(0-0-6)	4
Total Credits				**20**

Semester VIII				
Course Code	**SI. No.**	**Course Name**	**Total Credits** (L-T-P)	**Credits**
EC4XX	1	Elective III	3(3-0-0)	3
EC4XX	2	Elective IV	3(3-0-0)	3
EC4XX	3	Elective V	3(3-0-0)	3
EC4XX	4	Elective VI	3(3-0-0)	3
EC499	5	Major Project	6(0-0-9)	6
Total Credits				**18**

Note: A student has to choose 12 credits as Program Electives and 6 credits as Open Electives. Open Electives are courses which students can take from any department.

List of Electives

Program Electives				
Course Code	**SI. No.**	**Course Name**	**Total Credits** (L-T-P)	**Credits**
EC404	1	Electronic Instrumentation	3(3-0-0)	3
EC405	2	Digital System Design	3(3-0-0)	3
EC406	3	Computer Architecture and Organization	3(3-0-0)	3
EC407	4	Advanced Digital Signal Processing	3(3-0-0)	3
EC408	5	Statistical Signal Processing	3(3-0-0)	3
EC409	6	DSP Algorithm and Architecture	3(3-0-0)	3
EC410	7	Speech and Audio Processing	3(3-0-0)	3
EC411	8	Image and Video Processing	3(3-0-0)	3
EC412	9	Biomedical Signal Processing	3(3-0-0)	3
EC413	10	Error Control Coding	3(3-0-0)	3
EC414	11	Spread Spectrum Communication	3(3-0-0)	3
EC415	12	Optical Communication	3(3-0-0)	3
EC416	13	AdHoc and Sensor Networks	3(3-0-0)	3
EC417	14	Antennas and Propagation	3(3-0-0)	3
EC418	15	Satellite Communication	3(3-0-0)	3
EC419	16	Microwave Engineering	3(3-0-0)	3
EC420	17	Radar and Navigation Systems	3(3-0-0)	3
EC421	18	Digital Image Processing	3(3-0-0)	3
EC422	19	Active Filters and Data Converters	3(3-0-0)	3
EC423	20	Embedded Systems	3(3-0-0)	3
EC424	21	Low-Power VLSI Circuit Design.	3(3-0-0)	3
EC425	22	Logic Synthesis and Optimization	3(3-0-0)	3
HU401	23	Professional Communication - II and Language Lab	4(2-0-3)	4

First Year Course Contents

Subject Code **EE151/EC151**	**Basic Electrical Science**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To expose students to basic electric devices and components characteristics and techniques of analyzing them.	
Module 1	**DC circuit Analysis**	12 hours
Review of circuit elements, Voltage sources, Current sources, Ohm's Law, Kirchoff's Laws, Mesh and Node analysis of DC circuits,Source transformation, Star-Delta Transformation, Network theorems, Time domain analysis of RC, RL, RLC with DC excitation.		
Module 2	**Magnetic circuit Analysis and AC circuit Analysis**	12 hours
Electromagnetic Induction, Self and mutual inductances, Magnetic circuits. Fundamentals of A.C, Average and RMS values, Form and Peak factor, Concept of Phasors, Complex operator, Network theorems, Basic concepts of three phase circuits.		
Module 3	**Semiconductor Devices and Circuits**	14 hours
P-Njunction diode, Characteristics, Diode approximations, DC load line, AC equivalent circuits, Zener diodes Half-wave diode rectifier and Full-wave diode rectifier, Shunt capacitor filter, Ripple factor - Approximate analysis of capacitor filters, Power supply performance, Voltage regulators; Bipolar Junction transistor, Characteristics, DC Load line and Bias Point, Biasing circuit design, Amplifiers.		
Module 4	**Elements of Digital Electronics**	7 hours
Analog and Digital Signals, Introduction to Digital Electronics, Digital Logic Gates. Introduction to memory elements, SRAM, DRAM, ROM, PROM, EPROM, EEPROM.		
Text Books	3. Del Toro, *Electrical Engineering Fundamentals*, Pearson Education, 2002. 4. R.J. Smith, *Circuits, Devices and Systems: A First Course in Electrical Engineering*, Wiley-5th edition 4. William H. Hayt Jr., Jack E. Kemmerly, *Steven M. Durbin, Engineering Circuit Analysis*, TMH, 2002.	
Reference Books	2. A.S. Sedra & K.C Smith, *Microelectronic Circuits*, Oxford Univ. Press 1999.	

Subject Code EE152/EC 152	**Basic Electrical Science Laboratory**	**Credits: 2 (0-0-3)** **Total hours: 45**
Course Objectives	To have hands on experience on principle of basic electronic passive and active components and their analysis.	

List of Experiments

12. Verification of KVL and KCL circuit laws**.**
13. Designing and AC, Transient analysis of series and parallel RC, LC and RLC circuits .
14. Clipping , Clamping circuits & voltage multipliers with diodes.
15. Rectifiers with C, LC & CLC filters - half wave, full wave & Bridge.
16. Network Theorem - Superposition, Thevenin, Norton and Maximum Power Transfer
17. Phasor Analysis of series and parallel RC,LC and RLC circuits.
18. BJT and JFET Characteristics.
19. Transistor as an Amplifier.
20. Digital Combinational Logic gates.
21. Memory Elements.
22. Soldering and PCB design practice.

Second Year Course Contents

Subject Code EC201	**Analog Electronics**	Credits: 3(3-0-0) Total hours:45
Course Objectives	To develop the skill of analysis and design of various Analog circuit building blocks like Current Mirrors, Amplifiers, Differential Amplifiers using BJT and MOSFET. To understand the concept of Negative and Positive feedback.	
Module 1		**Hours 13**
Amplifiers: Introduction, Input and output impedance, Operating point analysis and design, Biasing schemes; Load line and Bias stability, Analyses and design of CC, CE and CB configurations; RC coupled and transformer coupled multistage Amplifiers; Thermal runaway in BJT Amplifiers. MOSFET Amplifier: Analysis and Design of Common Source, Common Drain and Common Gate Amplifier configurations – Thermal runaway in MOS Amplifiers.		
Module2		**Hours 12**
Cascode stages and Current Mirrors: MOS Current Mirrors, Types of Current Mirrors, Simple, Cascade type. Differential Amplifiers: MOS Differential pair, Small and Large Signal analysis, Common Mode Rejection, Differential pair with Active loads. Power amplifiers: Push pull stage, Heat dissipation, Class A, B, AB, C, D, E& S Power Amplifiers - Harmonic distortion – Conversion efficiency and Relative performance.		
Module 3		**Hours 08**
Frequency response of Amplifiers: Hybrid π equivalent circuit of BJT, Low and High Frequency BJT/MOSFET Model, Miller effect. Noise in Amplifiers: Types of Noise, Noise representation, Noise in different circuits.		
Module 4		**Hours 12**
Feedback and Stability: Introduction to Negative feedback – Basic feedback concepts; Ideal Feedback Topologies - Voltage shunt, Voltage series, Current series and Current shunt Feedback Configurations; Loop gain – Stability of feedback circuit, Nyquist stability criterion, Phase and Gain margins; Oscillators : Basic principles of Oscillators, Analysis of RC Phase Shift, Wein bridge, Colpitts, Hartley and Crystal Oscillators.		
Reference books	1. A S Sedra& K C Smith, "Microelectronic Circuits", Oxford University Press.1998. 2. BehzadRazavi, "Fundamentals of Microelectronics", John Wiley & Sons .2008. 3. Robert Boylestad & Louis Nashelsky ," Electronic Devices & Circuit Theory", PHI., 1995.	

Subject Code EC202	**Signals And Systems**	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	The objective of the course is to introduce the undergraduate students to concepts of continuous and discrete time signal and systems. In this regards emphasis is on developing and describing general principle. We will develop mathematical tolls for describing the signals and systems. After attending this course they are expected to analyze and design any signal processing system with ease.	
Module 1		**6 hours**
Motivation and introduction to the course, Basic concepts of signals and systems, signal transformations, continuous and discrete time systems, basic systems properties.		
Module2		**8 hours**
Linear time invariant (LTI) systems: Discrete and continuous – time LTI systems, convolution, properties of LTI systems, system described by differential and difference equations.		
Module 3		**10 hours**
Fourier representation of periodic signals: Representation of continuous time periodic signals and their properties, representation of discrete time periodic signals and their properties, Fourier series and LTI systems, filtering.		
Module 4		**14 hours**
Fourier Transform of aperiodic signals: Continuous and discrete time Fourier transform, properties of transforms, convolution and multiplication property, duality, time-frequency characterization, sampling.		
Module 5		**14 hours**
Laplace and z- transform: The Laplace and z-transform, region of convergence, properties, analysis and characterization of LTI system using Laplace and z – transform, realization of LTI system using Laplace and z – transform.		
Reference books	1. Oppenheim, Willisky and Hamid Nawab, "Signals and Systems", Prentice Hall, 2nd ed. 2. S. Haykin and B. V. Veen, et al , " Signals and Systems", Willey India Edition, 2nd ed.	

Subject Code EC203	**Network Theory and Synthesis**	Credits: 4(3-1-0) Total hours: 56
Course Objectives	• To expose the students to the basic concepts of Electric circuits and their analysis in Time and Frequency domain • To Introduce the techniques of Network Synthesis	

Module 1	**Hours 16**
Fourier Analysis: Evaluation of Fourier Coefficients, Waveforms Symmetry related to Fourier coefficients. Conventions for describing the Networks: Network equations, Number of network Equations, Source transformations, Loop variable analysis and Node variable analysis, Duality. First-order differential equations: General and Particular solutions, Time Constants, Initial conditions in networks, Second-order Differential Equations.	
Module2	**Hours 14**
The Laplace Transformation: Basic Theorems for the Laplace Transformation, Examples of the Solutions of Problem with Laplace Transformations, Partial Fraction Expansion, Transforms of other Signal Waveforms, Shifted Unit Step, Ramp, Impulse Functions, Waveform Synthesis, Impedance Functions; Network functions: Poles and Zeros, Restrictions on Pole and Zero Locations for driving point Impedance. Stability of Active networks.	
Module 3	**Hours 12**
Two-Port Parameters: Short-Circuit Admittance and Open-Circuit Impedance Parameters, Transmission and Hybrid Parameters, Relationship between Parameter sets. Sinusoidal Steady State Analysis: The Sinusoidal Steady State, Phasor Diagrams.	
Module 4	**Hours 14**
Network Synthesis: Elements of Realizability theory, Causality and Stability, Hurwitz polynomial, Positive Real Functions. Synthesis of One-port Network with two kinds of Elements- Properties of L-C Immittance functions, Synthesis of L-C Driving point Immittance functions, Properties of R-C Driving point Impedance function, Synthesis of R-C Driving point Impedance function, Properties of R-L Impedance and R-C Admittance function, Synthesis of R-L Impedance and R-C Admittance function. Properties of RC network functions - Foster and Cauer forms of RC and RL networks.	

Reference books	1. Van Valkenberg, "Network Analysis", Prentice Hall of India. 2. Franklin F. Kuo, "Network Analysis and Synthesis", Wiley International Edition 3. Roy Choudhary, "Network and Systems", Wiley Eastern, 2nd Ed., 1988.

Subject Code EC204	**Electromagnetic Theory**	Credits: 4(3-1-0) Total hours: 56
Course Objectives	To impart the knowledge of electric, magnetic fields and the equations governing them as well as time varying field. To develop understanding about guided waves & transmission lines.	
Module 1		**18 hours**
Static Electric & Magnetic field: Electrical scalar potential, Different types of potential distribution, Potential gradient, Energy stored in electric field, Boundary conditions Capacitance, Steady current and current density in a conductor, Equation of continuity; Energy stored in magnetic fields, Magnetic dipole-Electric and Magnetic boundary conditions, Vector Magnetic potential, Magnetic field intensity.		
Module 2		**14 hours**
Maxwell's equations and travelling waves: Conduction current and Displacement current, Electromotive force, Maxwell's equations, Plane waves, Poynting theorem, Plane electromagnetic waves - Solution for free space condition, Uniform plane wave-wave equation for conducting medium, Wave polarization, Poisson's and Laplace equations.		
Module 3		**14 hours**
Guided waves between parallel planes, Transverse electric and transverse magnetic waves and its characteristics, Linear Elliptical and Circular Polarization, Wave equations for conducting medium, Wave propagation in conductors and dielectric, Depth of penetration , Reflection and Refraction of plane waves by conductor and dielectric, Poynting Vector and flow of power.		
Module 4		**10 hours**
Transmission Lines and Waveguides: Transmission line equations, transmission line parameters, Skin effect, VSWR, Characteristic impedance; Theory of waveguide transmission, Rectangular waveguides- TE modes-TM modes.		
Reference books	1. W.H. Hayt, "Engineering Electromagnetics", Tata Mc-Graw Hill Edition, 5th Edition 2. David J. Griffithe, "Introduction to Electrodynamics", Prentice Hall India, 3rd Edition 3. E. C. Jordan, "Electromagnetic waves and radiating systems", Prentice Hall India,2nd edition.	

Subject Code MA 200	**Mathematics-III**	**Credits: 3 Total hours 42**
Course Prerequisites	Mathematics-I & II	
Objectives	This Mathematics course provides requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists. Important topics of applied mathematics, namely complex analysis, power series solutions and partial differential equations.	
Course Outcome	At the end of this course the students are expected to learn, Understand the statement of Cauchy's Theorem and compute the Taylor and Laurent expansions of simple functions, determining the nature of the singularities and calculating residues, series solution of the differential equations and solution of partial differential equations.	
Module 1	**Complex Analysis**	18 hours
Complex Numbers, geometric representation, powers and roots of complex numbers, Functions of a complex variable, Analytic functions, Cauchy-Riemann equations; elementary functions, Conformal mapping (for linear transformation); Contours and contour integration, Cauchy's theorem, Cauchy integral formula; Power Series and properties, Taylor series, Laurrent series, Zeros, singularities, poles, essential singularities, Residue theorem, Evaluation of real integrals and improper integrals.		
Module 2	**Power Series Solutions**	9 hours
Differential Equations Power Series Method - application to Legendre equation, Legendre Polynomials, Frobenious Method, Bessel equation, Properties of Bessel functions, Sturm- Liouville BVPs, Orthogonal functions.		
Module 3	**Partial Differential Equations**	15 hours
Introduction to PDE, basic concepts, second order PDE and classification, D'Alemberts formula and Duhamel's principle for one dimensional wave equation, Laplace's and Poisson's equations, Laplace, Wave, and Heat equations using separation of variables. Vibration of a circular membrane. Heat equation in the half space.		
Texts/References	1. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999). 2. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005). 3. R. V. Churchill and J. W. Brown, Complex variables and applications (7th Edition), McGraw-Hill (2003).	

Subject Code EC205	**Analog Electronics Laboratory**	Credits: 2(0-0-3) Total hours: 45
Course Objectives	To provide experience on design, testing, and analysis of basic Analog Electronic Circuits**.**	

List of Experiments

Experiment No. 1

Logic gates using Diodes

Experiment No. 2

Diode as a clipper,

Experiment No. 3

Clipping and Clamping Circuit

Experiment No. 4

Full wave rectifier

Experiment No. 5

Regulated and Unregulated Power supply

Experiment No. 6

RC Circuit Analysis

Experiment No. 7

Biasing Circuits:

Experiment No. 8

Effect of Negative feedback

Experiment No. 9

RC couple amplifier using BJT

Experiment No. 10

Complementary Push-Pull amplifier using BJT and OP-Amp

Subject Code EC206	**Signals and Systems Laboratory**	Credits: 2 (0-0-3) Total hours: 45
Course Objectives	This Laboratory course is offered in conjunction with lecture course "Signals and Systems". The aim of this course is to introduce students to simulate the theoretical ideas about signals and systems representation and processing in the simulation environment.	

List of Experiments

Experiment No. 1 Introduction to Signals and Matlab Software: Define the signals with certain characteristics and Transformation of Signals. Plot these signals with requisite labels.

Experiment No. 2 Convolution Operation and response to arbitrary signal.

Experiment No. 3 Demonstration and verifying the properties of Systems.

Experiment No. 4 Natural and Forced Response of Second order Systems.

Experiment No. 5 Fourier Series analysis of periodic signals.

Experiment No. 6 Fourier Transform analysis of aperiodic signals.

Experiment No. 7 Time Frequency Analysis of First and Second order systems and Bode plot.

Experiment No. 8 Sampling of continuous time signals and Aliasing

Experiment No. 9 Design of Frequency Selectivity filter with arbitrary central frequency.

Experiment No. 10 Pole – Zero Analysis of Second order system for continuous time signals. Time and Frequency Characteristics.

Experiment No. 11 Analysis of Second order system for discrete time signals.

Experiment No. 12 Feed Back System and their Characteristics.

Reference books	1. Oppenheim, Willisky and Hamid Nawab, " Signals and Systems", Prentice Hall, 2nd ed. 2. S. Haykin and B. V. Veen, et al , " Signals and Systems", Willey India Edition, 2nd ed.

Subject Code EC251	**Digital Electronics**	Credits: 3-0-0 (3) Total hours:45
Course Objectives	• This subject exposes the students to Digital Fundamentals. • After studying this subject the student will be able to Design, Analyze and Interpret Combinational and Sequential Digital Circuits.	

Module 1	**Hours 12**
Number Systems and Boolean Algebra, Simplification of functions using Karnaugh map and QuineMcCluskey Method, Boolean Function Implementation, Minimization and Combinational Design, Examples of Combinational Digital Circuits, Hazards in Combinational Circuits, Hazard free realization.	
Module2	**Hours 12**
Introduction to Sequential circuits: Latches and Flip-Flops (RS, JK, D, T and Master Slave), Design of a Clocked Flip-Flop, Flip-Flop conversion, Practical Clocking aspects concerning Flip-Flops. Counters: Design of Single Mode and Multimode Counters, Ripple Counters, Synchronous Counters, Shift Registers, Shift Register Counters and Random Sequence Generators.	
Module 3	**Hours 12**
Design and Analysis of Sequential Circuits: General model of Sequential Networks, State Diagram, Analysis and Design of Synchronous Sequential Circuits; Finite Sate Machine, State Reduction, Minimization and Design of the Next State Decoder. Asynchronous Sequential Logic: Analysis and Design, Race conditions and Cycles. Practical Design Aspects: Timing and Triggering considerations in the Design of Synchronous Circuits, Set up time, Hold time, Clock skew.	
Module 4	**Hours 9**
Logic Families: Fundamentals of ECL, TTL, CMOS Logic family, Transfer Characteristics, Input and Output Characteristics, Tristate Logic, Wired Logic and Bus Oriented structure, Practical Aspects, MOS gates, MOS Inverter, CMOS inverter, Rise and fall time in MOS and CMOS gates, Speed Power Product, Interfacing BJT and CMOS gates.	

Reference books	1. Wakerly J F, "Digital Design: Principles and Practices", Prentice-Hall, 2nd Ed., 2002 2. Mano M. M., "Digital Logic Design", Prentice Hall 1993.

Subject Code EC 252	**Communication Engineering**	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	To enable students to analyze and design analog communication systems and have overview of how modern communication system works.	

Module 1	**12 Hours**
Elements of electronic communication systems**,** Need for modulation, channel, noise, frequency spectrum, time and frequency domains, Review of Fourier analysis, Review of Random Processes : Stationary Processes, Power Spectral Density, Power and Bandwidth Calculations, Ergodicity.	
Module2	**11 Hours**
Amplitude Modulation (AM), DSB-SC, SSB, VSB and ISB transmissions, modulators, mathematical Analysis, modulation index, frequency spectrum, power requirement of these systems.	
Module 3	**13 Hours**
Angle Modulation: Frequency Modulation (FM), mathematical Analysis, modulation index, frequency spectrum, power requirement of FM, narrowband & wideband FM, noise triangle in FM, pre-emphasis and de-emphasis techniques, phase modulation, power contents of the carrier & the sidebands in angle modulation, noise reduction characteristics of angle modulation, generation of FM signals, comparison between AM & FM	
Module 4	**12 Hours**
Radio Receivers: Basic receiver (TRF), Super heterodyne receiver, performance parameters for receiver such as sensitivity, selectivity, fidelity, image frequency rejection etc., AM demodulation, FM demodulation, AGC technique, double-spotting effect, Performance Analysis of Amplitude and Angle Modulation Schemes in the presence of Noise : Signal to Noise Ratio (SNR) analysis.	
Module 5	**8 Hours**
Television Systems: Operating principles, composite video signal, blanking & synchronizing pulses, block schematic of TV transmitter & receiver, Color transmission & reception principles, TV standards such as CCIR-B, NTSC, PAL, SECAM.	

Reference books	1. Haykin S.,"Communications Systems", John Wiley and Sons, 2001. 2. Proakis J. G. and Salehi M., "Communication Systems Engineering",Pearson Education, 2002. 3. Taub H. and Schilling D.L., "Principles of Communication Systems",Tata McGraw Hill, 2001. 4. R.R Gulati, “Monochrome and Colour Television”, New Age International, 2007. 5. H. Stark, J. W. Woods, Probability and Random Processes with Applications to Signal Processing, Prentice-Hall, 2003. 6. Peyton Z. Peebles Jr., Probability, Random Variables and Random Signal Principles, 4/e, Tata McGraw-Hill, New Delhi, 2002.

Subject Code EC253	**Devices**	Credits: 3(3-1-0) Total hours: 56
Course Objectives	To understand the fundamental principles of various modern semiconductor devices. To understand and describe the impact of solid-state device capabilities and limitation's on electronic circuit performance .	
Module 1 :		**Hours 14**
Semiconductor materials: Periodic Structures, Crystal Lattices; Cubic Lattices - Planes and Directions, The Diamond lattice; Crystal Properties and Growth of Semiconductors. Energy Bands and Charge Carries in Semiconductors: Equilibrium Carrier concentration, Thermal Equilibrium and wave particle duality; Intrinsic semiconductor - Bond and Band models; Extrinsic semiconductor - Bond and Band models; Carrier transport, Random motion. Excess Carriers in Semiconductors: Injection level, Lifetime, Direct and Indirect Semiconductors, Diffusion and Drift of Carrier; Built-in Fields - Diffusion and Recombination, The Continuity Equation, Steady State Carrier Injection.		
Module2		**Hours 13**
P-N Junction: Device Structure, Equilibrium Picture, Band Diagram, DC Forward and Reverse Characteristics, Small-signal Equivalent Circuit, Switching Characteristics; Zener Breakdown; Graded Junctions, Metal -Semiconductor Junctions, Schottky Barriers, Rectifying contacts, Ohmic Contacts. Other PN Junctions: Photodiodes, Solar cells, Photo detectors, Noise and Bandwidth of Photo detectors, Light-Emitting Diode, Lasers, Semiconductor Lasers.		
Module 3		**Hours 13**
Bipolar Junction Transistor: Device Structures, Band Diagram, Operation, Transistor action and Amplification; Common Emitter DC characteristics, Small-signal Equivalent circuit; Ebers-Moll model, SPICE model.		
Module 4		**Hours 16**
MOS Junction: Band diagram, C-V characteristics, Threshold voltage, Body effect. Metal Oxide Field Effect Transistor: Device Structures, Band Diagram, Operation, Common Source DC Characteristics, Small-signal Equivalent of MOSFET, SPICE level-1 model. Secondary effects of MOSFET: Hot Electron Effects, Drain-Induced Barrier Lowering, Short Channel Effect and Narrow Width Effect, Gate-Induced Drain Leakage; Differences between a MOSFET and a BJT.		
Reference books	1. Ben.G.Streetman & Sanjan Banerjee, "Solid State Electronic Devices", 5th Edition, PHI Private Ltd, 2003 2. NanditaDas Gupta & Aamitava Das Gupta, "Semiconductor Devices; Modeling and Technology", PHI, 2004. 3. M.K. Achuthan and K.N.Bhat, "Fundamentals of Semiconductor Devices", Tata McGraw-Hill, New Delhi, First Print 2007	

Subject Code HS 250	**Economics**	Credits: 3(3-0-0) Total hours: 45
Course Outcome	The fundamental objective of this course aims at providing a comprehensive perspective in the broad area of economics and its scenario. The course aspires to bring the students into the light of economic decision makings, and facilitates tohave grip in economic issues.	
Module 1	**Introduction to Economics**	2 hours
Constructing a Model, Optimization and Equilibrium in market demand and supply, Comparative statistics and asset allocation.		
Module 2	**Utility, Choice, Budget Constraint and Consumer Preference**	6 hours
Cardinal Utility, Constructing a Utility Function, Budget constraint in case of two goods, Shifting of budget line and impact of Taxes, Subsidies, and Rationing. Indifference curve, Marginal Rate of Substitution, Cardinal utility and utility function, Indifference curve from utility functions, Marginal Utility vs MRS		
Module 3	**Demand, Revealed Preference & Slutsky Equation**	6 hours
Normal and Inferior Goods, Income Offer Curves and Engel Curves, Perfect Substitute, complement and Cobb-Douglas Preferences, The Idea of Revealed Preference, From Revealed Preference to reference,Recovering Preferences, The Substitution Effect, The Income Effect, Rate of Change and change of Demand.		
Module 4	**Consumer Surplus, Market Demand & Equilibrium**	6 hours
Demand for a Discrete Good, Constructing Utility from DemandFrom, Change inConsumer's Surplus, Individual to Market Demand, The Inverse Demand Function, The Extensive and the Intensive Margin, Elasticity, Elasticity and Demand, Market Supply, Market equilibrium, Inverse Demand and Supply Curves		
Module 5	**Technology and Profit Maximization**	3 hours
Inputs and Outputs, Describing Technological Constraints, Properties of Technology, The Technical Rate of Substitution, Diminishing Technical Rate of Substitution, Returns to Scale, Profits, The Organization of Firms, The Organization of Firms, Short-Run Profit Maximization, Profit Maximization in the Long Run, Profit Maximization and Returns to Scale		
Module 6	**National Income Accounting**	2 hours
National Income and Related concepts, Nominal or real GDP, Methods of measuring NI.		
Module 7	**Determinants of Equilibrium Output and IS – LM Model**	8 hours
Aggregate demand and Equilibrium output, Consumption function and aggregate demand, Multiplier, Govt. sector, Budget and Full employment, Asset and Goods Market, Equilibrium and adjustment to equilibrium in IS – LM model		
Module 8	**Money and Fiscal policy and International Linkages**	8 hours
Monetary and fiscal policy, crowding out, composition of output and policy mix, Balance of Payment and Exchange rate, Balance of Trade and capital mobility, Mundell-Fleming model, Capital Mobility and fixed exchange rates		
Module 9	**Aggregate Demand, Supply and Growth**	4 hours
Aggregate demand and policies, Aggregate Supply, Fiscal and monetary policy under Alternative supply Assumption, The quantity theory and neutrality of Money.		
Text Books	Varian, Hal R.: Intermediate Microeconomics, W.W. Norton & Co., New work (ISBN: 0393978303) Koutsoyiannis, A.: Modern Microeconomics, 2nd ELBS/Palgrave Macmillan, London Rudiger Dornbusch and Stanley Fisher: Macroeconomics, McGraw Hill Barro Robert J. "Macroeconomics, New York, John Wiley	

Subject Code MA 250	**Mathematics - IV (Probability, Statistics And Random Processes)**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	This course provides mathematical foundation to describe phenomenon occurring with chance. Students will be able to describe, analyze and draw inferences about experiment with probabilistic measure.	
Module 1		**6 hours**
Introduction to Probability: Relative frequency and notion of probability; Axiomatic definition; Sample Space and Events; Combinatorics; Joint and Conditional Probabilities; Independence; Bayes' Theorem and application.		
Module2		**15 hours**
Random Variables : Concept of Random Variables; Distribution and Density Function;; Jointly Distributed Random of Variables; Conditional and Joint Density Distribution function; Function of Random Variables; Expected Value: Mean, Variance and moments of random variable; Joint moments, conditional expectation; covariance and correlation; independent, uncorrelated and orthogonal random variables; Some special distributions: Uniform, Gaussian and Rayleigh distributions; Binomial, and Poisson distributions; Multivariate Gaussian distribution; Random vector: mean vector, covariance matrix and properties; Vector-space representation of random variables and Schwarz Inequality; Moment-generating and characteristic functions and their applications; Bounds and approximations		
Module 3		**6 hours**
Sequence of Random Variables :Almost sure (a.s.) convergence and strong law of large numbers; convergence in mean square sense; convergence in probability and convergence in distribution and Limit Theorems.		
Module 4		**6 hours**
Statistics :Elements of estimation theory: linear minimum mean-square error and Orthogonality principle in estimation; Parameter Estimation.		
Module 5		**12 hours**
Random process and ensemble; Mean, autocorrelation and autocovariance functions; Class of Stationarity processes; Autocorrelation and cross-correlation function; Ergodicity; Spectral representation of a real WSS process and analysis; Linear time-invariant system with input WSS process; Spectral factorization theorem ; Examples of random processes: white noise process and white noise sequence; Gaussian process; Poisson process, Markov Process.		
Reference books	1. H. Stark, J W. Woods, "Probability and Random Processes with Applications to Signal Processing", Third Edition, Pearson Education 2. A Papoulis, S. U. Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, Tata Mc. Graw-Hill	

Subject Code EC254	**Digital Electronics Laboratory**	Credits: 2(0-0-3) Total hours: 45
Course Objectives	To provide experience on design, testing, and analysis of digital electronic circuits.	

List of Experiments

Experiment No. 1
Realization of logic gates using diodes and transistors.
Experiment No. 2
Transfer Characteristics, Measurement of Sinking and Sourcing currents etc. of TTL gates.
Experiment No. 3
Realization of logic gates using universal gates.
Experiment No. 4
Code converters using basic gates.
Experiment No. 5
Seven segment display.
Experiment No. 6
Realization of Mux, Decoder and Encoder using basic gates.
Experiment No. 7
Combinational logic design using Decoders and Multiplexers.
Experiment No. 8
Half and Full adders and Subtractors.
Experiment No. 9
4 Bit adder-subtractor IC & BCD adder circuit.
Experiment No. 10
Flip-Flop Circuit (RS Latch, JK, T, D and Master Slave) using basic gates.
Experiment No. 11
Asynchronous Counters.
Experiment No. 12
Johnson and Ring Counters.
Experiment No. 13
Synchronous counters.
Experiment No. 14
A Sequence Generator/Detector circuit.

Subject Code EC 255	**Communication Engineering Laboratory**	Credits: 2 (0-0-3) Total hours: 45
Course Objectives	To introduce student to the experiments which demonstrate the theory learnt in the EC 253 Communication Engineering course so that they know how to design and implement important components used in analog communication systems.	

List of Experiments

Experiment No. 1

Fourier Series and Waveform Synthesis – Analysis

Experiment No. 2

DSB AM System SC/FC , with noise and without noise

Experiment No. 3

SSB AM System SC/FC, with noise and without noise

Experiment No. 4

FM Modulation- demodulation using Foster Seeley Discriminator

Experiment No. 5

Diode Detector circuit for AM demodulation

Experiment No. 6

Study and measurement of modulation index, Study of Super-heterodyne receiver

Experiment No. 7

Sensitivity, Fidelity and Selectivity of AM Communication System.

Experiment No. 8

Basic Pulse modulation scheme **:** Generation and demodulation of PWM and PPM

Experiment No. 9

Phase locked loop characteristics and FM modulation and demodulation using PLL

Experiment No. 10

Noise figure and Noise measurements for Amplifier, detector blocks in AM system

Subject Code: VE200	**Value Education**	**Credits: 1 (1-0-0) Total hours: 14**
Course Prerequisite	General Awareness of the Society/ Environment we live in	
Course Objectives	It aims at Holistic Development	
Course Outcome	At the end, the students should be a complete human being in every respect	
Module 1	**Ethics in Engineering**	4 hours
Concepts of Values and Ethics, History and Purposes, Utilitarianism, Duties, Rights, Responsibility, Virtue, Honesty, Moral Autonomy, Obligations of Engineering Profession and moral Propriety		
Module 2	**Engineer's Moral responsibility**	3 hours
Engineer's Moral responsibility for Safety and Human Rights, Risk Assessment and Communication, Product Liability, Engineers-Employers Liaison, Whistle-Blowing and Its Moral Justification		
Module 3	**Computer Ethics**	3 hours
Social Impact of Computer, Gender-Issues and Privacy, Cyber Crime, Ethical use of Software		
Module 4	**Intellectual property**	4 hours
Definition, Types, Rights and Functions, Patents, Trademark, Grant of Patent in India, Surrender and Revocation of Patents, Compulsory Licensing, Acquisition of Inventions by the Government, Contents of draft application of Patents, WTO		
Texts:	1. Vinod V. Sople, *Managing Intellectual Property*: The Strategic Imperative, PHI,2006 2. Govindarajan, *Natarajan & Senthil Kumar, Engineering Ethics*, PHI 3. Robin Attfield, *A Theory of Value and Obligation, London*: Croomhelm, 1987 4. Jones and barlett, " *Cyber Ethics: Morality and Law in Cyber Space"*	
Reference	Case Studies from Newspapers	

Third Year Course Contents

Subject Code ES300	ENVIRONMENTAL STUDIES	Credits: 3 (3-0-0) Total hours: 44
Course Objective	Understanding environment, its constituents, importance for living, ecosystem, human developmental activities vs environment, climate change, national and international environment related developments, need for public awareness, its protection and conservation activities.	
Module 1		**Hours : 2**
Multidisciplinary nature of environmental studies:Definition, scope and importance, Need for public awareness.		
Module 2		**Hours : 8**
Renewable and non-renewable Natural resources : Natural resources and associated problems; Forest resources : Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forest and tribal people; Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems; Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies; Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies; Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources, Case studies; Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.		
Module 3		**Hours : 10**
Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the Following ecosystem, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).		
Module 4		**Hours : 12**
Biodiversity and its conservation: Introduction – Definition : genetic, species and ecosystem diversity, Bio geographical classification of India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-sports of biodiversity, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity, Eco-cultural heritage of India-various festivals related to Environment, Tradition of community conserved areas-Sacred forests, sacred tanks, sacred mountains, sacred rivers.		

Module 5	**Hours : 12**
National and International Environment related developments Environmental ethics : Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear, accidents and holocaust, Environment related Acts, Issues involved in enforcement of environmental legislation, Public awareness, Wasteland reclamation, Consumerism and waste products, UN Frame Convention Climate Change, Kyoto protocol, concept of carbon credits, latest CoP meet Agenda; Filed Work(equal to 5 lecture hours): Visit to a local area to document environmental assets river/forest/grassland/hill/mountain/sacred groves/sacred forests, Visit to a local polluted site-Urban/Rural/Industrial/Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hill slopes, etc.	
Reference books	1. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education (online book -UGC Website), Erach Bharucha,University Grants Commission , India. 2. Anil Agarwal, Dying Wisdom, Publisher: Centre for Science and Environment, Edi:1st,1997 ISBN-13 9788186906200; ISBN-10 8186906207 3. R. Rajagopalan, Environmental Studies from Crisis to Cure, Oxford IBH Pub., 2005. 4. Benny Joseph, Environmental Science and Engineering, Tata McGraw Hill, 2006. 5. Erach Bharucha, Text Book for Environmental Studies, Pub., Universities Press, 2005. 6. Masters, Gilbert M., Introduction to Environmental Engineering and Sciences, Prentice Hall India, 1991

Subject Code EC 301	**Data Structures & Algorithm (DSA)**	**Credits: 4 (3-1-0)** **Total hours: 56**
Course Objectives	Following this course, students will be able to: 1) Assess how the choice of data structures and algorithm design methods impacts the performance of programs. 2) Choose the appropriate data structure and algorithm design method for a specified application. 3) Solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, tournament trees, binary search trees, and graphs and writing programs for these solutions. 4) Solve problems using algorithm design methods such as the greedy method, divide and conquer, dynamic programming, backtracking, branch and bound and writing programs for these solutions.	
Module 1		**6 Hours**
Introduction to data structures and objectives, basic concepts Arrays: one dimensional, multi-dimensional, Elementary Operations.		
Module 2		**8 Hours**
Stacks: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching, Queues: Simple queue, circular queue, dequeue, elementary operations and applications.		
Module 3		**10 Hours**
Linked lists: Linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation.		
Module 4		**12 Hours**
Trees: Binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees like AVL tree and 2-3 tree and other operations and applications of trees.		
Module 5		**20 Hours**
Graphs: Representation, adjacency list, graph traversal, path matrix, spanning tree; introduction to algorithm analysis and design techniques, algorithms on sorting: selection sort, bubble sort, quick sort, merge sort, heap sort, searching, linear and binary search.		
Reference books	(5) Alfred V Aho, John E Hopcroft, Jeffrey D. Ullman, "Data structures & algorithms", Addison Wesley. 2003 (6) Horowitz and Sahni , "Data Structures and algorithms using C/C++", 2003 (7) Michael T. Goodrich, Roberto Tamassia, "Data Structures and algorithms in Java", 4thEdition, John Wiley & Sons, Inc.	

Subject Code EC 302	**Control Systems**	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	To be familiar with basic control configurations and also to be competent in mathematic modelling of physical systems and analyze their time and frequency response.	

Module 1	**Hours 12**
Mathematical modelling: Introduction of Open loop and Closed loop systems, Mathematical modelling of Physical systems, Mechanical and Electrical systems, Transfer functions, Block diagrams, Block diagram reduction rules, Signal flow graphs, Mason's Gain formula, Feedback characteristics of closed loop system.	
Module 2	**Hours 12**
Time response Analysis: Standard test signals, Time response of First and Second order systems, Steady-state Errors and Error constants and Dynamic Error coefficients, Effect of addition of poles and zeroes on response of system, Response with P, PI and PID controllers, Performance Indices**.** Control system components, Stepper motors, Tachogenerators, DC and AC Servomotors.	
Module 3	**Hours 10**
Conceptof stability: Necessary conditions and Routh Criterion, Relative stability analysis, Concept of Root Locus and Construction, Gain margin and Phase margin, Addition of poles and zeroes on root locus.	
Module 4	**Hours 12**
Frequency domain Analysis: Frequency response specifications, Frequency and Time domain correlation, Bode plot, Polar plot, Nyquist criterion, Closed loop frequency response from Open loop Transfer Functions.	
Module 5	**Hours 10**
Compensation Techniques: Design of Lead, Lag, Lead-Lag Compensation. State variable Analysis: Concept of State, State Variables and State Model, State representation of Continuous-time systems, State equation, Solution of State equations, Concept of Controllability and Observability.	

Reference books	1. J. Nagrath M. Gopal, "Control Systems Engineering", New Age International, 4th Edition. 2. K. Ogata, "Modern Control Engineering", PHI, 3rd Edition. 3. M. Gopal, "Control Systems, Principles and Design", Tata McGraw Hill, 4th Edition.

Subject Code EC 303	**Digital Signal Processing**	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	Students will be exposed to specifications and design of digital signal processing algorithms. They will learn different design techniques and apply different fast algorithms for filtering and other tasks.	
Module 1		**8 hours**
Review of signals and systems: Motivation and introduction to the course, Basic concepts of signals and systems, interconnection of the systems and filtering, Z – transform and the Region of convergence of the system, Complex convolution theorem, system described by difference equations, Frequency response of LTI systems and system functions.		
Module2		**15 hours**
Structures for Discrete Time systems: Representation of system described by Linear Constant Coefficient Difference Equations, digital filter structures, relation between magnitude and phase, All pass systems, Minimum phase systems, Lattice Structures, Linear Systems with Generalized Linear Phase.		
Module 3		**16 hours**
Filter Design Techniques: Design of IIR filters and different transformations, IIR filter design techniques, FIR filter by windowing, FIR filter by the Kaiser window, and Optimum approximation of FIR Filters.		
Module 4		**9 hours**
The Discrete Fourier Transform and Computational Aspects: Orthogonal transform, discrete Fourier transform (DFT), Relation between Fourier transform and DFT, Circular Convolution, DFT properties, Computation of DFT, Linear Convolution using the DFT, Fast computation of DFT.		
Module 5		**8 hours**
DSP Algorithm implementation and Finite Worldlength Effect: Number representation and overflow, Quantization Process and Errors, fixed and floating point numbers, coefficient quantization, A/D conversion noise analysis, Low sensitivity digital filters, Limit Cycle oscillations in IIR digital filters.		
Reference books	1. Discrete time Signal Processing , 2nd Ed. – A. V. Oppenheim and Schafer 2. Digital Signal Processing, 3rd Ed. -- S. K. Mitra, Tata Mc-Graw Hill	

Subject Code EC304	**Microprocessors and Microcontrollers**	Credits: 3(3-0-0) Total hours: 45
Course Objectives	• To introduce the student with knowledge about architecture, interfacing and programming with 8086 microprocessors and 8051 microcontrollers. Also to give a brief introduction to ARM 7 and ARM 9 micro controllers. • After studying this subject, the student should be able to design Microprocessor/Microcontroller based system.	
Module 1		**Hours 12**
Introduction: History of Microprocessors, Basics of computer architecture, CISC and RISC; 8085 Microprocessor Family Overview, 8085 Architecture, Assembly Language Programming (ALP), and Program development.		
Module2		**Hours 12**
8086 Microprocessor: Main features, pin Diagram Description, Internal Architecture, 8086 Microcomputer System, Program development steps, Implementing Standard Program Structure in 8086 ALP, Strings, Procedures, Macros.		
Module 3		**Hours 11**
Interfacing: Input and Output Modes and Interfacing, Interrupts, Hardware Interrupt Applications, 8254 Programmable Timer/Counter, 8255 Programmable Peripheral Interface, 8259 Priority Interrupt Controller, DMA controller, 8279 Programmable Keyboard/ Display Interface, ADC, DAC Interfacing.		
Module 4		**Hours 10**
Intel 8051 Microcontroller: Architecture, Memory Space, Data Types and Directives, Register Banks and Stack, Assembly Language Programming, Introduction to ARM processors –features of ARM 7 and 9 processors.		
Reference books	1. Hall D.V., "Microprocessors and Interfacing", McGraw Hill 2. Ramesh Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085", Penram International Publishing, Fifth edition 3. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D Mckinlay, " 8051 Microcontroller and Embedded systems", Pearson Education.	

Subject Code EC 305	**Digital Signal Processing Laboratory**	Credits: 2 (0-0-3) Total hours: 45
Course Objectives	This Laboratory course is offered in conjunction with lecture course "Digital Signal Processing". The aim of this course is to introduce the design process of digital signal processing systems in a simulation environment.	

List of Experiments

Experiment No. 1 Simulation of discrete time system

Experiment No. 2 Discrete Time Fourier Transform

Experiment No. 3 Transfer Function and Frequency Response and Stability Test.

Experiment No. 4 Realization of FIR and IIR transfer function

Experiment No. 5 IIR Filter Design

Experiment No. 6 FIR Filter Design

Experiment No. 7 Optimal FIR Filter Design

Experiment No. 8 Simulation of FIR and IIR Filters

Experiment No. 9 Lattice Filter implementation and Stability Test.

Experiment No. 10 Analysis of Finite World Length Effect – Coefficient Quantization, Limit Cycle Oscillation.

Experiment No. 11 Implementation of Signal Processing tasks on DSP Processor.

Reference books	1. Discrete time Signal Processing , 2nd Ed. – A. V. Oppenheim and Schafer 2. Digital Signal Processing Laboratory, Tata Mc Graw Hill, 3rd Ed. -- S. K. Mitra

Subject Code EC306	**Microprocessor and Microcontrollers Laboratory**	**Credits: 2(0-0-3)** **Total hours: 45**
Course Objectives	To give hands on experience on 8085/8086 and 8051 programming	
List of Experiments		

Experiment No. 1

8085 and 8086 kit familiarization and basic experiments

Experiment No. 2

Programming exercise : sorting ,searching and string

Experiment No. 3

Interfacing with A/D and D/A converters

Experiment No. 4

Interfacing with stepper motors

Experiment No. 5

keyboard interfacing to 8086

Experiment No. 6

8255 interface to 8086

Experiment No. 7

Assembly language programming of 8051

Experiment No. 8

Timer programming of 8051, using interrupts

Experiment No. 9

LCD interfacing to 8051

Experiment No. 10

Mini-Project

Subject Code EC 351	**Wireless Communication**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To enable students to understand concepts regarding wireless medium, cellular systems of mobile communication and wireless networks.	

Module 1	**13 Hours**
Mobile Radio propagation Large Scale Path Loss: Free Space Propagation Model, Ground Reflection Model, Practical Link Budget Analysis : Log Normal Shadowing, Determination of Percentage of Coverage Area. Small Scale Fading and Multipath : Impulse Response Model of a Multipath Channel, Parameters of Mobile Multipath Channels: Time Dispersion Parameters, Coherence Bandwidth, Doppler Spread and Coherence Time, Types of Small Scale Fading : Flat Fading, Frequency Selective Fading, Fast Fading, Slow Fading. Level Crossing Rate and Average Fade Duration.	
Module2	**10 Hours**
GSM system (FDM-TDMA): Description of GSM system block diagram, SIR analysis, Channel reuse analysis : D/R ratio, N_reuse, Cell Sectorization, Spectrum Efficiency, Channel Allocation and Multicell Erlang Models, Call Blocking Analysis, Handovers – Techniques, Models and Analysis.	
Module 3	**10 Hours**
Diversity, Realization of Independent Paths, Diversity System Model, Selection Combining, Threshold Combining, Maximal Ratio Combining, Equal Gain Combining, Moment Generating Functions in Diversity Analysis, Transmitter Diversity.	
Module 4	**12 Hours**
Fundamental Concepts of Spread Spectrum Systems, Pseudo Noise Sequence, Performance of Direct Sequence Spread Spectrum Systems, Analysis of Direct Sequence Spread Spectrum Systems , The Processing Gain and Anti Jamming Margin, Frequency Hopped Spread Spectrum Systems , Time Hopped Spread Spectrum Systems, Synchronization of Spread Spectrum Systems, RAKE receiver	

Reference books	
	1. Theodore Rappaport,"Wireless Communications : Principles and Practice", Second Edition, Pearson 2010. 2. Anurag Kumar, D Manjunath, Joy Kuri, "Wireless Networking", Morgan Kaufmann Publishers, 2008 3. Simon Haykin, Michael Moher,"Modern Wireless Communication", Prentice Hall, 2005 4. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.

Subject Code EC352	**Linear Integrated Circuits**	Credits: 3(3-0-0) Total hours: 45
Course Objectives	• To develop the skill of analysis and design of various circuits using operational Amplifiers • To develop design skills to design various circuits using different data conversion Systems	
Module 1		**Hours 12**
Operational Amplifier and its Linear application: Ideal Op Amp circuit Analysis, Inverting and Non-Inverting Configuration, Differentiator, Integrator, The Negative resistance converter, Negative Feedback, Feedback in Op Amp circuit, Loop gain. Circuits with Resistive Feedback: Current-to-Voltage Converters, Voltage-to-Current converters, Current Amplifiers, Difference Amplifiers, Instrumentation Amplifiers and Applications.		
Module2		**Hours 10**
Active filters: First and Second order filter Transfer function, Butterworth response, Second-order Passive filters (RC, RLC), Emulation of Inductor using Op-Amps-R-C, Salen-Key Biquad, Tow-Thomas Biquad, Realization of higher order filters, All-pass filter.		
Module 3		**Hours 11**
Nonlinear circuits: Voltage Comparators, Comparator Applications, Zero-crossing detector, Precision rectifiers, Schmitt trigger (Inverting &Non Inverting), Astable Multivibrator, Triangular wave generator. Non idealities of Op-Amps and their effects. NE555 Timer circuits: Internal architecture, Schmitt trigger, Astable Multivibrator, Monostable Multivibrator, Saw-Tooth Wave generator.		
Module 4		**Hours 12**
Digital to Analog (D/A) Converters: Types of D/A converters, Accuracy, Resolution and Conversion speed, Offset error, Gain error, Integral and Differential Nonlinearity. Analog to digital (A/D) converters: A/D conversion techniques and their Nonlinearity's. Phase Locked Loop: Block schematic and Analysis of PLL, Lock range and Capture range, Typical applications of PLL, Basic Principles of operation of VCO and timer (555) and their applications.		
Reference books	1. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", McGraw Hill Book Company 1998. 3.Sedra A.S. & Smith K.C., "Microelectronic Circuits", Oxford University Press 1998 4.RamakanthGaykward, "Op Amps and Linear Integrated Circuits", Pearson Education, 1999.	

Subject Code EC 353	**Digital Communication**	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	To enable students to understand and compare the performance of different digital communication systems (BER, SNR etc).	

Module 1	**5 Hours**
Review of Random Processes. Gaussian Process. Correlation Functions and Power Spectra.	
Module2	**16 Hours**
Detection : Model of Digital Communication System, Gram-Schmidt Orthogonalization Procedure, Geometric Interpretation of Signals, Response of Bank of Correlators to Nosiy Input, Detection of Known Signals in Noise, Probability of Error, Correlation Receiver, Matched Filter Receiver, Detection of Signal with Unknown Phase in Noise. Estimation : Concepts and Criteria, Maximum Likelihood Estimation.	
Module 3	**17 Hours**
Sampling Theorem, Quadrature Sampling of Band-pass signals, Nyquist Criterion, Signal Distortion in Sampling. Intersymbol Interference. Waveform Coding Techniques : PCM, Channel Noise and Error probability, Quantization Noise and Signal to Noise Ratio, Robust Quantization, DPCM, Delta Modulation	
Module 4	**18 Hours**
Digital Modulation Techniques: Coherent Binary Modulation Techniques – PSK, FSK, Quadrature Amplitude Modulation. Noncoherent Binary Modulation Techniques, Continuous Phase Modulation and Minimum Shift Keying. Digital Modulation Tradeoffs. Optimum demodulation of digital signals over bandlimited channels- Maximum likelihood sequence detection (Viterbi receiver). Equalization techniques. Synchronization and Carrier Recovery for Digital modulation.	

Reference books	1. Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering", John Wiley, 1965. 2. Proakis J.G., ``Digital Communications", 4th Edition, McGraw Hill, 2000. 3. Simon Haykin, “Digital Communication Systems”, Wiley India Private Ltd.

Subject Code EC 354	**Communication Networks**	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	To enable students to understand layers of TCP/IP model, understand different protocols and their use in network design and implementation.	

Module 1	**9 Hours**
History of Computer Networking and the Internet, The Network Edge, The Network Core, Delay, Loss and Throughput in Packet Switched Networks. Protocol Layers and Their Service Models. Application Layer : Principles of Network Applications, The Web and HTTP, Electronics Mail in the Internet, DNS, Peer to Peer Applications.	
Module2	**13 Hours**
Transport Layer : Transport Layer Services, Multiplexing and Demultiplexing, Connectionless Transport, UDP, Principles of Reliable Data Transfer, Connection Oriented Transport : TCP, Principles of Congestion Control, TCP Congestion Control.	
Module 3	**12 Hours**
Network Layer: Virtual Circuit and Datagram Networks, Router Architecture, IP Protocol : Forwarding and Addressing in the Internet, Routing Algorithms: Link State Algorithm, Distance Vector Algorithm, Routing in the Internet, Broadcast and Multicast Routing.	
Module 4	**13 Hours**
Link Layer : Introduction and Services, Error Detection and Correction Techniques, Multiple Access Protocols(ALOHA, Slotted ALOHA, CSMA/CA,CSMA/CD), Link Layer Addressing, Ethernet, Link Layer Switches, PPP, Wireless networks : 802.11 Wireless LANs, Physical layer : Access Networks and Physical Media.	
Module 5	**9 Hours**
Multiplexing : Performance Measures and Engineering Issues, Stream Sessions In a Packet Network : Delay Guarantees, Quality of Service (QoS) Objectives in Networks, Stream Sessions : Deterministic Network Analysis, Weighted Fair Queueing, RSVP.	

Reference books	1. Kurose/Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Addison-Wesley, 3rd Edition, 2005. 2. Anurag Kumar, D Manjunath, Joy Kuri, "Communication Networking : An Analytical Approach", Morgan Kauffman Publishers (An imprint of elsevier)

	3. Dimitri Bertsekas, Robert Gallager, "Data Networks" (2nd edition), Prentice Hall. 4. Peterson, Davie, "Computer Networks : A Systems Approach", 5th Edition, Morgan Kaufmann Publishers.

Subject Code **EC355**	**Linear Integrated Circuits Laboratory**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To provide experience on design and analysis of various electronic circuits using op-amp and other linear IC's	
List of Experiments		
Experiment No. 1 Analysis of Inverting and non-Inverting amplifiers, **Experiment No. 2** Integrators and Differentiators - AC analysis, Transient analysis **Experiment No. 3** Negative Resistance Realization **Experiment No. 4** Design and Implementation of Comparators, Zero crossing Detector **Experiment No. 5** Design of Inverting and Non-Inverting Schmitt trigger. **Experiment No. 6** Single op-amp second order LFF and HPF - Sallen-Key configuration. **Experiment No. 7** Instrumentation amplifier-gain, CMRR & input impedance **Experiment No. 8** Astable and Monostable Multivibrators using IC 555 **Experiment No. 9** Design of regulated power supply **Experiment No. 10** Mini-Project		

Subject Code EC 356	**Digital Communication Laboratory**	Credits: 2 (0-0-3) Total hours: 45
Course Objectives	To introduce student to the experiments which demonstrate the theory learnt in the EC301 Digital Communication course so that they know how to design and implement important components used in Analog communication systems.	
List of Experiments		

Experiment No. 1

Pulse code modulation and demodulation : PCM, Adaptive PCM, Differential PCM

Experiment No. 2

Companded PCM A Law and mu law

Experiment No. 3

Delta modulation and demodulation, slope overload distortion and granular noise

Experiment No. 4

Manchester encoder and timing recovery

Experiment No. 5

Sampling And Reconstruction

Experiment No. 6

ASK Modulation and Demodulation

Experiment No. 7

FSK Modulation and demodulation: Hardware Implementation

Experiment No. 8

BPSK Modem: Simulation and Error probability evaluation

Experiment No. 9

BPSK generation and detection: Hardware Implementation

Experiment No. 10

QPSK generation and detection.

Fourth Year Course Contents

Subject Code EC401	VLSI Circuit Design	Credits: 3(3-0-0) Total hours: 45
Course Prerequisites	Analog Electronics and Digital Electronics	
Course Objectives	• To introduce the basic concepts of CMOS VLSI design, Simulation, Layout preparation. • To introduce the various steps in IC fabrication, starting from the raw material to the finished product and to understand the physical principles involved in these processes.	

Module 1	**Hours 08**
A Historical Perspective: Issues in Digital Integrated Circuit Design, Quality Metrics of a Digital Design, Overview of VLSI Design flow. Performance of CMOS Inverter: The Static CMOS Inverter, Evaluating the Robustness of the CMOS Inverter, The Static Behaviour, The Dynamic Behaviour, Power, Energy, and Energy-Delay, Technology Scaling and its Impact on the Inverter Metrics,	
Module2	**Hours 14**
Designing Combinational logic gates in CMOS: Static CMOS Design, Ratioed Logic, Pass-Transistor Logic, Dynamic CMOS Design, Designing Logic for Reduced Supply Voltages, Stick diagrams. Designing Sequential Logic Circuits: Static Latches and Registers, Dynamic Latches and Registers, Alternative Register Styles, An approach to optimize Sequential Circuits, Stick diagrams, layout editors (Magic/Micro Wind) and Circuit extraction.	
Module 3	**Hours 13**
Cell Based Design: Standard cells and Data path cells, Logic and Arithmetic Circuits – Adders, Ripple carry, Carry look ahead Adder and other high Speed Adders; Array and Tree multipliers, Logarithmic and Barrel Shifters, 6-Transistor SRAM and DRAM cell design. Driving large Capacitive loads: Wire Delay models, Lumped, RC and Distributed RC models, Delay Calculation with Distributed Circuit Elements, Latch up and its prevention, Input and Output circuits, Electro –Static Discharge (ESD) protection, Power Supply Noise, Supply Voltage scaling and its effect on circuit parameters, Scaling and Short Channel effects.	
Module 4	**Hours 10**
Wafer Processing: Wafer Preparation, Oxidation, Diffusion, Ion Implantation, Etching-Wet, Plasma and Ion etching; Epitaxial Growth - Molecular Beam Epitaxy; Optical lithography- Optical Exposures; Photoresists –Types of Photoresists, Positive and Negative PR.	

Reference books	1. Jan M. Rabaey, "Digital Integrated Circuits- A Design Perspective", Prentice Hall, Second Edition, 2005 2. Sung –Mo Kang & Yusuf Leblebici, "CMOS Digital Integrated Circuits- Analysis & Designing", MGH, Third Ed., 2003 3. John P Uyemura, "Introduction to VLSI Circuits and Systems", Wiley India, 2006 4. S K Gandhi, "VLSI Fabrication Principle", John Wiley.

Subject Code HS 400	**Management**	**Credits: 3 Total hours: 45**
Course Outcome	Develops the ability to understand and analyse the broad aspect of management and its financial dynamism	
Module 1	**Principles of Accounting**	5 hours
Accounting Cycle, Assumptions, Classifications of Accounts- Journal, Cash Book, Ledger, Final Accounts- Manufacturing Account, Trading Account, P & L Account, Balance Sheet.		
Module 2	**Financial Statement Analysis**	5 hours
Balance sheet, Profit and Loss Account, Economic vs Accounting Profit, Changes in Financial Position, Funds flow and cash flow statement.		
Module 3	**Ratio Analysis**	6 hours
Nature of Ratio Analysis, Liquidity Ratio, Leverage Ratio, Activity Ratio, Profitability Ratio, DuPont Analysis, Comparative statement and Trend Analysis, Inter-firm Analysis.		
Module 4	**Working Capital**	6 hours
Concept of working Capital, Operating and Cash conversion Cycle, Permanent and Variable working Capital, Balance working capital position and Issues.		
Module 5	**Time Value of Money**	5 hours
Time preference for money, Future value, Annuity, Perpetuity, Sinking fund factor, Present value, Annuity, Perpetuity, capital recovery factor, Multiple period Compounding.		
Module 6	**Capital Budgeting**	8 hours
Nature and type of Investment decision, Net Present value, (NPV), Internal Rate of Return (IRR), Payback period, Profitability Index, Nature and Behavior of Cost, Breakeven point, multiple products analysis, decision points.		
Module 7	**Financial System**	6 hours
Introduction to Indian Financial System, Financial Institutions and Financial Markets.		
Module 8	**Industrial Engineering & Project Management**	4 hours
Work Study, Time Study, Industrial Psychology, Project Management (PERT, CPM)		
Text Books	I.M Pandey, *Financial Management*, 10th edition, Vikish Publication Brealey Y Myers, *Principles of Corporate Finance*, McGraw-Hill Rajiv and Anil: *Financial Management*, 2nd Edition, Oxford University Press L.M Bhole: *Financial Institutions and Markets*, Tata McGrow-hill	

Subject Code EC 402	**Information Theory and Coding**	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	To enable students to analyze fundamental parameters of information theory, to explain source and channel coding and to find capacity for simple channels.	

Module 1	**9 Hours**
Introduction to Communication Systems and Information Theory: Introduction, Source Models and Source Coding, Channel Models and Channel Coding.A Measure of Information, Discrete Probability Review, Definition of Mutual Information and Entropy, Average Mutual Information and Entropy, Probability and Mutual Information for Continuous Ensembles.	
Module2	**8 Hours**
Conditional Entropy, Relative Entropy, Relations between them, Chain rules of Entropy, Convex Functions, Jensen's Inequality, Log Sum Inequality, Data Processing Inequality, Differential Entropy.	
Module 3	**15 Hours**
Coding for Discrete Source: Fixed Length Codes, Asymptotic Equipartition Property (AEP),Typical Set, Variable Length Codes, Prefix Codes, Uniquely Decodable Codes, Kraft Inequality, A Source Coding Theorem, An Optimum Variable Length Encoding Procedure, Huffman Codes, Lempel-Ziv Coding.	
Module 4	**15 Hours**
Discrete Memoryless Channels and Capacity: Classification of Channels, Discrete Memoryless Channels, Fano's Inequality, Channel Coding Theorem and the converse, Examples of Channel Capacity : Noiseless Binary Channel, Noisy Channel with Overlapping Outputs, Noisy typewriter, Binary Symmetric Channel, Binary Erasure Channel, Symmetric Channels, Jointly Typical Sequences.	
Module 5	**9 Hours**
Channel Coding : Introduction, Error detection and correction, Review of Vector Space, properties, Linear block codes- Construction and decoding, Standard Array decoding, Distance properties, Hamming Code, Convolution Codes.	

Reference books	1. Thomas Cover and Joy Thomas, "Elements of Information Theory", John Wiley, Second Edition. 2. R. G. Gallager, "Information Theory and Reliable Communication", Addison Wesley, 1987. 3. Shu Lin and Daniel J. Costello Jr., Error Control Coding: Fundamentals and Applications, Prentice Hall, 2003 4. Blahut R. E, Theory and Practice of Error Control Codes, Addison Wesley, 1983.

Subject Code EC403	VLSI Design Laboratory	Credits: 2(0-0-3) Total hours: 45
Course Objectives	To provide the practical knowledge of designing the VLSI circuit and layout using any of CAD tools like Spice/ MAGIC/ MIRCOWIND/Cadence.	
List of Experiments		

Experiment No. 1

P,N,CMOS - ID-VDS Characteristics – extraction of VT and body effect factor

Experiment No. 2

DC transfer characteristics of a CMOS inverter

Experiment No. 3

Design, Simulation and layout of CMOS NAND, NOR, XOR, XNOR

Experiment No. 4

Design, Simulation and layout of AND, OR, NOT

Experiment No. 5

Design, Simulation and layout of basic digital blocks such as Adder, Subtractor, Decoder, Mux etc

Subject Code EC404	**Electronic Instrumentation**	Credits: 3(3-0-0) Total hours: 45
Course Objectives	To understand the basic principles of instruments and measurements and various practical issues related to measurement.	

Module 1	**Hours 12**
Measurements and Measurement Systems; Characteristics of Instruments and Measurement System- Static Characteristics and Dynamic Characteristics; Errors in measurement, Classification and working of Transducers, Strain Gauges, Thermistors, LVDT.	
Module2	**Hours 10**
Electronic Instruments: Electronic Voltmeters, Electronic Multimeters, Signal Analysers - Wave Analysers, Harmonic Distortion Analysers, Spectrum Analysers.	
Module 3	**Hours 11**
Cathode Ray Oscilloscope: Cathode Ray Tube, Electrostatic Deflection, Measurement of Voltages and Currents, Measurement of Phase and Frequency, Sampling Oscilloscopes, Storage Oscilloscopes.	
Module 4	**Hours 12**
Biomedical Instrumentation: Bio-potential, ECG, Blood Pressure Measuring Instruments, Blood Flow Measurement,Electromayograph (EMG),Spirometer.	

Reference books	1. A.K.Sawhney, "Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai & Co. 2. Albert D. Helfrick, William D. Cooper, "Modern Electronic instrumentation and Measurement Techniques", PHI 3. Cromwell, Weibell, Pfeiffer , "Biomedical Instrumentation and Measurements", PHI.

Subject Code EC405	**Digital System Design**	Credits: 3(3-0-0) Total hours: 45
Course Objectives	• After learning this subject students must be able to Simulate and Implement typical Combinational and Sequential Digital Systems using VHDL. • To impart the basic idea of Memory & System organisation and Architecture of Computers.	
Module 1		**Hours 10**
Asynchronous Sequential Circuits: Asynchronous behaviour, Analysis of Asynchronous Circuits, Synthesis of Asynchronous Circuits, Race Condition, State reduction, State Assignment, Transition Diagrams, State Assignment using Additional State Variables.		
Module2		**Hours 12**
System Designing using VHDL: Behavioural, Data Flow and Structural Descriptions Identifiers, Data objects, Data types and Attributes, Delay models, Delta Delays, VHDL codes for Simple Combinational and Sequential Circuits, State Machine Design, Examples.		
Module 3		**Hours 11**
Design with Programmable Devices: Programmable Logic Arrays, Programmable Array Logic, Combinational PLDs (Eg: PAL14L4 &PAL12H6), Sequential PLDs (Eg: PAL16R4), Simple PLDs (Eg: 22V10), Complex Programmable Logic Devices (Eg: XC9500), Field Programmable Gate Arrays (FPGA) (Eg: XC 4000 & FLEX 10K).		
Module 4		**Hours 12**
Digital System Testing: Fault models, Fault Equivalence, Fault Location, Fault Dominance, Single and Multiple Stuck Faults, Testing for Single Stuck-at Faults, Design for Testability, Testing Combinational Logic and Sequential Logic, Scan Testing, Boundary Scan, Built –In- Self-Test(BIST).		
Reference books	1. C.H. Roth, "Digital system design using VHDL", PWS Publishing, 1998. 2. J. Bhasker, "A VHDL Synthesis Primer", B.S. Publications, 2001.	

Subject Code EC406	**Computer Architecture and Organization**	Credits: 3(3-0-0) Total hours: 45
Course Prerequisites	Digital Electronics	
Course Objectives	• To understand and Implement the Basic Architecture of Computers.	

Module 1	**Hours 09**
Basic Structure of Computers: Basic functional units , Bus structure, Software, Instruction set, CISC and RISC Machine Instructions and Programs, Numbers, Arithmetic operations and characters, Memory Locations and Address, Addressing Modes.	
Module2	**Hours 12**
Datapath Design: Fixed point Arithmetic, Arithmetic-Logic Units (ALU), Floating point Arithmetic and Pipelining. Control Design: Basic Concepts, Hardwired control, Microprogrammed Control, Pipeline Control, Superscalar processing.	
Module 3	**Hours 12**
Memory Organisation: Memory Hierarchy, Main Memory, RAM and ROM, Memory Address Map, Memory Connection to CPU, Hardware Organization, Read-Write Operation, Cache Memory, Associative Mapping, Direct Mapping, Set Associative Mapping, Virtual Memory , Address Space and Memory Space, Address Mapping Using Pages.	
Module 4	**Hours 10**
ARM Instruction sets: Register, Memory Access and Data Transfer, Arithmetic and Logic Instruction, Branch Instructions, Assembly languages, I/O operations, Subroutine, Program Examples.	

Reference books	1. John P Hayes, " Computer Architecture and Organization", (Third Edition) MCGraw Hill. 2. Carl Hamacher, Zvonkovranesic, Safat Z., "Computer Organization", McGraw-Hill.

Subject Code EC 407	**Advanced Digital Signal Processing**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	The students will be able to appreciate advance techniques of signal processing in very specific areas and apply this to variety of applications and also appreciate the current literature.	
Module 1		**1 hours**
Motivation and Review of fundamental of DSP		
Module 2		**10 hours**
Multirate Digital Signal Processing : Rate convertor and their time and frequency domain characterization, decimator and interpolator, Noble identities, Rational Sampling rate convertor, multistage design of Decimator and Interpolator, polyphase decomposition and applications, Interpolation and splines, Nyquist filters and application, Applications of mutirate systems.		
Module 3		**12 hours**
Filter Bank and Wavelets: Analysis and Synthesis filter bank, Uniform Filter Bank and efficient implementation, Two Channel filter bank, Quadrature Mirror Filter Bank, Perfect Reconstruction Filter Bank – Aliasing, Multiresolution Analysis and Filter Bank, Dyadic Wavelet, Orthinormal and Biorthogonal Wavelets Design and their properties, Application to subband coding and communication.		
Module 4		**12 hours**
Nonparametric Power Estimation : Spectrum Analysis of Deterministic Signals; Estimation of the autocorrelation of the stationary random signals; Estimation of Power Spectrum of Stationary Random Signals; Joint Signal Analysis; Multitapper Power Spectrum Estimation.		
Module 5		**10 hours**
Signal Modelling and Parametric Spectral Estimation :The modelling Process: theory and Practice; Estimation of All-pole Models; Estimation of Pole-Zero Models; Application: Spectral Estimation, Speech Modeling; Minimum Variance Spectrum Estimation; Harmonic Models and Frequency Estimation Techniques: Harmonic Models, Pisarenko Harmonic Decomposition, MUSIC algorithm, Minimum –Norm Method, ESPRIT Algorithm		
Reference books	1. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall,1993 2. Stephane Mallat, "A Wavelet Tour of Signal Processing : The Sparse Way", Academic Press, 2008 3. D. Manolakis, V Ingale, S Kogon, "Statistical and Adaptive Signal Processing",Artech House, 2005.	

Subject Code EC 408	**Statistical Signal Processing**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	The students will be able to appreciate advance techniques in signal processing in a non deterministic setting and apply this to variety of applications and also appreciate the current literature.	

Module 1	**6 hours**
Review of digital signal processing, representation of Narrow band signals, correlation analysis and spectral density, minimum phase and system invertibility, spectral factorization, lattice filter realization.	
Module2	**12 hours**
Statistical characterization and analysis of signals:Discrete time stochastic processes, Second Order statistics, Stationarity, Ergodicity, Frequency domain description of stationary processes: autocorrelation, power spectral density, white noise; Linear Systems with Stationarity random inputs and cross power spectral density; Innovation Representation – Eigen Decomposition, K-L transform.	
Module 3	**4 hours**
Linear Signal Models:Linear Non Parametric and parametric models, Mixed processes and the Wold Decomposition ; All-Pole Models : Model Properties, All-pole modelling and Linear Prediction, AR Models, Lower Order Models; All-Zero Models: Model properties, MA Models, Low order Models; Pole-Zero Models: Model Properties, Autoregressive Moving-Average Models, The First -Order Pole-Zero Model 1	
Module 4	**9 hours**
optimal linear filtering:Optimum signal estimation, Linear Mean Square Estimation – Error performance measure, Linear MMSE Estimator, Principal Component Analysis of the optimum Linear Estimator, Geometric Interpretation and Principle of Orthogonality, Optimum FIR and IIR Filter design and properties and application to filtering to additive noise, Linear Prediction.	
Module 5	**6 hours**
The principle of least squares, Linear Least-Squares Error Estimation, Least Square filtering, Least squares Signal Estimation, Least Square computations using SVD**.**	
Module 6	**6 hours**
Principle and Typical Applications (Echo cancellation, Linear Predictive coding, Noise Cancellation), Stability and Steady-State Performance of Adaptive filters; Methods of Steepest descent; Least-Mean-Square Adaptive Filters – stability and steady state in Stationary Signal Operating Environment (SOE), RLS Algorithm.	
Module 7	**2 hours**

Fundamentals of Array processing and Beam forming.	
Reference books	(1) D. Manolakis, V Ingale, S Kogon, "Statistical and Adaptive Signal Processing",Artech House, 2005. (2) S. Haykin, Adaptive Filter Theory, Pearson, 2002

Subject Code EC 409	**DSP Algorithm and Architecture**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	The students will be able to optimally implement given algorithm on a DSP programmable hardware and will be able to choose a DSP for given application..	
Module 1		**6 hours**
Introduction to Digital Signal Prcessing System: Important DSP Algorithms; Representation of DSP algorithms - block diagram, signal flow graph, data flow graph, dependence graph; DSP Hardware; DSP System Design; Introduction to DSP development Tool.		
Module2		**3 hours**
Numeric Representation and Arithmetic Operation: Fixed point and floating point representations; Extended precision; Floating point emulation; Q notation; Fixed point and floating point arithmetic operations.		
Module 3		**12 hours**
Architecture of Programmable Digital Signal Processors: Central processing unit- Data and program memory features; Peripheral interfacing; Instruction set; Execution control. Assembly and C Language Programming.		
Module 4		**9 hours**
Digital signal Processor specific Assembly language programming Instruction types; Addressing modes. Assembly language programming for specific fixed / floating points DSP processor; Pipelining.		
Module 5		**4 hours**
DSP Algorithms: Algorithmic Considerations; Convolution; FIR and IIR systems and FFT; Methods for generation of elementary functions; Pseudo-random number generation.		
Module 6		**12 hours**
Analysis and Optimization of DSP Algorithms and Systems: Loop bound and iteration bound; Retiming transformation; Unfolding transformation from data flow graph- folding transformation; Fast Convolution; Optimization using pipelining and / or parallel processing; Power estimation; Software optimization techniques for low power.		
Reference books	(1) Digital Signal Processsors: Architectures, Implementations and Applications, S.M. Kuo and and W S Gan, Pearson Prentice Hall, Second Edition, 2006.. (2) VLSI Digital Signal Processing Systems – Design and Implementation, Keshab K. Parhi, A Wiley InterScience Publication. (3) DSP Programmable Processor User Manual of Specific Processor	

Subject Code EC 410	**Speech And Audio Processing**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	After attending this course they will have sound understanding of speech production and representation. They can apply this knowledge to advanced techniques for implementation and research.	

Module 1	**12 hours**
Speech Production, Speech Perception: Human hearing, auditory psychophysics, just noticeable difference, pitch perception, masking, models of speech perception. Speech Analysis: Time domain and frequency domain analysis of speech, parameter estimation, Introduction to Speech Synthesis and Speech Recognition	
Module2	**9 hours**
Audio Signal Processing: Brief overview on sampling and quantization, Discrete Fourier transform, Filter Bank: Perfect reconstruction and Quadrature mirror filter, Wavelet transform, Modified discrete cosine transform, Stereo processing, Linear prediction (LP), Auditory filters, Auditory masking, Perceptual auditory models (Johnston's model, MPEG models), Spectral band replication, Temporal noise shaping.	
Module 3	**9 hours**
Speech Compression Scalar and Vector quantization, Lossless coding, Waveform and parametric coding, Vocoders, Linear Predictive coders, Analysis by Synthesis and Code excited LP codec, Adaptive multi-rate (AMR).	
Module 4	**12 hours**
Audio Coding and Standard Perceptual audio coders, MPEG-1, MPEG-2, MPEG-4, Dolby AC, Sony, AMR-WB, Generic coding.	
Module 5	**3 hours**
Evaluation of Audio and Speech coders: Objective and Subjective evaluation techniques (PESQ, PEAQ; MOS, MUSHRA) and Standardization (ITU).	

Reference books	1. Douglas O'Shaughnessy, Speech Communication, Human and Machine, IEEE Press, 1999 2. Fundamentals of Speech Recogniotion, Lawrence Rabiner, B H Juang, Second Indian Reprint, Pearson Education, 2005. 3. A. Spanias, Ted Painter, V Atti, Audio Signal Processing and Coding, Wiley, 2007

Subject Code EC 411	**Image And Video Processing**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	After attending this course they can apply different image and video processing application for representation, filtering, compression in various domains and would be able to undertake advanced techniques for implementation and research. They will also be in position to explore the multimedia standards in detail.	
Module 1		**2 hours**
Introduction Representation of digital images and video; Need for compression, Human Visual System, Redundancy – statistical and psycho visual; Basic image compression system; Video coder encoder.		
Module2		**5 hours**
Lossless Image Compression Image Compression; Elements of Source Coding; Huffman Coding; Arithmetic Coding; Arithmetic and Lempel-Ziev Coding; Estimation of Source Probability.		
Module 3		**9 hours**
2D transform and Wavelets Two – Dimensional Orthogonal and Unitary Transforms; Two-Dimensional Discrete Fourier Transform (DFT); Discrete Cosine and Sine Transform; Hadamard Transform; KL Transform; Wavelet Transform. Fast Algorithm for DCT and Wavelet Transform.		
Module 4		**12 hours**
Lossy Image Compression Quantization process and artifacts; Delta Modulation and DPCM; Transform Coding based on KL Transform, Discrete Cosine Transform; Embedded Wavelet Coding – Zerotree Coding, SPIHT algorithm, EBCOT algorithm; Image compression standard – JBIG and JPEG, JPEG 2000 - Architecture, Features, Region of Interest Coding, Error Resiliency.		
Module 5		**17 hours**
Digital Video Coding Methods and Standards Video Formats and Quality; Video CODEC; Temporal Model – Motion, Block based Motion Estimation and Compensation, sub-pixel Motion Compensation; Image Model – Predictive Coding, Transform Coding, Quantization, Reordering and Zero Encoding; MPEG-4 and H.264 video coding standards; High Efficiency Video Coding; Design and Performance issues.		
Reference books	1. V. Bhaskaran and K. Konstantinides, "Image and Video Compression Standards: Algorithms and Architecture," Kluwer, 1997. 2. Iain E. Richardson, "H.264 Advanced Video Compression Standard", Second Edition. 3. High Efficiency Video Coding – Literature will be provided.	

Subject Code EC 412	**Biomedical Signal Processing**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	Different theoretical measures of biomedical signals and an understanding of the information these measures provide regarding the sources of signals and the behaviors of their sources in response to natural or imposed perturbations. After attending this course students will have appreciation of the biological signals and their origin. They will understand the signal processing tool to model, analyze and validate.	
Module 1		**9 hours**
Introduction to human body and biomedical signals; Action potential, ECG, EEG and EMG signals, their origin and applications in medical diagnosis. Motivation for treating Real – world biomedical signals using stochastic approach.		
Module2		**6 hours**
Review of Digital Signal Processing		
Module 3		**9 hours**
Classical Spectral Estimation Techniques Discrete Fourier transform and FFT algorithms; The Periodogram; The Blackman – Tukey Spectral Estimation: Applications to Doppler Signals, Auditory Evoked Potentials (AEPs) and Heart Rate Variability; Cepstrum Analysis: Power Cepstrum and Complex Cepstrum; Application to Analysis of ECG signals, Diastolic Heart Sound.		
Module 4		**12 hours**
Adaptive Filters Principle of Adaptive Noise Cancelling; Adaptive Noise Cancellation with LMS and RLS Adaption Algorithm; Application to ECG Monitoring, Enhance Fetal ECG Monitoring and Enhance Electrogastric Mesurements; Adaptive Line Enhancer and its application to Diastolic Heart Sounds; Adaptive Zero-Tracking Methods and applications for detecting Epileptic Patients, detecting Multiple Sclerosis Patients.		
Module 5		**9 hours**
Parametric Modeling Methods Autoregressive (AR) Methods and Linear Prediction; Yule-Walker Method; Adaptive AR method; Application to modelling of ECG signals, Knee Vibration Signals, Fetal Breathing Movement, Arterial Blood Pressure, EEG modelling during Neurosurgical Operations, Surface EMG, Heart Rate Variability, Lung Sound; The Autoregressive Moving Average (ARMA) method and their applications to modelling of Somatosensory Evoked Potentials, Modeling of Diastolic Heart Sounds and Modelling of Cutaneous Electrogastric Signals.		
Reference books	1. Metin Akay, "Biomedical Signal Processing", Academic Press 1994 2. L. Cromwell, F. Weibell, E. A. Pfiffer "Biomedical Instrument and Measurement", Prentice Hall, 1980.	

Subject Code EC 413	**Error Control Coding**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To enable students to understand and use appropriately different error control techniques.	

Module 1	**13 Hours**
Coding for Reliable Digital Transmission and Storage: Types of Codes, Modulation and Coding, Maximum Likelihood Decoding, Types of Errors, Error Control Strategies, Performance Measures. Introduction to Algebra : Groups, Fields, Binary Field Arithmetic, Construction of Galois Field GF(2^m), Basic Properties of Galois Field GF(2^m), Vector Spaces, Matrices.	
Module2	**9 Hours**
Linear Block Codes : Introduction, Syndrome and Error Detection, The Minimum Distance of a Block Code, Error Detecting and Error Correcting Capabilities of a Block Code, Standard Array and Syndrome Decoding, Probability of an Undetected Error for Linear Codes over a BSC. Hamming Codes, Reed Muller Codes, Golay Code.	
Module 3	**10 Hours**
Cyclic Codes : Generator and Parity Check Matrices of Cyclic Codes, Encoding and Decoding of Cyclic Codes, Syndrome Computation and Error Detection. BCH Codes : Binary Primitive BCH Codes, Decoding of BCH Codes, Iterative Algorithms, Corrections of Errors and Erasures.	
Module 4	**13 Hours**
Reed Solomon Codes, Convolutional codes, Decoding algorithms for Convolutional codes, Viterbi, Trellis coded modulation, Introduction to Space-Time codes and modern coding concepts (soft decision decoding algorithms, iterative decoding algorithms).	

Reference books	1. Shu Lin and Daniel J. Costello Jr., "Error Control Coding: Fundamentals and Applications", Prentice Hall, 2003. 2. S. B Wicker, "Error Control Systems for Digital Communication and Storage", Prentice Hall, 1995. 3. Blahut R. E, "Theory and Practice of Error Control Codes", Addison Wesley, 1983. 4. Blahut R.E., "Algebraic codes for Data transmission", Cambridge University Press, 2003

Subject Code EC 414	**Spread Spectrum Communication**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To enable students to understand different spread spectrum techniques and their commercial applications.	

Module 1	**14 Hours**

Revision of Basic Digital Communications Concept : Detection of Binary Signals in Additive White Gaussian Noise, Coherent and Non-coherent Modulation Schemes,

Introduction to Spread Spectrum Systems: Introduction, Pulse Noise Jamming, Low Probability of Detection, Direct Sequence Spread Spectrum, Frequency Hop Spread Spectrum, Hybrid Direct Sequence/ Frequency Hop Spread Spectrum.

Module2	**12 Hours**

Binary Shift Register Sequences for Spread Spectrum Systems : Definitions, Mathematical Background and Sequence Generator Fundamentals, Maximum Length Sequences, Gold Codes, Nonlinear Code Generators.

Code Tracking Loops: Optimum Tracking of Wideband Signals, Baseband Delay Lock Tracking Loop, Code Tracking Loops for Frequency Hop Systems.

Module 3	**11 Hours**

Synchronization: Initial Synchronization of the Receiver Spreading Code, The Optimum Synchronizer, Serial Search Synchronization Techniques, Generalized Analysis of Average Synchronization Time.

Jamming : Performance of Spread Spectrum Systems in Jamming Environments, Performance in AWGN or Barrage Noise Jamming.

Module 4	**8 Hours**

Code Division Multiple Access Systems: Cellular Radio Concept, CDMA Digital Cellular Systems, IS 95.

Reference books

1. R.L. Peterson, "Introduction to Spread spectrum Communication", PH, 1995.
2. B.Sklar, "Digital Communications", Pearson Education, 2001.
3. M.K.Simon, "Spread spectrum communications", Handbook, McGraw-Hill, 2001.
4. J.S.Lee, "CDMA Systems Engineering handbook", Artech House, 1998.

Subject Code EC 415	**Optical Communication**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	The objective is to understand concepts related to optical components, links and systems.	

Module 1	**14 Hours**

Motivation for Light wave Communications, Key Elements of Optical Fibre Systems, Standards for Optical Fibre Communication.

Optical Fibres (Structures, Wave guiding and Fabrication) : Fundamentals of Optical Laws and Definitions, Optical Fibre Modes and Configurations, Mode Theory for Circular Waveguides, Single Mode Fibres, Graded Index Fibre Structure. Signal Degradation in Optical Fibres, Attenuation, Losses, Dispersion and Group Delay, Pulse Broadening in GI Fibres.

Module2	**14 Hours**

Optical Sources: Direct and Indirect band gap materials, LED and Laser Diodes – Principle of Operation , Concepts of Line Width, Phase Noise, Switching and Modulation Characteristics

Optical Detectors : PN detector, pin detector, Avalanche photodiode – Principles of operation, concepts of responsivity, sensitivity and quantum efficiency, noise in detection, typical receiver configurations (high impedance and trans Impedance receivers).

Module 3	**9 Hours**

Optical Amplifiers: Basic Applications and Types of Optical Amplifiers, Semiconductor Optical Amplifiers, Erbium-Doped Fibre Amplifiers, Amplifier Noise, Optical SNR, Raman Amplifiers.

Module 4	**8 Hours**

Digital transmission system-point-to-point links, fibre splicing and connectors, link power budget, rise-time budget, noise effects on system performance, operational principals of WDM and SONET.

Reference books	1. Gerd Keiser, "Optical Fiber Communication", McGraw-Hill International, Singapore, 2000 A Selvarajan, S.Kar, Optical Communications, TMH, 2006 2. Leonid Kazovsky, Sergio Benedetto and Alan Willner, "Optical Fiber Communication Systems", Artech House, 1996. 3. G.P.Agrawal, "Nonlinear Fiber Optics", 3rd Ed; Academic Press, 2004. 4. G.P. Agrawal , "Fiber optic communication systems", 3rd Ed; Wiley-Interscience, 2002.

Subject Code EC 416	Ad Hoc and Sensor Networks	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To enable students to understand and to explain concepts of Ad hoc and Sensor Networks and network architectures, protocol.	
Module 1		**4 Hours**
Introduction to mobile ad hoc networks and wireless sensor networks concepts and architectures. Wireless LAN and PAN, IEEE 802.11 Standard, HIPERLAN, Bluetooth, Home-RF.		
Module2		**8 Hours**
Routing Protocols for ad-hoc Network :Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks. Classifications of Routing Protocols. Table-Driven Routing Protocols. On-Demand Routing Protocols. Hybrid Routing Protocols. Routing Protocols with Efficient Flooding Mechanisms. Hierarchical Routing Protocols. Power-Aware Routing Protocols.		
Module 3		**11 Hours**
MAC Protocols for Ad Hoc Wireless Networks: Issues in Designing a MAC Protocol for Ad Hoc Wireless Networks. Design Goals of a MAC Protocol for Ad Hoc Wireless Networks. Classifications of MAC Protocols. Contention-Based Protocols. Contention-Based Protocols with Reservation Mechanisms. Contention-Based MAC Protocols with Scheduling Mechanisms. MAC Protocols That Use Directional Antennas. Other MAC Protocols.		
Module 4		**12 Hours**
Transport Layer and Security Protocols for Ad Hoc Wireless Networks: Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks. Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks. Classification of Transport Layer Solutions. TCP Over Ad Hoc Wireless Networks. Other Transport Layer Protocols for Ad Hoc Wireless Networks. Security in Ad Hoc Wireless Networks. Network Security Requirements. Issues and Challenges in Security Provisioning. Network Security Attacks. Key Management. Secure Routing in Ad Hoc Wireless Networks.		
Module 5		**10 Hours**
Wireless sensor networks architecture: hardware and software components of a sensor node, OS for WSN, WSN MAC layer strategies; naming and addressing; Clock Synchronization; Node Localization; WSN Routing.		
Reference books	1. C Sivarama Murthy and B S Manoj, "Ad-Hoc Wireless Networks, Architectures and Protocols", PH, 2004. 2. Labiod. H, "Wireless Adhoc and Sensor Networks", Wiley, 2008. 3. Li, X, "Wireless ad -hoc and sensor Networks: theory and applications", Cambridge University Press,2008.	

Subject Code EC 417	**Antennasand Propagation**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To impart the basic concepts of radiating structures and their arrays. To give idea about basic propagation.	

Module 1	**12 Hours**

Antenna fundamentals and definitions: Types of Antennas, Radiation Mechanism Current distribution on thin wire antenna, Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector effective length, Friis Transmission equation, Antenna Temperature.

Module2	**11 Hours**

Radiation integrals and Auxiliary potential functions: Duality, Reciprocity and Reaction theorems, Inhomogeneous Wave Equation, Solution by potentials.

Linear Wire Antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, half wave dipole, Ground effects. Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non-uniform current.

Module 3	**12 Hours**

Array antennas: Linear Arrays, Two element array, N Element array, Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, Planar array, Design consideration;

Aperture Antennas, Horn Antennas, Micro strip Antennas, Reflector Antennas- Plane reflector, parabolic reflector, Cassegrain reflectors.

Module 4	**10 Hours**

Factors involved in the propagation of radio waves: The ground wave-Reflection of radio waves by the surface of the earth, Space Wave propagation, Considerations in Space Wave propagation-Atmospheric effects in space wave propagation, Ionosphere and its effects on radio waves, Mechanism of ionosphere propagation, Refraction and Reflection of sky waves by Ionosphere.

Reference books	1. C.A Balanis , Antenna Theory, John Wiley, 1996. 2. Electromagnetic waves & Radiating Systems– Jordan & Balman, Prentice Hall India.

Subject Code EC418	**Satellite Communication**	**Credits:(3-0-0) 3** **Total hours: 45**
Course Objectives	With this paper, the students should have thoroughly known about the principle of earth station, satellite link, communication satellites, satellite orbits and different types of channel accessing mechanisms.	
Module 1		11**hours**
Satellite orbits, Solar day and Sidereal day ,Orbital parameters, Satellite trajectory, Period, Velocity and Position of a satellite, Geostationary satellites, Non-geostationary constellations ,Launching of geostationary satellites, Hohmann transfer, Effect of earth's shape, Other heavenly bodies, Atmospheric drag and Radiation pressure on the satellite's orbit.		
Module 2		**10 hours**
Communication satellites, Spacecraft subsystems, Payload, Repeater, Antenna, Attitude and Control systems, Telemetry, Tracking and Command, Power sub system and Thermal control Earth stations, Antenna and feed systems, Satellite tracking system, Amplifiers, Fixed and Mobile satellite service earth stations.		
Module 3		**16 hours**
Communication link design, Frequency bands used, Antenna parameters, Transmission Equations, Noise considerations, Link design , Very Small Aperture Terminals (VSAT) - VSAT design issues.		
Module 4		**8 hours**
Multiple access techniques, Frequency division multiple access , Time division multiple access , Code division multiple access, Access protocols for data traffic Applicability of CDMA to commercial systems, Demand access in the INTELSAT, TDMA system, SPADE, the INMARSAT system, Earth station, Satellite television networks.		
Reference books	(1) Richharia M., "Satellite Communication Systems", Macmillan Press Ltd. (2) Ha T.T., "Digital Satellite Communication" (3)T. Pratt, "Satellite Communications".	

Subject Code EC419	**Microwave Engineering**	**Credits:(3-0-0) 3** **Total hours: 45**
Course Objectives	To give the basic ideas about the characteristics and applications of Microwave frequency bands To understand the working of various Microwave passive and active devices and Circuits.	
Module 1		10 H**ours**
Characteristic, Features and Applications of Microwaves, Scattering matrix representation of microwave networks, Properties of scattering matrices, Properties and S-matrices for typical network such as section of uniform transmission line, 3-port networks (reciprocal and nonreciprocal), T-junctions directional coupler, Magic tee, Ferrite devices, Isolator, Circulators.		
Module 2		**10 Hours**
Generation of microwaves by tubes, Limitations of conventional tubes, Klystron amplifiers - analysis, Reflex klystron oscillator-analysis, Magnetrons, Traveling wave tube (TWT), Backward wave oscillator (BWO)-basic principles, Millimeter wave tubes-introduction.		
Module 3		**11 Hours**
High frequency limitations of transistors, Microwave transistors, Varators, Manley Rowe relations, Parametric Amplifiers and frequency multipliers, Tunnel diodes, Gunn effect, Gunn Diode oscillators, Avalanche effect, IMPATT & TRAPATT diodes, PIN diodes and their applications, Schottky barrier and backward diodes.		
Module 4		**11 Hours**
Planer transmission lines such as Stripline, Microstrip line, Slotline, Technology of hybrid MICs, Monolithis MICs. Comparison of both MICs; VSWR Measurement, microwave power Measurement, Impedance measurement, Frequency measurement, Concept of microwave communication - repeaters.		
Reference books	1. Liao S.Y.,"Microwave devices and Circuits", Prentice Hall Of India, New Delhi, 3rd Ed. 2006 2. Collin. R.E, "Foundation of Microwave Engineering", IEEE Press, 2004	

Subject Code EC420	**Radar & Navigation Systems**	**Credits:(3-0-0) 3** **Total hours: 45**
Course Objectives	To give the basic ideas about the working of radar and navigation systems	

Module 1	**15 hours**
The nature of the radar, The Radar Equation, Frequency modulated CW Radar, multiple-frequency CW Radar, Moving-target-indication (MTI) Radar, Pulse-Doppler Radar, Tracking radar.	
Module 2	**15 hours**
Radar transmitters: Magnetron Oscillator, Klystron Amplifier, Traveling-wave-tube Amplifier Grid-controlled Tubes ; Radar Receivers: Super heterodyne Receiver, Receiver Noise, Detection of radar signals in noise, Extraction of information from radar signals. Clutter and noise suppression, Propagation characteristics over land and sea.	
Module 3	**15 hours**
Electronic counter measure, Hyperbola system of navigation, Instrument landing system, Microwave landing systems, Satellite navigation systems.	

Reference books	(1) M.I.Skolnik, "Introduction to Radar Systems", McGraw Hill, 1980 (2) D.K.Barton, "Modern radar systems analysis", Artech House, 1988. (3) B Edde, "Radar: Principles, Technology, Applications", Prentice Hall.

Subject Code EC 421	**Digital Image Processing**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	After attending this course they can apply different image processing application in various domains and would be able to undertake advanced techniques for implementation and research.	
Module 1		**3 hours**
Introduction and Motivation to Digital Image Processing; Human Visual System: Image formation in the eye; Light and electromagnetic spectra; Image Processing Application; Image capturing, Sampling and Quantization.		
Module2		**5 hours**
Image Enhancement in the Spatial Domain Intensity transformation, Histogram Processing: Equalization, Matching and use in local and Global Enhancement; Spatial Filtering- Filtering, Smoothening Filtering: Linear Filters, Order Statistics Filters; Sharpening Filtering: Using Gradient and Laplacian.		
Module 3		**6 hours**
Frequency Domain Filtering and Processing : Image Transformation, Discrete Fourier Transform, FFT, K-L Transform, Convolution, Correlation, 2D Sampling, Discrete Cosine Transform, Frequency domain filtering and filters and artifacts.		
Module 4		**5 hours**
Image Restoration : Degradation due to know noise models; Restoration due to known filtering: Mean filters, Order filters, Adaptive filters for noise removal, Restoration using frequency domain filtering; Model of Degradation: Estimating Degradation Function, Inverse Filtering, Mean Square Error (Wiener) Filtering, Constrained Least Square Filtering; Image Reconstruction from Projection.		
Module 5		**5 hours**
2D transform and Wavelets : Two – Dimensional Orthogonal and Unitary Transforms; Two-Dimensional Discrete Fourier Transform (DFT); Discrete Cosine and Sine Transform; Hadamard Transform; KL Transform and Wavelet Transform.		
Module 6		**3 hours**
Colour Image Processing : Colour Models: RGB Colour Model, HSI color Model; Pseudocolour Image Processing: Intensity Slicing, Gray level to colour transformation, Full colour image processing; Colour transformations.		
Module 7		**8 hours**
Image Compression: Statistical and Psychovisual Redundancy; Fidelity Criterion; Image compression Models; Source coding theorem; Lossless Compression: Variable-Length coding, LZW Coding, Bit-Plane Coding, Lossless Predictive Coding; Lossy Compression: Lossy Predictive Coding; Transform Coding and Wavelet Based Coding; Image Compression Standards: Binary Image Compression Standards, Continuous Tone Still Image Compression Standards.		

Module 8	**5 hours**
Morphological Image Processing Problems and Motivation; Basic Concepts from Set Theory; Basic Morphological Operation: Dilation and Erosion, Opening and Closing, The Hit-or-Miss Transformation; Morphological Algorithm: Boundary Extraction, Region Filling, Extraction of connected components, Convex Hull, Thinning, Thickening, Skeletons, Pruning; Extension to Gray Scale Images.	
Module 9	**5hours**
Image Segmentation Introduction to segmentation problem: discontinuity and similarity; Detection of Discontinuity; Edge Linking and Boundary Detection; Thresholding; Region Based Segmention; Segmentation by Morphological Operations (Watersheds); Colour Segmentation.	
Reference books	1. Gonzalez R. C. And Woods R. E., "Digital Image Processing", Second Edition, Pearson Education 2. Anil K. Jain, "Fundamentals of Digital Image Processing"

Subject Code EC 422	**Active Filters and Data Converters**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	• To understand the design and analysis of various active filters. • To develop skills to design various circuits using different data conversion systems.	

Module 1	**Hours 15**
First order Filters: Biliner Transfer functions and Frequency response. First order and second order function for low-pass, high-pass, band –pass, band-stop and all –pass filters. Sallen-key LPF and HPF. Active filters: Filter transfer function, Butterworth and Chebyshev filters response and pole locations. Inverse Chebyshev and Cauer Filter. Delay Filter.	
Module2	**Hours 15**
LC ladder filter –prototype & synthesis; Frequency transformation of low-pass filter. Ladder Simulations by Element Replacement, Impedance converters,.Gm-C filters: Elementary Transconductance Building blocks, Switched capacitor filters: First-order building blocks, Second order sections.	
Module 3	**Hours 15**
Digital-to- Analog Converter: General considerations, Static non-idealities and Dynamic non-idealities; Current-steering DAC – Binary weighted DAC, Thermometer DAC, Design issues, Effect of Mismatches. A/D converter : General considerations, static and dynamic non-Idealities. Flash ADC – Basic architecture, Design issues, Comparator and Latch, Effect of non-idealities, Interpolative and Folding architectures. Successive Approximation ADC; Pipeline ADC. Over sampling ADC – Noise shaping, Sigma-Delta modulator	

Reference books	1. M.E. Van Valkenburg, Analog Filter Design, Oxford University Press, 1995. 2. Behzad Razavi, Principles of Data Conversion System Design, Wiley-IEEE Press, 1995 3. Rudy J. van de Plassche, CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters,Springer, 2003

Subject Code EC 423	**Embedded Systems**	Credits: 3(3-0-0) Total hours: 45
Course Objectives	• To give ideas about Embedded Systems and System Development • To Impart knowledge about Real Time Operating Systems and Microcontrollers	
Module 1		**Hours 12**
Introduction to Embedded systems: Processor Embedded into a system, Embedded hardware Units and Devices in Systems, Embedded software, Examples, Embedded System on Chip (SOC) and VLSI Circuit Design Technology, Design Process, Classification of Embedded Systems, Skills required for an Embedded System Designer.		
Module2		**Hours 11**
8051 and Advanced Processor Architectures: Memory Organization and Real world Interfacing, Processor and Memory Organization, Instruction level Parallelism, Performance Matrix. Processor and Memory Selection, Devices and Communication Buses, IO Types, Serial Communication, Parallel Device Ports, Wireless Device, Real Time Clock, Networked Embedded System.		
Module 3		**Hours 10**
Real Time Operating Systems: OS Services, Process management, Timer and Event Functions, Memory Management, Device, File and I/O Subsystems Management, Interrupt routine and RTOs Environment, Basic Design using RTOs, Task Scheduling, Interrupt Latency, OS Security Issues.		
Module 4		**Hours 12**
Embedded Software Development Tools: Host and Target Machines, Linker/Locators for Embedded Software, Getting Embedded Software to the Target Systems, Debugging Techniques, Testing on your Host machines, Instruction set Simulators, Laboratory Tools.		
Reference books	1. David Simon, "An Embedded Software Primer", Addison Wesley, 2000. 2. Raj Kamal, "Embedded Systems: Architecture, Programing and Design", TMH.	

Subject Code EC 424	**Low-Power VLSI Circuit Design**	Credits: 3(3-0-0) Total hours: 45
Course Objectives	• To understand and design Low-power VLSI circuits for growing reliance on battery-powered portable computing and wireless communications products. • To understand the critical issue related to continued progress of high-performance and reliable microelectronic systems.	
Module 1		**Hours 10**
Introduction: Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits, Emerging Low power approaches. Device & Technology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.		
Module2		**Hours 12**
Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation. Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.		
Module 3		**Hours 11**
Low Power Circuit's: Transistor and gate sizing, network restructuring and Reorganization, Special Flip Flops & Latches design, high capacitance nodes, low power digital cells library. Logic level: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic.		
Module 4		**Hours 12**
Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components. Low power Clock Distribution: Power dissipation in clock distribution, Single driver Vs Distributed buffers, Zero skew Vs tolerable skew, chip & package co- design of clock network.		
Reference books	1. Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP, 2002 2. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley, 2000. 3. Rabaey, Pedram, "Low Power Design Methodologies" Kluwer Academic	

Subject Code EC 425	**Logic Synthesis and Optimization**	Credits: 3(3-0-0) Total hours: 45
Course Objectives	• To learn about state-of-the-art techniques and algorithms for synthesis and verification of digital systems. • To understand the high-level and architectural synthesis, decision and word-level diagrams, combinational logic optimization, and sequential optimization.	
Module 1		**Hours 12**
Introduction: Microelectronic design style, Design of Microelectronic circuits, Computer aided Synthesis and optimization. Background: Graphs, Graphs Optimization problems and Algorithms, Boolean Algebra and applications.		
Module2		**Hours 14**
Hardware Modelling: Hardware Modelling Languages, Abstract Models, Compilation and Behaviour Optimization. Two level Combinational level Optimization. Sequential Logic Optimization.		
Module 3		**Hours 11**
Architecture Level Synthesis and Optimization: Circuit Specification for Architecture Synthesis, Area and Performance Estimation, Data Path Synthesis and Control Path Synthesis.		
Module 4		**Hours 08**
Cell Library Binding: Problem Formulation and Analysis, Algorithms for Library Binding, Rule Based Library Binding.		
Reference books	1. Giovanni De Micheli, "Synthesis and Optimization of Digital Circuits", McGraw Hill, 1994. 2. S. Hassoun and T. Sasao, "Logic Synthesis and Verification", Kluwer Academic publishers, 2002. 3. Srinivas Devadas, Abhijith Ghosh and Kurt Keutzer, "Logic Synthesis", Kluwer Academic, 1998.	

Subject Code: **HU 401 & HU 402**	**Professional Communication-II and Language Lab**	**Credits: 4 (2-0-3)** **Total hours: 56**
Course Prerequisite	Knowledge of English	
Course Objectives	This course aims at Personality Development	
Course Outcome	At the end, the students should possess a Saleable Image with employability skills	
Module 1	**Principles of Soft Skills and Practice**	12 hours
Definition of Soft Skills and Personality, Attitude, Dress Code, Body Language, Individual and Group Behaviour, Personality Test, C.V Writing and the difference between CV & Resume		
Module 2	**Group Discussion, Extempore, JAM and Survey**	16 hours
Topics: Is Cloning Ethical, Shopping Mall vs Retailer, Should Animals be used for Drug-Test, Effects of Advertisement on Youth, Google vs Social Networking Sites, Newspaper is the thing of Past, Diversity in Indian Culture, Gender Discrimination, Who is Smarter: Human Beings or Computer and so on		
Module 3	**Interview**	14 hours
Types of Interview, Interview Ethics, Questions and Mock-Interview Sessions		
Module 4	**Business Presentation and Seminars**	14 hours
Business Presentation and Students' Seminar		
Texts:	1.W.B. Martin, *Ethics in Engineering* Tata McGraw Hill, India 2. Patnaik,Priyadarshi, *Group Discussion and Interview Skills*, New Delhi: CUP, (Video CD) 3..Downes, Colm, *Cambridge English for Job Hunting*,2009, New Delhi,CUP (2 Audio CDs)	
Reference	TV News (Headlines Today, ND TV and BBC), Chat-Shows on TV, Magazines like India Today, Outlook, The Week and English Dailies. Reader's Digest for Expressive Skill, English Films & English Comics	

Academic Hand Book

for

Bachelor of Technology Programme

in

Electrical & Electronics Engineering

National Institute of Technology Goa

Farmagudi, Ponda, Goa - 403 401

Semester-wise Credit Distribution

Semester	Total Credits
I	22
II	22
III	22
IV	21
V	22
VI	23
VII	20
VIII	18
Total Credits	**170**

I Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	MA100	Mathematics-I	4-0-0	4
2	PH100	Physics	3-0-0	3
3	ME100	Engineering Mechanics	3-0-0	3
4	CS100	Computer Programming and Problem solving	2-0-3	4
5	HU100	Professional Communication	2-0-2	3
6	ME101	Engineering Drawing	1-0-3	3
7	PH101	Physics Laboratory	0-0-3	2
		Total Credits		**22**

II Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	MA150	Mathematics-II	4-0-0	4
2	PH150	Material Science	3-0-0	3
3	CY150	Chemistry	3-0-0	3
4	ME150	Elements of Mechanical Engineering	2-0-0	2
5	EE151	Basic Electrical Science	3-0-0	3
6	ME151	Workshop Practices	0-0-3	2
7	CY151	Chemistry- Laboratory	0-0-3	2
8	EE152	Basic Electrical Science Lab	0-0-3	2
9	PE150	Physical Education	1-0-0	1
		Total Credits		**22**

III Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	MA200	Mathematics-III	3-0-0	3
2	EE200	Electromagnetic Theory	3-1-0	4
3	EE201	Analog Electronics	3-0-0	3
4	EE202	Circuit Theory	3-1-0	4
5	EE203	Electrical Measurements & Instrumentation	3-1-0	4
6	EE204	Circuit Theory Lab	0-0-3	2
7	EE205	Electrical Measurements and Instrumentation Lab	0-0-3	2
		Total Credits		**22**

IV Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	MA250	Numerical Methods (Maths 4)	3-0-0	3
2	EE250	Digital Electronics	3-0-0	3
3	EE251	Electrical Power Generation	3-0-0	3
4	EE252	Electrical Machines-I	3-1-0	4
5	HS250	Economics	3-0-0	3
6	EE253	Electrical Machines-I Lab	0-0-3	2
7	EE254	Analog and Digital Electronics Lab	0-0-3	2
8	VE200	Value Education	1-0-0	1
		TOTAL CREDITS		**21**

V Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	EE300	Electrical Power Transmission and Distribution	3-1-0	4
2	EE301	Electrical Machines-II	3-1-0	4
3	EE302	Control Systems	3-1-0	4
4	EE303	Microprocessors and Microcontrollers	3-0-0	3
5	EE304	Electrical Machines-II Lab	0-0-3	2
6	EE305	Microprocessors and Microcontrollers Lab	0-0-3	2
7	ES300	Environmental Studies	3-0-0	3
		TOTAL CREDITS		**22**

VI Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	EE350	Switchgear and Protection	3-1-0	4
2	EE351	Power System Analysis	3-1-0	4
3	EE352	Power Electronics	3-1-0	4
4	EE353	Integrated circuits	3-0-0	3
5	EE5**/HU501 and HU 502	Elective – 1	3-0-0	3
6	EE354	Electrical Simulation Lab	0-0-3	2
7	EE355	Control Systems Lab	0-0-3	2
8	EE356	Mini Project/Training		1
		TOTAL CREDITS		**23**

VII Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	EE400	Electrical Drives	3-0-0	3
2	HS400	Management	3-0-0	3
3	EE5**	Elective – 2	3-0-0	3
4	EE5**	Elective – 3	3-0-0	3
5	EE401	Power Electronics & Drives Lab	0-0-3	2
6	EE402	Seminar	3-0-0	2
7	EE403	Programme Major Project-I	0-0-4	4
		TOTAL CREDITS		**20**

VIII Semester Details

Sl. No	Sub. Code	Subjects	L-T- P	Credits
1	EE450	Power System Operation and Control	3-0-0	3
2	EE5**	Elective – 4	3-0-0	3
3	EE5**	Elective – 5	3-0-0	3
4	EE5**	Elective – 6	3-0-0	3
5	EE452	Programme Major Project-II	0-0-6	6
		TOTAL CREDITS		**18**

Subject Code **MA 200**	**Mathematics-III**	**Credits: 3 (3-0-0)** **Total hours 42**
Objectives	This Mathematics course provides requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists. Important topics of applied mathematics, namely complex analysis, power series solutions, fourier series and transforms and partial differential equations.	
Module 1	**Complex Analysis**	18 hours
Complex Numbers, geometric representation, powers and roots of complex numbers, Functions of a complex variable, Analytic functions, Cauchy-Riemann equations; elementary functions, Conformal mapping (for linear transformation); Contours and contour integration, Cauchy's theorem, Cauchy integral formula; Power Series and properties, Taylor series, Laurrent series, Zeros, singularities, poles, essential singularities, Residue theorem, Evaluation of real integrals and improper integrals.		
Module 2	**Power Series Solutions**	9 hours
Differential Equations Power Series Method - application to Legendre equation, Legendre Polynomials, Frobenious Method, Bessel equation, Properties of Bessel functions, Sturm- Liouville BVPs, Orthogonal functions.		
Module 3	**Partial Differential Equations**	15 hours
Introduction to PDE, basic concepts, second order PDE and classification, D'Alemberts formula and Duhamel's principle for one dimensional wave equation, Laplace's and Poisson's equations, Laplace, Wave, and Heat equations using separation of variables. Vibration of a circular membrane. Heat equation in the half space.		
Texts/References	4. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999). 5. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005). 6. R. V. Churchill and J. W. Brown, Complex variables and applications (7th Edition), McGraw-Hill (2003).	

Subject Code EE200	**Electromagnetic Theory**	**Credits: 4 (3-1-0)** **Total hours: 56**
Course Objective	To understand the concepts of coordinate systems and realize the electromagnetic fields, charges and currents. To calculate electromagnetic field distribution and impart knowledge on vector fields - electrostatic and magneto static fields, electrodynamics and electromagnetic waves.	
Module 1		**20 hours**
Introduction to Electric Fields: Coulomb's law and Electric Field Intensity, Electric Flux density, Gauss law, divergence theorem, definition of potential difference, potential gradient, dipole, Electric field intensity due to various forms of uniformly distributed charges, point charge, infinite line, circular ring, infinite plane sheet, dielectrics and capacitance, Poisson's law; Introduction to Steady Magnetic Fields: Charged particles in motion, Biot-Savart law, Ampere's Circuital law, curl, stokes theorem, Magnetic flux and Magnetic flux density due to infinite line, sheet carrying current, Scalar and vector Magnetic potentials, Lorentz force equation.		
Module 2		**12 hours**
Time varying fields and Maxwell's Equations: Faraday's law, displacement current, Maxwell's equations in point form, in integral form, in derivative form, EMF equation, Uniform plane waves in dielectrics and conductors, pointing theorem, skin effect.		
Module 3		**10 hours**
Transmission lines: Transmission Line Equations, Solutions to equations in phasor form, loss less and low-loss propagation, wave reflection at discontinuities, transmission lines of finite length, Smith chart.		
Module 4	**14 hours**	
Guided waves between parallel planes, Transverse electric and transverse magnetic waves and its characteristics, Linear Elliptical and Circular Polarization, Wave equations for conducting medium, Wave propagation in conductors and dielectric, Depth of penetration, Reflection and Refraction of plane waves by conductor and dielectric, Poynting Vector and flow of power.		
Reference books	1. William H. Hayt Jr., JA Buck, "Engineering Electromagnetics" MGH, 7th Edition, 2013. 2. Kraus, Fleisch, "Electromagnetics with Applications" MGH, 5th Edition, 2010. 3. Nannapaneni Narayan Rao, "Elements of Engineering Electromagnetics" Pearson, 6th Edition, 2006. 4. Karl E. Lonngren, Savov and RJ Jost, "Fundamentals of Electromagnetics with MATLAB" PHI, 2nd Edition, 2007.	

Subject Code EE201	**Analog Electronics**	Credits: 3(3-0-0) Total hours:42
Course Objectives	To develop the skill of analysis and design of various Analog circuit building blocks like Current Mirrors, Amplifiers, Differential Amplifiers using BJT and MOSFET. To understand the concept of Negative and Positive feedback.	

Module 1	**Hours 12**
Amplifiers:Introduction, Input and output impedance, Operating point analysis and design, Biasing schemes; Load line and Bias stability, Analyses and design of CC, CE and CB configurations; RC coupled and transformer coupled multistage Amplifiers; Thermal runaway in BJT Amplifiers. MOSFET Amplifier: Analysis and Design of Common Source, Common Drain and Common Gate Amplifier configurations – Thermal runaway in MOS Amplifiers.	
Module2	**Hours 12**
Cascode stages and Current Mirrors: MOS Current Mirrors, Types of Current Mirrors, Simple, Cascade type. Differential Amplifiers: MOS Differential pair, Small and Large Signal analysis, Common Mode Rejection, Differential pair with Active load. Power amplifiers:Push pull stage, Heat dissipation, Class A, B, AB, C, D, E& S Power Amplifiers - Harmonic distortion – Conversion efficiency and Relative performance.	
Module 3	**Hours 08**
Frequency response of Amplifiers: Hybrid π equivalent circuit of BJT, Low and High Frequency BJT/MOSFET Model, Miller effect.Noise in Amplifiers: Types of Noise, Noise representation, Noise in different circuits.	
Module 4	**Hours 10**
Feedback and Stability: Introduction to Negative feedback – Basic feedback concepts; Ideal Feedback Topologies - Voltage shunt, Voltage series, Current series and Current shunt Feedback Configurations; Loop gain – Stability of feedback circuit, Nyquist stability criterion, Phase and Gain margins; Oscillators : Basic principles of Oscillators, Analysis of RC Phase Shift, Wein bridge, Colpitts, Hartley and Crystal Oscillators.	

Reference books	1. A S Sedra& K C Smith, “Microelectronic Circuits”, Oxford University Press.1998. 2. BehzadRazavi, “Fundamentals of Microelectronics”, John Wiley & Sons .2008. 3. Robert Boylestad& Louis Nashelsky ,” Electronic Devices & Circuit Theory”, PHI., 1995.

Subject Code EE202	Circuit Theory	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	To develop an understanding of the fundamental elements of electric circuits. To develop the ability to apply the basic theorems to analyze a DC and AC electric circuit. Use mathematical methods such as Laplace and Fourier transforms and some linear algebra techniques and differential equations to solve circuits problems. Synthesize a network with stable condition.	
Module 1		**Hours : 10**
Basic DC and AC circuits analysis:Kirchhoff's laws (KCL and KVL), DC and AC Circuits, Mesh current, node voltage method, super node and super mesh analysis for D.C and A.C. circuits. Source transformation, star-delta conversion.Complex Waves: RMS and average value of complex waves, circuit response to non-sinusoidal excitations.		
Module 2		**Hours : 12**
Network Theorems and topology:Thevenin'stheorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Millman's theorem, Tellegen's theorem, Reciprocity theorem and compensation theorem. Concepts of Graph theory- Cut set and Tie set using Network topology, Network equilibrium equations, Duality.		
Module 3		**Hours : 12**
Resonance in AC Circuits:Series and parallel resonance, frequency response, Quality factor and Selectivity, Bandwidth, Characteristics, properties of resonance circuits, current locus diagrams. Coupled Circuits:Self and mutual inductance, Coefficient of coupling, Tuned circuits, Single tuned circuits. Dot convention, Analysis of coupled circuits. Transients in Electric circuits: DC and AC transients in R-L, R-C and R-L-C circuits using Differential equations and Laplace Transforms.		
Module 4		**Hours : 10**
Two-port Networks: Two-port network concept, Representation in T and π Configuration, Z, Y, h and ABCD parameters, image impedances, Interconnection of Two-port networks. Network Functions: Natural frequency of a network variable and a network, Network functions with examples and general properties, concept of complex frequency, poles, zeros and frequency response.		
Module 5		**Hours : 12**
Network Realisation and synthesis: Concept of poles and zeros-Hurwitz polynomials-Routh's criterion of stability of network functions-Synthesis of one port LC networks-Foster and Cauer methods-Synthesis of RL and RC one port networks-Foster and Cauer methods.		
Reference books	1. William H. Hayt, Jack E. Kemmerly, Steven M. Durbin, "Engineering Circuit Analysis," 6th Edition, TMH, 2002. 2. Charles A. Desoer, Ernest S. Kuh, "Basic Circuit Theory,"TMH, 1969. 3. M. E. Van Valkenberg, "Network analysis," PHI, 1990. 4. DeCarlo& Lin, "Circuit Theory: Linear Circuit Analysis", 2nd edition, Oxford press, 2004.	

Subject Code EE203	**Electrical Measurements and Instrumentation**	Credits: 4 (3-1-0) Total hours:56
Course Objectives	Students will be able to understand about the operation of an indicating instrument and use them for measurement of electrical quantities. To obtain adequate knowledge of comparison methods of measurement and also various transducers and data acquisition system.	
Module 1		**Hours:14**
General principles of measurements, units, dimensions, standards and calibration of meters, characteristics of instruments: qualities and errors of measurements and its analysis, principle, construction, operation, torque equation, calibration and application of D'Arsonval Galvanometer. Direct Deflecting Instruments: Moving coil, moving iron, dynamo meter, induction, thermal, electrostatic and rectifier type meters, shunts and multipliers, various types of galvanometers. (principle, construction, operation, torque equation and comparison).		
Module2		**Hours:12**
Measurement of Current, Voltage and resistance, Wheatstone bridge, Kelvin double bridge, Carey Foster slide wire bridge, bridge current limitations, insulation resistance, earth resistance, earth tester localization of cable fault by Murray and Varley loop tests. measurement of power and energy: dynamometer type wattmeter, error and compensation, ampere hour meter, single and three phase energy meters (induction type), calibration, phantom loading, current transformer and potential transformer: construction, theory operation, phasor diagram, characteristics, error elimination and its application. Tri-vector meter, frequency meters, power factor meters.		
Module 3		**Hours: 10**
DC Potentiometer: Crompton potentiometer, Vernier potentiometer, Diesselhorst potentiometer, method of use, use of potentiometer for measurement of resistance, current and voltage and power. applications of DC potentiometers. A.C. Potentiometers: applications of AC potentiometers, various A.C. bridges and measurement of inductance & capacitance and frequency.		
Module 4		**Hours: 10**
Magnetic Measurements: Classification, magnetometer measurement, ballistic galvanometer flux meter, magnetic potentiometer, Hall effect devices, B.H. curve and permeability measurement, hysteresis measurement, Hibbert's magnetic standard, core loss measurement.Illumination: Laws of Illumination, standards of luminous intensity, measurement of luminous intensity, distribution of luminous intensity, MSI, Rousseau's construction, integrating sphere, illumination photometers		
Module 5		**Hours:10**
Cathode ray oscilloscope, theory and working, measurements using CRO, types of CRO, time base generator circuit, applications.		
Reference books	1. A. K Sawhney, "Electrical and Electronic Measurements and Instrumentation", DhanpathRai& Co.,2012 2. E.W. Golding,"Electrical Measurements & Measuring Instruments", 5th Edition , Reem Publications,2009 3. W.D Cooper, "Modern Electronics Instrumentation and Measurement Techniques", Prentice Hall of India, 1st Edition,2011	

Subject Code EE204	Circuit Theory Lab	Credits: 2 (0-0-3) Total hours:45hr
Course Objective	Laboratory exercises and assignments based on experiments and PSPICE and/or MATLAB simulation to supplement EE200.	
	Experiments lists 1. Verification of Reciprocity and Milliman's theorem. 2. Find Z and Y parameters for a given circuit. 3. ABCD parameters for a given circuit. 4. Series and parallel resonant circuits. 5. Measurement of Self and Mutual Inductance. 6. MATLAB Simulation model for DC, AC network transient analysis. 7. MATLAB Simulation model to plot poles and zeros of a network. 8. PSPICE simulation model to verify Mesh and Nodal analysis to find branch voltages and currents 9. PSPICE Simulation model to find response for a network with DC, AC voltage sources. 10. Modelling of electrical circuits	
Reference books	1. William H. Hayt, Jack E. Kemmerly, Steven M. Durbin, "Engineering Circuit Analysis," TMH, 6th Edition, 2002. 2. Muhammad H.Rashid, "Inroduction to PSPICE using ORCAD for Circuits and Electronics", PHI, 2008.	

Subject Code EE205	**Electrical Measurements and Instrumentation Lab**	Credits: 2 (0-0-3) Total Hours:45 Hrs
Course Objective	Laboratory exercises and assignments to supplement EE253.	
	Experiments lists 1. Calibration of 1-ph Energy meter using phantom loading. 2. Measurement of low resistance using Kelvins Double bridge. 3. Measurement of low resistance using Wheatstone bridge 4. Measurement of self-inductance using Anderson- bridge 5. Measurement of capacitance using Schering bridge 6. Measurement of inductance using Maxwell- bridge 7. Measurement of pressure using Piezoresistive transducer. 8. Measurement of strain using Piezoresistive transducer 9. Calibration of power factor meter 10. Measurement of power using two wattmeter method	
Reference books	(1) A. K Sawhney, "Electrical and Electronic Measurements and Instrumentation", DhanpathRai& Co.,2007 (2) E.W. Golding,"Electrical Measurements & Measuring Instruments", 5edition , Reem Publications,2009 (3) W.DCooper, "Modern Electronics Instrumentation", Prentice Hall of India, 1996	

<table>
<tr><td>Subject Code

MAT250</td><td colspan="2">Numerical Methods</td><td>Credits: 3(3-0-0)

Total hours: 42</td></tr>
<tr><td>Course Objective</td><td colspan="3">To get familiarized with the numerical solution of linear and non-linear systems, Numerical solution of ordinary differential equations and partial differential equations.</td></tr>
<tr><td>Module 1</td><td colspan="2"></td><td>Hours : 10</td></tr>
<tr><td colspan="4">Solution of linear system: Gauss elimination and Gauss-Jordan methods, LU decomposition methods, Jacobi and Gauss-Seidel iterative methods, sufficient conditions for convergence, power method to find the dominant Eigen value and eigenvector.</td></tr>
<tr><td>Module 2</td><td colspan="2"></td><td>Hours : 12</td></tr>
<tr><td colspan="4">Solution of nonlinear equation: Bisection method, Secant method, Regular-Falsi method, Newton- Raphson method- order of convergence, interpolation curve fitting, method of least squares, numerical differentiation and integration and numerical solution of ordinary differential equations.</td></tr>
<tr><td>Module 3</td><td colspan="2"></td><td>Hours : 11</td></tr>
<tr><td colspan="4">Numerical solution of ordinary differential equations: Euler's method, Euler's modified method, Taylor's method and Runge-Kutta method for simultaneous equations and 2nd order equations, multistep methods, Milne's and Adams' methods.</td></tr>
<tr><td>Module 4</td><td colspan="2"></td><td>Hours : 12</td></tr>
<tr><td colspan="4">Numerical solution of partial differential equations: Liebmann's method, solution of one dimensional heat flow equation, Bender - Schmidt recurrence relation, Crank-Nicolson method, solution of one dimensional wave equation</td></tr>
<tr><td>Reference Books</td><td colspan="3">1. M.K. Jain, S. R. K Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering Computation," New Age Publishers, 6th Edition, 2012.
2. Erwin Kreyszig, "Advanced Engineering Mathematics," 8th Edition, Wiley India Pvt. Ltd. (Reprint 2010).
3. G.D Smith, "Numerical solution of Partial Differential Equations," Oxford University Press.
4. Peter V. ONeil, "Advanced Engineering Mathematics," 5th Edition, Thomson, Book/Cole. (2003).
5. B. S. Grewal, "Higher Engineering Mathematics," 42nd Edition. Khanna Publications, 2013.</td></tr>
</table>

Subject Code EE250	**Digital Electronics**	Credits: 3-0-0 (3) Total hours:42
Course Objectives	This subject exposes the students to Digital Fundamentals.After studying this subject the student will be able to Design, Analyze and Interpret Combinational and Sequential Digital Circuits.	

Module 1	**Hours 10**
Number Systems and Boolean Algebra, Simplification of functions using Karnaugh map and QuineMc-Cluskey Method, Boolean Function Implementation, Minimization and Combinational Design, Examples of Combinational Digital Circuits, Hazards in Combinational Circuits, Hazard free realization.	
Module2	**Hours 10**
Introduction to Sequential circuits: Latches and Flip-Flops (RS, JK, D, T and Master Slave), Design of a Clocked Flip-Flop, Flip-Flop conversion, Practical Clocking aspects concerning Flip-Flops. Counters: Design of Single Mode and Multimode Counters, Ripple Counters, Synchronous Counters, Shift Registers, Shift Register Counters and Random Sequence Generators.	
Module 3	**Hours 12**
Design and Analysis of Sequential Circuits: General model of Sequential Networks, State Diagram, Analysis and Design of Synchronous Sequential Circuits; Finite Sate Machine, State Reduction, Minimization and Design of the Next State Decoder. Asynchronous Sequential Logic: Analysis and Design, Race conditions and Cycles. Practical Design Aspects: Timing and Triggering considerations in the Design of Synchronous Circuits, Set up time, Hold time, Clock skew.	
Module 4	**Hours 10**
Logic Families: Fundamentals of ECL, TTL, CMOS Logic family, Transfer Characteristics, Input and Output Characteristics,TristateLogic,Wired Logic and Bus Oriented structure, Practical Aspects, MOS gates, MOS Inverter, CMOS inverter, Rise and fall time in MOS and CMOS gates, Speed Power Product, Interfacing BJT and CMOS gates.	

Reference books	1. Wakerly J F, "Digital Design: Principles and Practices", Prentice-Hall, 2nd Ed., 2002 2. Mano M. M., "Digital Logic Design", Prentice Hall 1993.

Subject Code EE251	Electrical Power Generation	Credits: 3 (3-0-0) Total hours: 56
Course Objectives	Electrical Power plays significant role in day to day life of entire mankind. This course concerns the generation of power along with the economic aspects. Principle of operation, Performance of electric power generation plants (Hydel, Thermal and nuclear).	

Module 1	**Hours : 9**
Generation of electrical energy by conventional methods, Comparison of different sources of power. Nonconventional sources of energy. Hydro Electric Generation: Classification of hydro plant, Selection of site, Estimation of power available, Selection of turbine and modelling of turbine. Plant layout, Governors and Hydro plant auxiliaries.	
Module 2	**Hours : 9**
Thermal Power Plant: Line diagram of the plant. Boilers: working and classification. Super-heaters, Re-heaters, economizers, air-heaters, draft system, feed water heaters and evaporators, cooling water supply and cooling towers. Speed governing and governors. Station auxiliaries. Generator cooling and exciters.	
Module 3	**Hours : 9**
Nuclear Power Generation: Principle of energy production by nuclear fission, schematic of nuclear power plant, nuclear fuels and fertile materials, nuclear reaction construction. Chain reaction, Moderator, coolants, control of fission, Reactor operation, different types of reactors, Problem of nuclear power plants.	
Module 4	**Hours : 9**
Economics of Power Generation: Cost of electrical energy, Methods of determining depreciation, straight line, diminishing value and sinking found method. Types of Tariffs influence of load and power factor on tariff, economics of power factor improvement. Commissioning and Testing of Transformers and Alternators: Transformer connections, arrangement of transformer, commissioning and testing of transformers and alternators, supply system to station auxiliaries.	
Module 5	**Hours : 9**
Problems with conventional energy, possible options for use as non-conventional sources. Solar Energy: solar thermal & photovoltaic conversion of solar energy, applications of solar energy. Wind energy: Betz limit, wind energy conversion devices: classification, characteristics, and applications. Hybrid systems, safety and environmental aspects.	

Reference books	1) Soni, Gupta, Bhatnagar and Chakrabarti, "A text book on Power Systems Engineering," DhanpatRai and Sons, New Delhi, 1997. 2) C.L.Wadhwa,"Generation, Distribution and Utilization of Electrical Energy," Wiley Eastern Ltd, N.D.1992. 3) M.V. Deshpande, "Elements of Electrical Power station Design Pitman," NewDelhi, TMH , 1990. 4) G. D.Rai, "Non-conventional Energy Sources", Khanna Publishers, New Delhi, 2007.

Subject Code EE 252	**Electrical Machines-I**	**Credits: 4 (3-1-0)** **Total hours: 56**
Course Objectives	Understand the basic concepts about the dc machines and transformers. Learn the various tests for studying the performance of the machines. Learn about the various tests on transformers and its performance.	
Module 1		**Hours 15**
D.C. Generator- Construction, principle of operation, windings, emf equation, armature reaction, methods of limiting effects of armature reaction, commutation process, methods of improving commutation, operating characteristics of shunt, series, compound generator O.C.C, internal and external characteristics, power flow diagram, testing of d.c generators applications.		
Module 2		**Hours 15**
D.C Motor- Principle of operation, torque equation, characteristics of shunt, series, compound motors, speed regulation, starters, speed control methods – voltage control, armature resistance control and field control methods, braking – regenerative braking, rheostatic braking and plugging, testing of d.c motors - brake test, Swinburne's test, Hopkinson's test, retardation test, fields test, applications.		
Module 3		**Hours 15**
1-Ø transformers - construction, principle of operation, emf equation, no-load and on-load phasor diagrams, equivalent circuit, losses, testing of transformers – load test, OC and SC test, separation of core losses, efficiency, voltage regulation, all-day efficiency, parallel operation of transformers with equal and unequal voltage ratios, sumpner test, auto transformers, pulse transformers, instrument transformers.		
Module 4		**Hours 11**
3-Ø transformers –construction, operation, different connections of three phase transformers - v-v connection, scott connection, on -load and off-load tap changers, different types of cooling.		
Reference books	1. A.E Fitzgerald, Charles Kingsley, Stephen D Umans"Electrical Machinery" 6th Edition, Tata McGraw Hill, 2003. 2. Clayton, Hancock, "Performance & Design Of DC Machines" CBS, 3rd Edition, 2001 3. S.J Chapman, "Electric Machinery Fundamentals" McGraw Hill, 4th Edition, 2010. 4. I.J.Nagarath, D.P Kothari, "Electric Machines" Tata McGraw Hill, 4th Edition, 2010. 5. P. S Bimbhra, "Electrical Machinery" 7th Edition, Khanna Publishers, 2008.	

Subject Code HS 250	**Economics**	Credits: 3(3-0-0) Total hours: 45
Course Outcome	The fundamental objective of this course aims at providing a comprehensive perspective in the broad area of economics and its scenario. The course aspires to bring the students into the light of economic decision makings, and facilitates tohave grip in economic issues.	
Module 1	**Introduction to Economics**	2 hours
Constructing a Model, Optimization and Equilibrium in market demand and supply, Comparative statistics and asset allocation.		
Module 2	**Utility, Choice, Budget Constraint and Consumer Preference**	6 hours
Cardinal Utility, Constructing a Utility Function, Budget constraint in case of two goods, Shifting of budget line and impact of Taxes, Subsidies, and Rationing. Indifference curve, Marginal Rate of Substitution, Cardinal utility and utility function, Indifference curve from utility functions, Marginal Utility vs MRS		
Module 3	**Demand, Revealed Preference & Slutsky Equation**	6 hours
Normal and Inferior Goods, Income Offer Curves and Engel Curves, Perfect Substitute, complement and Cobb-Douglas Preferences, The Idea of Revealed Preference, From Revealed Preference to reference,Recovering Preferences, The Substitution Effect, The Income Effect, Rate of Change and change of Demand.		
Module 4	**Consumer Surplus, Market Demand & Equilibrium**	6 hours
Demand for a Discrete Good, Constructing Utility from DemandFrom, Change inConsumer's Surplus, Individual to Market Demand, The Inverse Demand Function, The Extensive and the Intensive Margin, Elasticity, Elasticity and Demand, Market Supply, Market equilibrium, Inverse Demand and Supply Curves		
Module 5	**Technology and Profit Maximization**	3 hours
Inputs and Outputs, Describing Technological Constraints, Properties of Technology, The Technical Rate of Substitution, Diminishing Technical Rate of Substitution, Returns to Scale, Profits, The Organization of Firms, The Organization of Firms, Short-Run Profit Maximization, Profit Maximization in the Long Run, Profit Maximization and Returns to Scale		
Module 6	**National Income Accounting**	2 hours
National Income and Related concepts, Nominal or real GDP, Methods of measuring NI.		
Module 7	**Determinants of Equilibrium Output and IS – LM Model**	8 hours
Aggregate demand and Equilibrium output, Consumption function and aggregate demand, Multiplier, Govt. sector, Budget and Full employment, Asset and Goods Market, Equilibrium and adjustment to equilibrium in IS – LM model		
Module 8	**Money and Fiscal policy and International Linkages**	8 hours
Monetary and fiscal policy, crowding out, composition of output and policy mix, Balance of Payment and Exchange rate, Balance of Trade and capital mobility, Mundell-Fleming model, Capital Mobility and fixed exchange rates		
Module 9	**Aggregate Demand, Supply and Growth**	4 hours
Aggregate demand and policies, Aggregate Supply, Fiscal and monetary policy under Alternative supply Assumption, The quantity theory and neutrality of Money.		
Text Books	Varian, Hal R.: Intermediate Microeconomics, W.W. Norton & Co., New work (ISBN: 0393978303) Koutsoyiannis, A.: Modern Microeconomics, 2nd ELBS/Palgrave Macmillan, London Rudiger Dornbusch and Stanley Fisher: Macroeconomics, McGraw Hill. Barro Robert J. "Macroeconomics, New York, John Wiley.	

Subject Code: VE200	**Value Education**	**Credits: 1 (1-0-0)** **Total hours: 14**
Course Objectives	It aims at Holistic Development	
Module 1	**Ethics in Engineering**	4 hours
Concepts of Values and Ethics, History and Purposes, Utilitarianism, Duties, Rights, Responsibility, Virtue, Honesty, Moral Autonomy, Obligations of Engineering Profession and moral Propriety		
Module 2	**Engineer's Moral responsibility**	3 hours
Engineer's Moral responsibility for Safety and Human Rights, Risk Assessment and Communication, Product Liability, Engineers-Employers Liaison, Whistle-Blowing and Its Moral Justification		
Module 3	**Computer Ethics**	3 hours
Social Impact of Computer, Gender-Issues and Privacy, Cyber Crime, Ethical use of Software		
Module 4	**Intellectual property**	4 hours
Definition, Types, Rights and Functions, Patents, Trademark, Grant of Patent in India, Surrender and Revocation of Patents, Compulsory Licensing, Acquisition of Inventions by the Government, Contents of draft application of Patents, WTO		
Texts:	1. Vinod V. Sople, Managing Intellectual Property: The Strategic Imperative, PHI,2006 2. Govindarajan, Natarajan&Senthil Kumar, Engineering Ethics, PHI 3. Robin Attfield, A Theory of Value and Obligation, London: Croomhelm, 1987 4. Jones and barlett, " Cyber Ethics: Morality and Law in Cyber Space	
Reference	Case Studies from Newspapers	

Subject Code EE 253	**Electrical Machines- I Lab**	**Credits: 2 (0-0-3)** **Total hours:45**
Course Objectives	Laboratory exercises and assignments based on hardware to supplement EE205.	
	1. Open circuit and short circuit test on single phase transformer. 2. Direct load test on single phase transformer 3. Sumpner's test on single phase transformer 4. Scott connection of two single-phase transformers 5. Parallel operation of two different KVA 1-phase transformers 6. Magnetization characteristics of dc shunt generator 7. Performance characteristics of dc shunt generator 8. Performance characteristics of dc compound generator 9. Performance characteristics of dc series generator 10. Swinburne's test on dc shuntmotor 11. Speed control of dc shunt motor 12. Load characteristics of dc shunt motor 13. Performance characteristics of dc compound motor 14. Retardation test on dc motor 15. Field test on dc series motor	
Reference books	1. A.E Fitzgerald, Charles Kingsley, Stephen D Umans "Electrical Machinery" 6th Edition, Tata McGraw Hill, 2003. 2. Clayton, Hancock, "Performance & Design Of DC Machines" CBS, 3rd Edition, 2001 3. S.J Chapman, "Electric Machinery Fundamentals" McGraw Hill, 4th Edition, 2010. 4. I.J.Nagarath, D.P Kothari, "Electric Machines" Tata McGraw Hill, 4th Edition, 2010.	

Subject Code EE254	**Analog and Digital Electronics Lab**	**Credits: 2 (0-0-3)** **Total hours: 45**
Course Objectives	Laboratory exercises and assignments based on hardware and SPICE simulation to supplement EE251 and EE252.	
	1. Testing of Diode clipping (Single/Double ended) circuits for peak clipping, peak detection 2. Testing of Clamping circuits: positive clamping /negative clamping. 3. Testing of a transformer less Class – B push pull power amplifier and determination of its conversion efficiency. 4. Testing of Half wave, Full wave and Bridge Rectifier circuits with and without Capacitor filter. Determination of ripple factor, regulation and efficiency. 5. Wiring and Testing for the performance of BJT-RC Phase shift Oscillator for f0 ≤ 10 KHz 6. Testing for the performance of BJT – Hartley &Colpitts Oscillators for RF range f0 ≥100KHz. 7. Testing for the performance of BJT -Crystal Oscillator for f0 > 100 KHz 8. Study of BASIC Gates 9. Study of Universal Gates 10. Study of Full & Half Adder &Subtractor using Gates 11. Study of Magnitude Comparator 12. Study of Multiplexer 13. Study of Demultiplexer 14. Implementation of Flip-Flops using NAND & Study of 7476 15. Study of Shift Register	
Reference books	1. M.Morris Mano, "Digital Electronics", Prentice Hall PTR, New Jersey, 3rd Edition, 2001. 2. J.F. Wakerly, "Digital Design Principles and Practices", PHI, 1999. 3. R.J.Tocci, "Digital Systems – Principles & Applications", Prentice Hall India, New Delhi, 10th Edition , 2008. 4. A S Sedra& K C Smith ,"Microelectronic Circuits", Oxford University Press.2005 5. Donald A. Neamen, "Electronic Circuit Analysis and Design", MCGraw Hill 2003, 2nd Edition	

Subject Code EE300	**Electrical Power Transmission and Distribution**	**Credits: 4 (3-1-0)** **Total hours: 56**
Course Objectives	This course is an extension of electric power generation course. It deals with basic theory of transmission lines modelling and their performance analysis. Also this course gives emphasis on mechanical design of transmission lines, cables and insulators.	

Module 1	**Hours : 12**
Basic structure of power system, transmission voltages, and bundled conductors, transmission line parameters: resistance, inductance and capacitance calculations - single phase and three phase lines, double circuit line, effect of earth on transmission line capacitance. performance of transmission lines: representation of lines, classification of transmission lines, short transmission line, medium (Nominal-T, Nominal-π, End condenser method) length transmission line, long transmission line, evaluation of ABCD parameters, surge impedance and SIL of long lines, wave length and velocity of propagation of waves, incident, reflected and refracted waves, representation of Long Lines - Equivalent T and Π models.	
Module 2	**Hours : 14**
Mechanical design of overhead lines: general consideration, line supports, span conductor configuration, spacing and clearances, sag and tension calculations with equal and unequal heights of towers, effect of wind and ice on weight of conductor, stringing chart and sag template and its applications. Skin effect, proximity effect, Ferranti effect, corona: The phenomenon of corona, corona loss, factors and conditions affecting coronal loss, corona in bundled conductor lines. Interference between power and communication lines. Overhead line insulators: insulator materials, types of insulators, voltage distribution over insulator string, improvement of string efficiency, insulator failure, testing of insulators. Capacitance grading and static shielding.	
Module 3	**Hours : 12**
Underground cables: classification of cables, types of cables, construction, types of insulating materials, calculations of insulation resistance and stress in insulation. Capacitance of single and 3-core belted cables. Grading of cables - capacitance grading, description of inter-sheath grading.Design of transmission lines: choice of voltage, selection of conductor size, choice of span, number of circuit, conductor, configuration. Power system earthing.	
Module 4	**Hours : 10**
Power system transients: circuit closing transient, sudden symmetrical short circuit of alternator, recovery transient due to removal of short circuit, travelling or propagation of surges, attenuation, distortion, reflection and refraction coefficients. Termination of lines with different types of conditions, open circuited line, short circuited line, T-Junction, lumped reactive junctions. Bewley's lattice diagrams. Arcing grounds, line design based on direct strokes, surge arrestors insulation coordination. Extra high voltage transmission: need for EHV transmission, use of bundled conductors, radio noise from EHV lines, shunt compensation static-var systems, series compensation, EHV systems in India.	

Module 5	**Hours : 8**
Distribution: comparison of various distribution systems, voltage drop in distribution, Kelvin's Law, general design consideration, load estimation.	
1) Soni, Gupta, Bhatnagar and Chakrabarti, "A text book on Power Systems Engineering," DhanpatRai and Sons, New Delhi, 1997. 2) C.L.Wadhwa,"Generation, Distribution and Utilization of Electrical Energy," Wiley Eastern Ltd, N.D.1992. 3) W.D. Stevenson Jr., "Elements of Power System Analysis", McGraw,Hill, 1968.	

Subject Code EE 301	**Electrical Machines-II** **(Induction Machines & Synchronous Machines)**	**Credits: 4 (3-1-0)** **Total hours: 56**
Course Objectives	To learn the basic concepts about the different types of induction and synchronous machines. To understand the speed control and the starting operations.	

Module 1	**Hours 15**
Induction Machines- construction, principle of operation, types of induction motors, phasor diagram, rotor MMF, rotor frequency, rotor current and production of torque, slip, equivalent circuit. torque-slip characteristics, maximum torque, no-load and blocked rotor tests, losses and efficiency, circle diagrams, starters, direct on line starters, star-delta and auto transformer starters.	
Module 2	**Hours 15**
Slip ring induction motor, double cage induction motor, cogging and crawling, speed control of three phase induction motors, induction generator. Single phase induction motors, double field revolving theory, equivalent circuit, starting methods, applications.	
Module 3	**Hours 15**
Alternators - construction, principle of operation, winding factors, generated emf, phasor diagram, armature reaction, voltage regulation, methods of predetermination of regulation – EMF, MMF and ZPF methods, two reaction theory, power-angle characteristics, synchronization and synchronizing power, transient, sub transient and steady state reactance, parallel operation and load sharing, effect of change in excitation and mechanical input.	
Module 4	**Hours 11**
Synchronous motor -principle of operation , method of starting, equivalent circuit, effect of increased load with constant excitation, effect of changing excitation with constant load. V curves and inverted V curves, power developed, power circles, hunting, different starting methods.	

Reference books	1. A.E Fitzgerald, Charles Kingsley, Stephen D Umans "Electrical Machinery" 6th Edition, Tata McGraw Hill, 2003. 2. Clayton, Hancock, "Performance & Design Of DC Machines" CBS, 3rd Edition, 2001 3. S.J Chapman, "Electric Machinery Fundamentals" McGraw Hill, 4th Edition, 2010. 4. P. S Bimbhra, "Electrical Machinery" 7th Edition, Khanna Publishers, 2008.

Subject Code EE 302	**Control Systems**	**Credits: 4 (3-1-0)** **Total hours: 42**
Course Objectives	To be familiar with basic control configurations and also to be competent in mathematic modelling of physical systems and analyze their time and frequency response.	

Module 1	**Hours 12**
Mathematical modelling: Introduction of Open loop and Closed loop systems, Mathematical modelling of Physical systems, Mechanical and Electrical systems, Transfer functions, Block diagrams, Block diagram reduction rules, Signal flow graphs, Mason's Gain formula, Feedback characteristics of closed loop system.	
Module 2	**Hours 12**
Time response Analysis: Standard test signals, Time response of First and Second order systems, Steady-state Errors and Error constants and Dynamic Error coefficients, Effect of addition of poles and zeroes on response of system, Response with P, PI and PID controllers, Performance Indices**.** Control system components, Stepper motors, Tacho-generators, DC and AC Servomotors.	
Module 3	**Hours 10**
Concept of stability: Necessary conditions and Routh Criterion, Relative stability analysis, Concept of Root locus and Construction, Gain margin and Phase margin, Addition of poles and zeroes on root locus.	
Module 4	**Hours 12**
Frequency domain Analysis:Frequency response specifications, Frequency and Time domain correlation, Bode plot, Polar plot, Nyquist criterion, Closed loop frequency response from Open loop Transfer Functions.	
Module 5	**Hours 10**
Compensation Techniques: Design of Lead, Lag, Lead-Lag Compensation.State variable Analysis: Concept of State, State Variables and State Model, State representation of Continuous-time systems, State equation, Solution of State equations, Concept of Controllability and Observability.	

Reference books	1. J. Nagrath M. Gopal, "Control Systems Engineering", New Age Int., 4th Edition. 2. K. Ogata, "Modern Control Engineering", PHI, 3rd Edition. 3.M.Gopal, "Control Systems, Principles and Design", Tata McGraw Hill,4th Edition.

Subject Code EE303	**Microprocessors and Microcontrollers**	**Credits: 3(3-0-0)** **Total hours:42**
Course Objectives	To introduce the student with knowledge about architecture, interfacing andprogramming with 8086 microprocessors and 8051 microcontrollers. Also to give a brief introduction to ARM 7 and ARM 9 micro controllers.After studying this subject, the student should be able to designMicroprocessor/Microcontroller based system.	
Module 1		**Hours 10**
Introduction: History of Microprocessors, Basics of computer architecture, CISC and RISC; 8085 Microprocessor Family Overview, 8085 Architecture, Assembly Language Programming (ALP), and Program development.		
Module2		**Hours 12**
8086 Microprocessor: Main features, pin Diagram Description, Internal Architecture, 8086 Microcomputer System, Program development steps,Implementing Standard Program Structure in 8086 ALP, Strings, Procedures, Macros.		
Module 3		**Hours 10**
Interfacing: Input and Output Modes and Interfacing, Interrupts, Hardware Interrupt Applications, 8254 Programmable Timer/Counter, 8255 Programmable Peripheral Interface, 8259 Priority Interrupt Controller, DMA controller, 8279 Programmable Keyboard/ Display Interface, ADC, DAC Interfacing.		
Module 4		**Hours 10**
Intel 8051 Microcontroller: Architecture, Memory Space, Data Types and Directives, Register Banks and Stack, Assembly Language Programming, Introduction to ARM processors –features of ARM 7 and 9 processors.		
Reference books	1. Hall D.V., "Microprocessors and Interfacing", McGraw Hill 2. Ramesh Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085", Penram International Publishing, Fifth edition 3. Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D Mckinlay," 8051 Microcontroller and Embedded systems", Pearson Education.	

Subject Code EE 304	**Electrical Machines Lab-II**	**Credits: 2 (0-0-3)** **Total hours: 45**
Course Objectives	Laboratory exercises and assignments based on hardware to supplement EE254.	
	1. Load characteristics of single phase capacitor start & run motor 2. Direct load test on 3phase squirrel cage induction motor 3. No load and block rotor test on three phase induction motor 4. Circle diagram of 3-phase induction motor- performance evaluation. 5. Voltage regulation of an alternator by emf and mmf method. 6. Synchronization of the alternator with infinite bus bar 7. Voltage regulation of an alternator by zpf method 8. V' and inverted 'V' curves of a synchronous motor	
Reference books	1. A.E Fitzgerald, Charles Kingsley, Stephen D Umans "Electrical Machinery" 6th Edition, Tata McGraw Hill, 2003. 2. Clayton, Hancock, "Performance & Design Of DC Machines" CBS, 3rd Edition, 2001 3. S.J Chapman, "Electric Machinery Fundamentals" McGraw Hill, 4th Edition, 2010. 4. I.J. Nagarath, D.P Kothari, "Electric Machines" Tata McGraw Hill, 4th Edition, 2010.	

Subject Code EE305	**Microprocessor and Microcontrollers Lab**	Credits: 2(0-0-3) Total hours:3hrs/week
Course Objectives	To give hands on experience on 8085/8086 and 8051 programming	

List of Experiments

Experiment No. 1

8085 and 8086 kit familiarization and basic experiments

Experiment No. 2

Programming exercise : sorting ,searching and string

Experiment No. 3

Interfacing with A/D and D/A converters

Experiment No. 4

Interfacing with stepper motors

Experiment No. 5

keyboard interfacing to 8086

Experiment No. 6

8255 interface to 8086

Experiment No. 7

Assembly language programming of 8051

Experiment No. 8

Timer programming of 8051 ,using interrupts

Experiment No. 9

LCD interfacing to 8051

Experiment No. 10

Mini-Project

Subject Code ES300	Environmental Studies	Credits: 3 (3-0-0) Total hours: 44
Course Objective	Understanding environment, its constituents, importance for living, ecosystem, human developmental activities vs environment, climate change, national and international environment related developments, need for public awareness, its protection and conservation activities.	
Module 1		**Hours : 2**
Multidisciplinary nature of environmental studies:Definition, scope and importance, Need for public awareness.		
Module 2		**Hours : 8**
Renewable and non-renewable Natural resources : Natural resources and associated problems; Forest resources : Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forest and tribal people; Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems; Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies; Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies; Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources, Case studies; Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.		
Module 3		**Hours : 10**
Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the Following ecosystem, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).		
Module 4		**Hours : 12**
Biodiversity and its conservation: Introduction – Definition : genetic, species and ecosystem diversity, Bio geographical classification of India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-sports of biodiversity, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity, Eco-cultural heritage of India-various festivals related to Environment, Tradition of community conserved areas-Sacred forests, sacred tanks, sacred mountains, sacred rivers.		

Module 5	**Hours : 12**
National and International Environment related developments Environmental ethics : Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear, accidents and holocaust, Environment related Acts, Issues involved in enforcement of environmental legislation, Public awareness, Wasteland reclamation, Consumerism and waste products, UN Frame Convention Climate Change, Kyoto protocol, concept of carbon credits, latest CoP meet Agenda; Filed Work(equal to 5 lecture hours): Visit to a local area to document environmental assets river/forest/grassland/hill/mountain/sacred groves/sacred forests, Visit to a local polluted site-Urban/Rural/Industrial/Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hill slopes, etc.	
Reference books	1. Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education (online book -UGC Website), Erach Bharucha,University Grants Commission , India. 2. Anil Agarwal, Dying Wisdom, Publisher: Centre for Science and Environment, Edi:1st,1997 ISBN-13 9788186906200; ISBN-10 8186906207 3. R. Rajagopalan, Environmental Studies from Crisis to Cure, Oxford IBH Pub., 2005. 4. Benny Joseph, Environmental Science and Engineering, Tata McGraw Hill, 2006. 5. Erach Bharucha, Text Book for Environmental Studies, Pub., Universities Press, 2005. 6. Masters, Gilbert M., Introduction to Environmental Engineering and Sciences, Prentice Hall India, 1991

Subject Code EE350	Switchgear and Protection	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	This course introduces all varieties of circuit breakers and relays for protection of generators, transformers and feeder bus bars from over voltages and other hazards. It emphasis on neutral grounding for overall protection.	

Module 1	**Hours : 10**
Fuses: Types of fuses, application of HRC fuses. Neutral Grounding: grounded and un-grounded neutral systems. effects of ungrounded neutral on system performance. Methods of neutral grounding: solid, resistance, reactance and arc suppression coil or peterson coil. arcing grounds.	
Module 2	**Hours : 10**
Circuit Breakers: Arcs, Interruption, RRRV, current chopping, interruption of capacitive current, resistance switching. Types of circuit breakers (minimum and bulk oil circuit breakers, air blast circuit breakers, vacuum and SF6 circuit breakers), Circuit Breaker ratings, Auto reclosure.	
Module 3	**Hours : 14**
Protective relaying: Need for power system protection, evolution of protective relays, zones of protection, protective relays and schemes. Electromagnetic relays, microprocessor based protective relays. Over current protection, distance protection, auto re-closing. Pilot relaying schemes, bus zone protection, protection of generators, static relays, microprocessor based relays, advantages, over current relays, directional relays, distance relays.	
Module 4	**Hours : 12**
Protection of generator: Protection against abnormal condition, stator and rotor protection. restricted earth fault and inter-turn fault protection. Protection of transformers: Incipient fault,differential protection, percentage differential protection, restricted earth fault protection, Buchholtz relay Protection.	
Module 5	**Hours : 10**
Protection against over voltages: Causes of over voltage ground wires, surge absorbers and diverters, insulation coordination:BIL, impulse ratio, standard impulse test wave, volt-time characteristics. Bus bar protection: Frame leakage scheme, translay scheme, circulating current scheme introduction to protection against surges.	

Reference books

1) Ravindranath, Chander, "Power System Protection and Switchgear," Wiley Eastern, 1994.
2) C. L. Wadhwa, "Electrical Power Systems," 2nd Edition, PHI, 1993.
3) Arun G. Phadke, S H Horowitz, "Power System Relaying, 2nd Edition, John Wiley, 1995.
4) Badriram, D. N. Vishwakarma, "Power System Protection and Switchgear," TMH, 1995.
5) J. L. Blackburn and T. J. Domin, "Protective Relaying: Principles & Applications," CRC Press, 2006.
6) S. S. Rao, "Switch gear and protection," Khanna publishers, 1997.
7) T. S. MadhavaRao, "Power system protection: Static Relays," Tata McGraw Hill, 1989
8) Y. G. Paithangar, "Fundamentals of power system protection," PHI

Subject Code EE 351	**Power System Analysis**	Credits: 4 (3-1-0) Total hours: 56
Course Objectives	To learn the fundamentals of power system for designing a system that meets specific need. To analyse the phasor techniques in the analysis of power systems. To know the necessity of load flow in a regulated system. To examine the need of various analysis like fault analysis, short circuit analysis stability analysis, steady state and transient analysis.	

Module 1	**Hours 10**
Modelling of power system components: representation of power system components, single phase representation of balanced three phase networks, single line diagram, per unit quantities, impedance diagram, reactance diagram, steady state model of synchronous machine, power transformer, representation of loads, formulation of bus impedance and admittance matrix.	
Module 2	**Hours 12**
Power flow Analysis: Network model formulation, load flow problem, Gauss Seidel, Newton Raphsonand fast decoupled methods, comparison of load flow methods, control of voltage profile: excitation control, VAR generators, tap changing transformers, load flow for DC links.	
Module 3	**Hours 10**
Symmetrical fault Analysis: Transients on a transmission line, Short circuit analysis of synchronous machine, symmetrical fault analysis in the network, fault analysis through impedance matrix, circuit breaker rating,selection of circuit breakers, current limiting reactors	
Module 4	**Hours 12**
Unsymmetrical fault analysis: Symmetrical components, Concept of sequence impedances and sequence networks of synchronous machine, transmission lines, transformers, power system, LG, LL, LLG and open circuit faults analysis through sequence components, Digital methods for fault analysis	
Module 5	**Hours 12**
Stability Analysis Angle stability dynamics of a synchronous machine, swing equation, power angle equation, steady state and transient stability, equal area criterion, numerical solution of swing equation, multi machine stability analysis, Voltage stability: Reactive power flow and voltage collapse, mathematical formulation of voltage stability problem, voltage stability analysis.	

Reference books	1. D P Kothari,I J Nagrath, "Power System Engineering", Tata Mc,Graw 2nd Edition 2. C.L.Wadhwa,"Electrical Power Systems",NewAge International Publishers, 6th Edition 3. W.D.Stevenson Jr. "Elements of Power System Analysis", TMH, 1968. 4. I.J.Nagrath,D.P.Kothari, "Modern Power System Analysis", TMH, 4th Edition ,2011

Subject Code EE 352	**Power Electronics**	Credits: 4 (4-0-0) Total hours: 56
Course Objectives	Learn the static and dynamic characteristics of power semiconductor devices. Understand the principles of operation of power electronic converters. Study the various control strategies of various power converters. Study the design parameters for control circuitry requirement of various converters.	

Module 1	**Hours 12**
Introduction- power diodes, types of power semiconductor switches and V-I characteristics, Thyristors: structure, static and dynamic characteristics, device specifications and ratings, methods of turning on (gate firing circuits), methods of turning off (commutation circuits), IGBTs- basic structure and V-I characteristics. MOSFETs - basic structure and V-I characteristics.	

Module 2	**Hours 12**
Phase Controlled Rectifiers: single phase, half wave rectifier with R, RL and RLE loads, full wave half controlled and fully controlled converters with R, RL and RLE loads, input side harmonics and power factor, effect of source inductance. Three phase-half wave rectifier with R and RL loads. Full wave half controlled and fully controlled converters with R, RL loads, single-phase and three-phase dual converters.	

Module 3	**Hours 10**
A.C. Voltage controllers: operation of controllers for R, R-L loads, current and power factor. Cyclo-converters: single phase mid-point and bridge configuration with R, R-L loads, circulating current mode of operation	

Module 4	**Hours 12**
Choppers: principle of operation, time ratio control and current limit control, step-up and step-down choppers with R, RL and RLE loads. Switching regulators: buck regulators, boost regulators, buck-boost regulators. Switched mode power supply: principle of operation and analysis.	

Module 5	**Hours 10**
Inverters: principle of operation, series inverter, parallel inverter, single phase bridge inverters. Three phase bridge inverters- 120^0 and 180^0 degrees mode of operation, single, multiple and sinusoidal pulse width modulation.	

Reference books	1. M.H. Rashid, "Power Electronics - Circuits, Devices and Applications",PHI, 3rd Edition,2003. 2. Ned Mohan,Undelandand P Robin, "Power Electronics Converters, Applications and Design", John Wiley & Sons,3rd Edition,2007 3. G.K.Dubey, "Thyristorised Power Controllers", Wiley Eastern Ltd, 1993. 4. .P.S.Bimbhra, "Power Electronics" , Khanna Publishers, New Delhi, 2002

Subject Code EE353	**Integrated Circuits**	**Credits: 3(3-0-0)** **Total hours:42**
Course Objectives	To develop the skill of analysis and design of various circuits using operational Amplifiers. To develop design skills to design various circuits using different data conversion Systems.	

Module 1	**Hours 12**
Operational Amplifier and its Linear application: Ideal Op Amp circuit Analysis, Inverting and Non-Inverting Configuration, Differentiator, Integrator, The Negative resistance converter, Negative Feedback, Feedback in Op Amp circuit, Loop gain. Circuits with Resistive Feedback: Current-to-Voltage Converters, Voltage-to-Current converters, Current Amplifiers, Difference Amplifiers, Instrumentation Amplifiers and Applications.	
Module2	**Hours 08**
Active filters: First and Second order filter Transfer function, Butterworth response, Second-order Passive filters (RC, RLC), Emulation of Inductor using Op-Amps-R-C, Salen-Key Biquad, Tow-Thomas Biquad, Realization of higher order filters, All-pass filter.	
Module 3	**Hours 10**
Nonlinear circuits: Voltage Comparators, Comparator Applications, Zero-crossing detector, Precision rectifiers, Schmitt trigger (Inverting &Non Inverting),AstableMultivibrator, Triangular wave generator. Non idealities of Op-Amps and their effects. NE555 Timer circuits: Internal architecture, Schmitt trigger, AstableMultivibrator,MonostableMultivibrator, Saw-Tooth Wave generator.	
Module 4	**Hours 12**
Digital to Analog (D/A) Converters: Types of D/A converters, Accuracy, Resolution and Conversion speed, Offset error, Gain error, Integral and Differential Nonlinearity. Analog to digital (A/D) converters: A/D conversion techniques and their Nonlinearity's. Phase Locked Loop: Block schematic and Analysis of PLL, Lock range and Capture range, Typical applications of PLL, Basic Principles of operation of VCO and timer (555) and their applications.	

Reference books	1. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", McGraw Hill Book Company 1998. 3.Sedra A.S. & Smith K.C., "Microelectronic Circuits", Oxford University Press 1998 4.RamakanthGaykward, "Op Amps and Linear Integrated Circuits", Pearson Education, 1999.

Subject Code EE354	Electrical Simulation Lab	Credits: 2 (0-0-3) Total Hours:45 Hrs
Course Objective	Laboratory exercises and assignments based on hardware and MATLAB simulation to supplement EE352.	

Experiments lists

1) Simulation of 1- Φ half wave controlled rectifier with R and R-L load using MATLAB.

2) Simulation of 1- Φ full wave controlled bridge rectifier and semi-controlled bridge rectifier with R and R-L load.

3) Simulation of 3-Φ full wave controlled rectifier with R and R-L load.

4) Simulation of a basic series inverter.

5) Simulation of parallel inverter.

6) Simulation of dual converter.

7) Simulation of step down/buck chopper and step up/boost chopper.

8) Simulation of 120^o and 180^o modes of operation of inverter.

9) Simulation of sinusoidal pulse width modulation.

10) Simulation of hysteresis band pulse width modulation.

11). Simulation of speed control schemes for DC and AC motors.

12. Mathematical modeling of Power Electronic Systems.

Reference books	1. M.H. Rashid, "Power Electronics - Circuits, Devices and Applications",PHI, 3rd Edition,2003. 2. Ned Mohan,Undelandand P Robin, "Power Electronics Converters, Applications and Design", John Wiley & Sons,3rd Edition,2007 3 .P.S.Bimbhra, "Power Electronics" , Khanna Publishers, New Delhi, 2002

Subject Code EE355	Control Systems Lab	Credits: 2 (0-0-3) Total Hours:45 Hrs
Course Objective	Laboratory exercises and assignments based on hardware and MATLAB simulation to supplement EE302.	

Experiments lists

1. Determination and analysis of transfer function for Speed control characteristics of DC motor
2. Determination and analysis of transfer function of DC servo-motor
3. Determination and analysis of transfer function of AC servo-motor
4. Characteristics of Stepper motor
5. Characteristics of Synchrotransmitter / receiver
6. Design of PI and PID controller
7. Timeresponse analysis of first and second order systems using MATLAB/SIMULINK
8. Frequency response analysis of second order system using MATLAB/SIMULINK
9. Design of lag-lead compensator
10. Simulink model for servo system
11. Simulink model for speed control of motors

Reference books	1. I.J. Nagrath, M. Gopal, "Control Systems Engineering", New Age International, 4th Edition 2. K. Ogata, " Modern Control Engineering", PHI, 3rd Edition. 3. M.Gopal, "Control Systems, Principles and Design", Tata McGraw Hill,4th Edition.

Subject Code EE 400	**Electrical Drives**	Credits: 3 (3-0-0) Total hours: 56
Course Objectives	Understand the classification and characteristics of drives. Analyse the various types and operations of DC drives. Analyse the various types and operations of induction motor drives	
Module 1		**Hours 10**
Introduction: Electrical drives, parts of electrical drives, selection of power rating for drives, dynamics of electrical drives, fundamental torque equation, components of load torques, speed-torque characteristics of various types of motors and loads, condition of steady state stability. DC shunt motor and series motor speed-torque characteristics in different quadrants		
Module 2		**Hours 10**
Controlled rectifier fed DC drives:1-phase fully and half controlled converter fed dc separately shunt and dc series motor, mathematical analysis of 1-phase converter fed dc motors, 1-phase dual converter- waveforms, operations with and without circulating current. Steady state analysis of three phase fully and half controlled DC motor drive. Power factor considerations of converters, power factor improvement of phase controlled converters.		
Module 3		**Hours 8**
Chopper controlled fed DC drives: Single-quadrant chopper controlled drives, evaluation of performance parameters for separately excited and series motor drives. Two quadrant and four quadrant chopper controlled drives. Closed loop control of dc drives.		
Module 4		**Hours 10**
Stator voltage control of 3-phase induction motors by AC voltage controllers. VSI fed induction motor drives, constant v/f control, constant flux control, constant slip-speed control, torque pulsation, effect of harmonics and its control, PWM control, flux weakening operation, Current Source Inverter (CSI) fed induction motor drives. Rotor side control of induction motors: static rotor resistance control, slip power recovery scheme, static scherbius drive, static Kramer's drive and their performance, speed- torque characteristics		
Module 5		**Hours 07**
Control of synchronous motor**: s**eparate control &self-control of synchronous motor drive by VSI and CSI. Load commutated CSI fed synchronous motor, speed torque characteristics, closed loop control operation of synchronous motor drives, solar and battery powered drives.		
Reference books	1. G.K.Dubey, "Fundamentals of Electrical Drives", Narosa Publications, 1995 2. M.H. Rashid, "Power Electronics - Circuits, Devices and Applications", PHI, 2002. 3. G.K.Dubey, "Thyristorised Power Controllers", Wiley Eastern Ltd, 1993.	

Subject Code HS 400	**Management**	**Credits: 3 Total hours: 45**
Course Outcome	Develops the ability to understand and analyse the broad aspect of management and its financial dynamism	
Module 1	**Principles of Accounting**	5 hours
Accounting Cycle, Assumptions, Classifications of Accounts- Journal, Cash Book, Ledger, Final Accounts- Manufacturing Account, Trading Account, P & L Account, Balance Sheet.		
Module 2	**Financial Statement Analysis**	5 hours
Balance sheet, Profit and Loss Account, Economic vs Accounting Profit, Changes in Financial Position, Funds flow and cash flow statement.		
Module 3	**Ratio Analysis**	6 hours
Nature of Ratio Analysis, Liquidity Ratio, Leverage Ratio, Activity Ratio, Profitability Ratio, DuPont Analysis, Comparative statement and Trend Analysis, Inter-firm Analysis.		
Module 4	**Working Capital**	6 hours
Concept of working Capital, Operating and Cash conversion Cycle, Permanent and Variable working Capital, Balance working capital position and Issues.		
Module 5	**Time Value of Money**	5 hours
Time preference for money, Future value, Annuity, Perpetuity, Sinking fund factor, Present value, Annuity, Perpetuity, capital recovery factor, Multiple period Compounding.		
Module 6	**Capital Budgeting**	8 hours
Nature and type of Investment decision, Net Present value, (NPV), Internal Rate of Return (IRR), Payback period, Profitability Index, Nature and Behavior of Cost, Breakeven point, multiple products analysis, decision points.		
Module 7	**Financial System**	6 hours
Introduction to Indian Financial System, Financial Institutions and Financial Markets.		
Module 8	**Industrial Engineering & Project Management**	4 hours
Work Study, Time Study, Industrial Psychology, Project Management (PERT, CPM)		
Text Books	I.M Pandey, *Financial Management*, 10th edition, Vikish Publication Brealey Y Myers, *Principles of Corporate Finance*, McGraw-Hill Rajiv and Anil: *Financial Management*, 2nd Edition, Oxford University Press L.M Bhole: *Financial Institutions and Markets*, Tata McGrow-hill	

Subject Code EE401	**Power Electronics and Drives Lab**	**Credits: 2 (0-0-3)** **Total Hours:45 Hrs**
Course Objective	Laboratory exercises and assignments based on hardware and MATLAB simulation to supplement EE303.	
	Experiments lists 1. Static characteristics of SCR. 2. Static characteristics of MOSFET and IGBT 3. SCR turn - on circuit using synchronized UJT relaxation oscillator 4. SCR digital triggering circuit for a single – phase controlled rectifier and AC voltage controller 5. Series inverterwith R & R L loads 6. Parallel inverter with R & R L loads 7. Buck Converter 8. Boost converter 9. Single – phase controlled full wave rectifier with R and R-L loads 10. AC voltage controller using TRIAC and DIAC 11. MOSFET or IGBT based single-phase full-bridge inverter connected to R load 12. Speed control of universal motor using AC voltage controller 13. Speed control of a separately excited D.C.motor using an IGBT or MOSFET chopper 14. Speed Control of D.C. motor using single semi converter	
Reference books	1. M.H. Rashid, "Power Electronics - Circuits, Devices and Applications", PHI, 2002. 2. Mohan Undeland Robin, "Power Electronics - Converters, Applications and Design", John Wiley & Sons,2002 3. P.S.Bimbhra, "Power Electronics" , Khanna Publishers, New Delhi, 2002. 4. G.K.Dubey, "Thyristorised Power Controllers", Wiley Eastern Ltd, 1993.	

Subject Code EE 450	**Power System Operation and Control**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To explain the performance of supervision and control systems of electric power and describe their main functions. To acquaint students with the principles of state estimation. To acquaint students with the problem of system control centre and automatic control. To acquaint students with the performance of electronic systems of control and equipment's of electrical networks	

Module 1	**Hours 10**
Economic Load Dispatch (ELD): Characteristics of power generation units, input output characteristics, cost curves, incremental fuel cost curves, formulation of ELD problem, ELD neglecting losses, ELD including losses, transmission loss coefficients in terms of real power, concept of penalty factor, solution methods for ELD, Lambda iteration method, non smooth cost functions, dynamic programming.	
Module 2	**Hours 07**
Unit Commitment (UC): Problem formulation and constraints, UC solution methods, priority list method, dynamic programming, reliability in optimal uc problems, security constraints.	
Module 3	**Hours 10**
Load Frequency Control (LFC):LF problem, modelling of components of generating systems, speed governing system, turbine, generator, load, LFC in single area and two area, steady state and dynamic state analysis, analysis of integral control, tie line bias control, AGC in a restructured power system.	
Module 4	**Hours 08**
Power System Security (PSS): Factors affecting PSS, concept of system security, contingency analysis, Lyapunov method, pattern recognition, security enhancement	
Module 5	**Hours 10**
State estimation in power system and load forecasting: state estimation, least squares estimation, maximum likelihood criterion, detection and identification of bad data, state estimator linear model, load forecasting techniques, short term and long term load forecasting techniques	

Reference books	1. D P Kothari,I J Nagrath , "Power System Engineering", Tata Mc,Graw, 2nd Edition 2. C.L.Wadhwa,"Electrical Power Systems", ,New Age International Publishers, 6th Edition 3. W.D. Stevenson Jr., "Elements of Power System Analysis", McGraw,Hill, 1968. 4. I.J.Nagrath ,D.P.Kothari, "Modern Power System Analysis", Tata Mc,Graw Hill, 4th Edition ,2011

Elective Subjects

Subject Code EE 501	Data Structures and Algorithms	Credits: 3 (3-0-0) Total hours:45
Course Objectives	Following this course, students will be able to: Assess how the choice of data structures and algorithm design methods impacts the performance of programs. Choose the appropriate data structure and algorithm design method for a specified application. Solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, tournament trees, binary search trees, and graphs and writing programs for these solutions. Solve problems using algorithm design methods such as the greedy method, divide and conquer, dynamic programming, backtracking, branch and bound and writing programs for these solutions.	
Module 1		**6 Hours**
Introduction to data structures and objectives, basic concepts Arrays: one dimensional, multi-dimensional, Elementary Operations		
Module 2		**7 Hours**
Stacks: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching; Queues: simple queue, circular queue, dequeue, elementary operations and applications		
Module 3		**8 Hours**
Linked lists: Linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation		
Module 4		**10 Hours**
Trees: Binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees like AVL tree and 2-3 tree, tries and other operations and applications of trees		
Module 5		**15 Hours**
Graphs: Representation, adjacency list, graph traversal, path matrix, spanning tree; introduction to algorithm analysis and design techniques, algorithms on sorting: selection sort, bubble sort, quick sort, merge sort, heap sort, searching, linear and binary search		
Reference books	(8) Alfred V Aho, John E Hopcroft, Jeffrey D. Ullman, "Data structures & Algorithms", Addison Wesley. 2003 (9) Horowitz and Sahni , "Data Structures and Algorithms using C/C++", 2003 (10) Michael T. Goodrich, Roberto Tamassia, "Data Structures and Algorithms in Java", 4th Edition, John Wiley & Sons, Inc.	

Subject Code EE502	Electronic Instrumentation	Credits: 3(3-0-0) Total hours:45
Course Objectives	To understand the basic principles of instruments and measurements and various practical issues related to measurement.	

Module 1	**Hours 14**
Measurement of voltage, current, power, noise, resistance, capacitance, inductance, time, frequency, charge and pulse energy	
Module2	**Hours 7**
Designing for EMC: EMC regulations, typical noise path, methods of noise coupling, and methods of reducing interference in electronic systems.	
Module 3	**Hours 10**
Capacitive coupling, inductive coupling, effect of shield on capacitive and inductive coupling, effect of shield on magnetic coupling, magnetic coupling between shield and inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, shielding properties of various cable configurations, coaxial cable versus shielded twisted pair, braided shields, ribbon cables.	
Module 4	**Hours 14**
Safety grounds, signal grounds, single-point ground systems, multipoint-point ground systems, hybrid grounds, functional ground layout, practical low frequency grounding, hardware grounds, grounding of cable shields, ground loops, shield grounding at high frequencies, guarded instruments. Protection Against Electrostatic Discharges: Static generation, human body model, static discharge, ESD protection in equipment design.	

Reference books	1. Clyde F JrCoombs,"Electronic Instrument handbook", Amazon, 1999 2. Joseph J. Carr,"Elements of Electronic Instrumentation and Measurements", 3rd Ed, Prentice Hall, 1995 3. Kim R. Fowler,"Electronic Instrument Design", Oxford University Press, 1996. 4. Henry W.Ott,"Noise Reduction Techniques in Electronic Systems", 2nd Ed; John Wiley & Sons, 1988.

Subject Code EE 503	**Elements of Analog and Digital Communication**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To give a basic insight to Basic Communication Engineering	
Module 1 Introduction to Analog and Digital Communication		**Hours 12**
Bandwidth and information capacity, transmission modes, signal analysis, noise considerations. modulation and demodulation concepts (AM, FM, PM), TDM and FDM concepts, Classification of amplifiers (Class A, B, and C), tuned amplifiers, oscillators, amplitude modulation, demodulation circuits, mixer, TRF, super heterodyne and direct conversion receivers, monochrome TV transmitter and receivers.		
Module 2 Digital and data communication		**Hours 12**
Sampling theorem, coding and decoding, pulse modulation, waveform coding techniques, pulse code modulation, channel noise and error probability, quantisation noise, signal to noise ratio, FSK, PSK, modem.		
Module 3 Serial and parallel interface		**Hours 09**
Computer network configurations and protocols, OSI reference model, Internet protocol, IP protocol: forwarding and addressing in the internet, routing algorithms, packet switching.		
Module 5 Satellite ,Mobile and optical fibre communication		**Hours 12**
Orbital patterns, geostationary satellites, frequency band allocation, digital telephony, PSTN and cellular telephony, Optical fibre communication: Mode of signal transmission, signal sources and detectors, attenuators and channel capacity.		
Reference books	1. Wayne Tomasi, "Electronic Communication Systems", Pearson Education, 4th Edition, 2002 2. Kennedy, "Communication Systems", 4th edition. 3. Gary Miller, "Modern Electronic Communication", 7th Edition. 4. Andrew S. TanenBaum, "Computer Networks", 3rd Edition. 5. William C. Y. Lee, "Mobile Cellular Telecommunication", 2nd Edition.	

Subject Code EE 504	**Digital Signal Processing**	Credits: 3 (3-0-0) Total hours: 56
Course Objectives	Basic concepts of discrete time signals and systems, interconnection of the systems and filtering. Transform analysis of LTI systems; system functions; All pass systems, minimum phase systems, linear systems with generalized linear phase; structures for discrete time systems, lattice structures; FIR and IIR filter design techniques; The discrete fourier transform, computational aspects and fast algorithms; miscellaneous topics.	

Module 1	**8 hours**
Review of signals and systems: Motivation and introduction to the course, Basic concepts of signals and systems, interconnection of the systems and filtering, Z – transform and the Region of convergence of the system, Complex convolution theorem, and system described by difference equations, Frequency response of LTI systems and system functions.	
Module2	**10 hours**
Structures for Discrete Time systems: Representation of system described by Linear Constant Coefficient Difference Equations, digital filter structures, relation between magnitude and phase, All pass systems, Minimum phase systems, Lattice Structures, Linear Systems with Generalized Linear Phase.	
Module 3	**10 hours**
Filter Design Techniques: Design of IIR filters and different transformations, IIR filter design techniques, FIR filter by windowing, FIR filter by the Kaiser window, and Optimum approximation of FIR Filters.	
Module 4	**9 hours**
The Discrete Fourier Transform and Computational Aspects: Orthogonal transform, discrete Fourier transform (DFT), Relation between Fourier transform and DFT, Circular Convolution, DFT properties, Computation of DFT, Linear Convolution using the DFT, Fast computation of DFT.	
Module 5	**8 hours**
DSP Algorithm implementation and Finite Wordlength Effect: Number representation and overflow, Quantization Process and Errors, fixed and floating point numbers, coefficient quantization, A/D conversion noise analysis, Low sensitivity digital filters, Limit Cycle oscillations in IIR digital filters.	

Reference books	1. A. V. Oppenheim and Schafer, “Discrete time Signal processing,” 3rd Edition, PHI. 2. S. K. Mitra, “Digital Signal Processing,” 3rd Edition, TMH.

Subject Code EE505	**Digital Computer Organization and Architecture (COA)**	**Credits: 3 (3-0-0)** **Total hours:45**
Course Objectives	To develop an understanding of the nature and characteristics of the architecture and design of the modern computer systems.	
Module 1		**6 Hours**
Introduction to computer architecture and organization: digital components, Von Neumannmachine architecture, Flynn classification register transfer language: micro operations, data transfer operations, arithmetic, logic and shift micro operations and their hardware implementations as a simple arithmetic and logic unit.		
Module 2		**13Hours**
CPU Organization: Addressing techniques, instruction set design, example for zero address, one address, two address and three address machines, stack, accumulator and general purpose register organization. Arithmetic algorithms: Arithmetic and Logic Unit, adders, multiplication, add and shift method, Booth's Multiplier, m -array multiplier, division, restoring and non restoring method.		
Module 3		**12 Hours**
Pipelining: Pipeline structure, pipeline performance measures, pipeline types, memory organization, memory device characteristics, RAM organization, virtual memory, paging and segmentation, high speed memories.		
Module 4		**14 Hours**
Control unit design, hardwired and micro programmed control unit design, implementation techniques, memory hierarchies, input-output design, IO interface, bus structure, modes of data transfer, interrupts, input output processor, serial communication.		
Reference books	1. J.L. Hennessy and D.A. Patterson, "Computer Architecture: A Quantitative Approach", 4th Edition, Elsevier. 2. M. Morris Mano, "Computer System Architecture", PHI. 3. Carl Hamacher, "Computer Organization", McGraw-Hill, 5th Ed. 4. J.P Hayes, Computer Architecture & Organization, McGraw-Hill.	

Subject Code EE 506	**Advanced Control Systems**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To incite a wide knowledge on the description and stability of non-linear system. To examine the conventional technique of non-linear system analysis. To solve the analysis discrete time systems using conventional techniques. To understand the analysis of digital control system using state-space formulation. To look at the formulation and analysis of multi input multi output (MIMO) system	

Module 1	**Hours 11**
Discrete control system: Introduction to discrete time control system, block diagram of a digital control system, sampling process, data reconstruction and hold circuits, zero and first order hold, review of z- transforms and inverse z- transforms, solution of difference equations, pulse transfer function, pulse transfer function with dead time, system time response, realization of pulse transfer functions, stability studies.	

Module 2	**Hours 10**
State variable analysis of discrete system: Concept of controllability and observability for a linear time invariant discrete time control system, condition for controllability and observability, state feedback, condition for arbitrary pole placement, design via pole placement, state observers.	

Module 3	**Hours 12**
Non Linear system: Characteristics of non- linear systems, types of non-linearity, phase plane analysis, construction of phase trajectory, Isocline method and delta method ,singular points and classification, describing function analysis, basis of describing function approach, describing functions of common non- linearity namely dead zone saturation, ideal relay, combined dead- zone and saturation, relay with hysteresis	

Module 4	**Hours 12**
Stability of non-linear systems: Liapunov Methods, Liapunov stability, definition of stability, asymptotic stability and instability, quadratic forms and sign definiteness of scalar function, Liapunov stability theorems, Liapunov stability analysis of LTI continuous and discrete time systems methods of construction of Liapunov function for non- linear systems.	

Reference books	1. M.Gopal, "Control System Principles and Design",TataMcGraw Hill,4th edition 2. I. J. Nagrath, M. Gopal, "Control Systems Engineering" New Age International, 4th Edition 3. K. Ogata, "Modern Control Engineering", PHI, 3rd Edition 4. K. Ogata, "Discrete Time Control Systems", Pearson Education, 2nd Edition

Subject Code EE507	**Travelling Waves on Transmission System**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To understand the various types of travelling waves on transmission system.	

Module 1	**Hours : 12**
The line equations: The ideal (no-loss) line, the distortion-less line, line with small losses, exact solution of the infinite line, line of finite length, attenuation and distortion of traveling waves. Reflection of traveling waves: behaviour of a wave at a transition point, dissimilar voltage and current waves, typical cases, current-limiting reactors. Successive reflections: the reflection lattice, construction and use of the lattice-diagram, charging of a line from various sources, reflection between a capacitor and a resistor, effect of short lengths of cable, effect of insulator capacitance.	
Module 2	**Hours : 10**
Traveling waves on multi conductor systems: The general differential equations of traveling waves, transition points on multi conductor circuits, multi velocity waves, surge tests on transmission lines, physical concept of multi velocity waves, two-conductor system, multi conductor system.	
Module 3	**Hours : 10**
Theory of ground-wires: Direct stroke to a tower, effect of reflections up and down the tower, tower grounding. The counterpoise: Multi velocity waves on the counterpoise, tests on the counterpoise, successive reflections on the insulated counterpoise.	
Module 4	**Hours : 13**
Induced lightning surges: The field gradient, induced surges with ideal ground wires. Arcing grounds: normal frequency arc extinction - single-phase and three-phase, oscillatory-frequency arc extinction, high-frequency effects, interruption of line-charging currents, cancellation waves, initiated waves, steady-state waves, recovery voltage, restriking phenomena.	

Reference books	1) L. V. Bewley, "Traveling Waves on Transmission Systems," John Wiley and Sons, 1951. 2) H. H. Skilling, "Electric Transmission Lines," TMH, 1951. 3) F. Woodruff, "Principles of Electric Power Transmission," John Wiley and Sons, 1952 .

Subject Code EE 508	**Utilisation of Electrical Energy**	Credits: 3 (3-0-0) Total hours:45
Course Objectives	Understand concept of illumination systems, heating and welding systems. Learn the requirements of traction systems.	

Module 1	**Hours 14**
Electric traction: requirements of an ideal traction system, systems of traction, requirements of ideal traction motors, comparison and control of traction motors, mechanics of train movement, tractive effort for acceleration ,train resistance, gradient, coefficient of adhesion, speed time curves, specific energy consumption.	
Module 2	**Hours 12**
Electric heating: advantages, classification of heating equipment's, methods of heat transfer, resistance heating, design of heating element, induction heating, eddy current heating, dielectric heating.	
Module 3	**Hours 12**
Electric welding: resistance welding, arc welding. Electrolytic processes: Faraday's laws of electrolysis, calculation of current required and related definitions, factors governing the character of deposits, preparation of work for electroplating, electro-extraction and refining of copper and aluminium.	
Module 4	**Hours 7**
Illumination: definition, illumination standards, laws of illumination, lighting calculations, polar curves, Rousseau's construction, illumination measuring devices, various illumination devices.	

Reference books	1. Partab , Art and Science of Utilization of Electrical Energy. 2. E. O. Taylor, Utilization of Electric Energy. 3. C. L Wadhwa , Generation ,Distribution and Utilization of Electrical Energy.

Subject Code EE509	**Introduction to Database management Systems**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	This course covers the relational database systems RDBS - the predominant system for business, scientific and engineering applications at present.	
Module 1		**6 Hours**
Introduction & need for database systems, views of data, data models, database system architecture, database users and administrator.		
Module 2		**10 Hours**
Entity relationship model (E-R model), E-R diagrams, introduction to relational databases, keys, relational algebra,domain, relational calculus, tuple relational calculus.		
Module 3		**15 Hours**
SQL: A relational database language, data definition in SQL. SQL queries: The form of a basic SQL query, union, intersect, and except, aggregate operators, specifying constraints,view and joins in SQL, specifying constraints, introduction to nested queries.		
Module 4		**14 Hours**
Functional dependencies, non-loss decomposition, first, second, third normal forms, Boyce Codd normal form, transaction concepts, transaction recovery, ACID properties, Concurrency. Storage: overview of physical storage media, magnetic disks, RAID, tertiary storage,file organization, organization of records in files, indexing and hashing, database security.		
Reference books	(1) Korth, Silberschatz, "Database System Concepts", 4th Ed., TMH, 2003. (2) Elmsari and Navathe, "Fundamentals of Database Systems", 4th Ed., A. Wesley, 2004. (3) Raghu Ramakrishnan , Johannes Gehrke, " Database Management Systems", 3rd Edition, , McGraw- Hill, 2003. (4) J D Ullman, "Principles of database systems", 2001.	

Subject Code EE 510	**Computer Networks**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	This course focuses on understanding the design of computer networks, assimilating hubs into a personal network.	
Module 1		**8 Hours**
Introduction to computer networks, overview of OSI reference model. Topology design, problems and protocols, practical local area network design and implementation. IEEE LAN standards, logical link control protocols, HDLC, ALOHA, SLOTTED ALOHA, FDDI, client server model and related softwares. Computer networks and internet, network edge, network core, network access, delay and loss.		
Module 2		**16 Hours**
Transport layer services, UDP, TCP, new transport layer protocols, congestion control and resource allocation, new versions of TCP, network layer services, routing, IP, routing in internet, router, IPV6, multicast routing.		
Module 3		**10 Hours**
Link layer services, error detection and correction, multiple access protocols, ARP, ethernet, hubs, bridges, switches, wireless links, mobility, PPP, ATM, MPLS, VLAN.		
Module 4		**11 Hours**
Multimedia networking, streaming stored audio and video, real-time protocols, security, Cryptography, authentication, integrity, key distribution, network management, firewalls, brief functioning of upper layers, e-mail and other application.		
Reference books	1. J. F. Kurose and K. W. Ross, "Computer Networking: A Top-Down Approach Featuring Internet", 3/e, Pearson Education, 2005. 2. Peterson L.L. & Davie B.S., "Computer Networks, A systems approach", 3/E, Harcourt Asia, 2003. 3. Andrew. S. Tanenbaum, "Computer Networks", Prentice Hall of India, 5th Edn, 2002. 4. Fred Halsall, "Data Communications, Computer networking on OSI", Addison Wesley Publishing Co., 2nd Edition, 2002. 5. William Stallings, "Data & Computer Communications", 2nd Edition, Maxwell, MacMillan International Edn. 2003. 6. Behrouz A. Forouzan, "Data Communications & Networks", 3rd Ed., TMH.	

Subject Code EE 511	**Embedded Systems**	Credits: 3(3-0-0) Total hours:45
Course Objectives	To give ideas about embedded systems and system development. To impart knowledge about real time operating systems and microcontrollers	
Module 1		**Hours 10**
Introduction to embedded systems: embedded system examples, parts of embedded system- processor, power supply, clock, memory interface, interrupt, I/O ports, buffers, programmable devices, ASIC,etc. interfacing with memory and I/O devices. memory technologies – EPROM, Flash, OTP, SRAM,DRAM, SDRAM etc.		
Module2		**Hours 8**
Embedded system design: embedded system product development life cycle (EDLC), hardware development cycles, specifications, component selection, schematic design, PCB layout, fabrication and assembly. Product enclosure design and development. Embedded system Development Environment – IDE, cross compilation, simulators/emulators, hardware debugging. hardware testing methods like boundary scan, In Circuit Testing (ICT) etc. Bus architectures like I^2C, SPI, AMBA, CAN etc.		
Module 3		**Hours 12**
Operating systems: concept of firmware, operating system basics, real time operating systems, tasks, processes and threads, multiprocessing and multitasking, task scheduling, task communication and synchronisation, device drivers.		
Module 4		**Hours 15**
System design examples : system design using ARM/PSoC/MSP430 processor		
Reference books	1. J.W. Valvano, Embedded Microcomputer System: Real Time Interfacing, Brooks/Cole, 2000. 2. David Simon, An Embedded Software Primer, Addison Wesley, 2000. 3. Shibu K.V.: Introduction to Embedded Systems, Tata McGraw Hill, 200	

Subject Code EE512	High Voltage DC (HVDC) Transmission	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	The course aims at use of high voltages as the key to efficient transmission and distribution of electrical power. To have an overview about different forms of insulation and their behaviour, over voltage conditions and protection of equipment's. To analyse the malfunctioning of converters and protection.	
Module 1		**Hours : 8**
Historical development of HVAC and HVDC links, comparison, economics of power transmission, technical performance, reliability, limitations, application of dc transmission, description of DC Transmission System, types of DC links and converter station, planning for HVDC transmission. modern trends in DC transmission.		
Module 2		**Hours : 10**
Thyristor valve: Introduction, thyristor devices, thyristor valve, valve test, recent trends. analysis of HVDC converters; pulse number, choice of converter configuration, Simplified analysis of Graetz circuit, convertor bridge characteristics, characteristics of a twelve pulse converters, detailed analysis of converters.		
Module 3		**Hours : 8**
Converter and HVDC system control: general, principles of dc link control, converter control characteristics, system control hierarchy firing angle control, current and extinction angle control, starting and stopping of dc link, power control, higher level controllers, telecommunication requirements.		
Module 4		**Hours :9**
Converter faults and protection: introduction, converter faults, protection against over currents over voltages in a converter station, surge arrests, protection against over voltages. smoothing reactor and dc line; introduction, smoothing reactors, dc line, transient over voltages in dc line, protection of dc line, dc breakers, monopolar operation, effects of proximity of ac and dc transmission lines.		
Module 5		**Hours : 10**
Reactive power control; introduction, reactive power requirements in steady state, sources of reactive power, static var systems, reactive power control during transients, harmonics and filters; introduction, generation of harmonics, design of ac filters, dc filters, carrier frequency and RI noise, multi terminal dc systems; introduction, potential applications of MTDC systems, types of MTDC systems, control and protection of MTDC systems, control and protection of MTDC Systems study of MTDC systems.		
Reference books	1) K. R. Padiyar, "HVDC Power transmission System," New age International, 1996. 2) J. Arrillaga, "HVDC transmission," IET, 1998. 3) E.X. Kimbark, "Direct Current Transmission," Vol. I, Wiley Interscience, Newyork, 1971.	

Subject Code EE513	**Flexible AC Transmission Systems**	Credits: 3 (3-0-0) Total hours: 56
Course Objectives	To enhance the transmission capability of transmission system by shunt and series compensation using static controllers. To understand the concept of flexible AC transmission and the associated problems. To review the static devices for series and shunt control. To study the operation of controllers for enhancing the transmission capability.	

Module 1	**Hours : 10**
FACTS concepts and general system consideration: Power flow in AC Systems. Definition of FACTS, power flow control, constraints of maximum transmission line loading. Benefits of FACTS transmission line compensation: uncompensated line, shunt compensation. series compensation, phase angle control.	
Module 2	**Hours : 9**
Static shunt compensators: SVC: Static Var Compensator, and STATCOM: static synchronous compensator. operation and control of TSC:Thyristor Switched Capacitor, TSR: Thyristor Switched Reactor, TCR: Thyristor Controlled Reactor, and STATCOM, compensator control, comparisons between SVC and STATCOM.	
Module 3	**Hours : 9**
Static series compensation: TSSC:Thyristor Switched Series Capacitor, SSSC: static Synchronous Series Compensator, Static voltage and phase angle regulators TCBR: Thyristor Controlled Braking Resistor, TCPAR: Thyristor Controlled Phase Angle Regulator. Operation and control applications.	
Module 4	**Hours : 9**
Unified Power Flow Controller: circuit arrangement, operation and control of UPFC, basic principle of P and Q control, independent real and reactive power flow control, applications, introduction to interline power flow controller.	
Module 5	**Hours : 8**
Introduction to APF technology, solutions for mitigation of harmonics, classification of power filters- passive filters, active filters, hybrid filters; active filters applications depending on power quality issues; selection of power filters; categorization of active power filter, converter based categorization, topology based categorization, supply system based categorization, selection considerations of APFS; technical and economic considerations.	

Reference books	1) N.G Hingorani, L. Gyugyi,"Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001. 2) P.Kundur , "Power System Stability and Control", McGraw-Hill EPRI Power System Engineering Series, 3) K. R. Padiyar, "Power System Dynamics, Stability and Control", 2nd Edition, B.S. Publishers. 1994. 4) T.J.E Miller, "Reactive Power Control in Electric Systems", Wiley

Subject Code EE514	Soft Computing Techniques	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	This course presents the basics of neural networks and essentials of artificial neural networks with single layer and multilayer feed forward networks. Also deals with fuzzy sets and fuzzy logic system components. The neural network and fuzzy network system application to electrical engineering is also presented.	
Module 1		**Hours : 10**
Introduction to biological and artificial neuron models, operations of artificial neuron, types of neuron activation function, history of artificial neural systems development, Mcculloch-Pitts neuron model, ANN architectures, neural dynamics (activation and synaptic), neural processing,, learning strategies, learning rules.		
Module 2		**Hours : 10**
Classification model, features, and decision regions, discriminant functions, models of Artificial Neural Networks: feed forward network, feedback network, single and multilayer feed forward neural networks- introduction, perceptron models: discrete, continuous and multi-category, training algorithms: discrete and continuous perceptron networks, perceptron convergence theorem, limitations of the single layer perceptron model (XOR Problem), Applications; credit assignment problem, generalized delta rule, Back Propagation Algorithm (BPA), learning difficulties and improvements.		
Module 3		**Hours : 8**
Associative memories: Hebbian learning, general concepts of associative memory (associative matrix, association rules, hamming distance, Bidirectional Associative Memory (BAM) architecture, architecture of Hopfield network: discrete and continuous versions, storage and recall algorithm. Counter propagation networks, Full CPN, Forword only CPN, Training Phases, ADALINE and MADALINE networks. Neural network applications: process identification, control, fault diagnosis and load forecasting. Applications of neural networks.		
Module 4		**Hours : 12**
Introduction to classical sets - properties, operations and relations; fuzzy sets, membership, uncertainty, operations, properties, fuzzy relations, cardinalities, membership functions. Fuzzification, membership value assignment, development of rule base and decision making system, fuzzy inference systems: Mamdani max-min and max-product composition scheme, defuzzification to crisp sets, defuzzificationmethods:centroid of area, bisector of area, mean, smallest, and largest of maximum. Design of control rules: trapezoidal MF, triangular MF and Gaussian MF. Rule base fuzzy logic applications: fuzzy logic control and fuzzy classification. Applications of fuzzy systems.		
Module 5		**Hours : 5**
Introduction to Type-2 FLC: The structure of Type-2 FLC, Type-2 fuzzy inference system with different fuzzy MFs (Trapezoidal membership function, Triangular MF and Gaussian MF).		
Reference books	1) J. M. Zurada, "Introduction to artificial neural networks,"Jaico publishing, 1997. 2) Simon Haykin, "Neural Networks A Comprehensive Foundation," PHI, 1999. 3) J. S. R. Jang, C. T. Sun , E. Mizutani, "Neuro-Fuzzy and Soft Computing A Computational Approach to Learning and Machine Intelligence," PHI, 2002. 4) Timothy J Ross, "Fuzzy Logic with Engineering Applications," TMH, 2007.	

Subject Code EE515	Renewable Energy Systems	Credits: 3 (3-0-0) Total hours:45
Course Objectives	To explain concept of various forms of renewable energy and to outline the utilization of renewable energy sources for both domestic and industrial applications	

Module 1	**Hours: 10**
Introduction to renewable energy, various aspects of energy conversion, principle of renewable energy systems, environment and social implications Solar Energy: Solar radiation its measurements and prediction, solar thermal flat plate collectors, concentrating collectors, applications, heating, cooling, desalination, power generation, drying, cooking etc, principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, and water pumping, power generation schemes.	
Module2	**Hours: 9**
Wind Energy: Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, aerodynamics of wind turbine rotor, site selection, wind resource assessment, wind energy conversion devices: classification, characteristics, and applications. Hybrid systems, safety and environmental aspects.	
Module 3	**Hours: 9**
Bio-Energy: Biomass resources and their classification, chemical constituents and physicochemical characteristics of biomass, biomass conversion processes, thermo chemical conversion: direct combustion, gasification, pyrolysis and liquefaction. Biochemical conversion: anaerobic digestion, alcohol production from biomass.Chemical conversion process: hydrolysis and hydrogenation. Biogas: generation, types of Biogas Plants, applications	
Module 4	**Hours:9**
Hydrogen And Fuel Cells: Thermodynamics and electrochemical principles, basic design, types, and applications, production methods,Biophotolysis: Hydrogen generation from algae biological pathways, storage gaseous, cryogenic and metal hydride and transportation. Fuel cell: principle of working, various types, construction and applications.	
Module 5	**Hours: 8**
Other Types Of Energy: ocean energy resources: principles of ocean thermal energy conversion systems, ocean thermal power plants,and principles of ocean wave energy conversion and tidal energy conversion, microhydelpower, site selection, construction, environmental issues.Geothermal energy, types of geothermal energy sites, site selection and geothermal power plants. MHD Power Generation.	

Reference books	(1) G. D.Rai, "Non-conventional Energy Sources", Khanna Publishers, Delhi, 2007. (2) S.P.Sukhatme, "Solar Energy", TMH, New Delhi, 2006. (3) Godfrey Boyle, "Renewable Energy: Power for a sustainable future", Oxford University press, Second edition.

Subject Code EE 516	**Static Relays**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To understand the causes of abnormal operating conditions (faults, lightning and switchingsurges) of the apparatus and system.To understand the characteristics and functions of static relays and protection schemes and to give an insight on Static Relay protection schemes.	
Module 1		**Hours 09**
Power system protection and its requirements, conventional Vs static relays, steady state and transient performance of signal deriving elements signal mixing techniques and measuring techniques, construction and characteristics function of static relays, static relay components.		
Module 2		**Hours 12**
Phase comparator directional units, amplitude comparator directional units, poly phase directional relays, differential relays: operating characteristics, restraining characteristics, types of differential relays, analysis of electromagnetic and static differential relays, static relay scheme.		
Module 3		**Hours 12**
Principle and practical circuits of Instantaneous over current relays, time current relays, time over current relays. Distance relays: standard three zone protection, characteristics and types, switched distance scheme, poly phase distance relays, operating time characteristics, static distance relay scheme.		
Module 4		**Hours 12**
Pilot wire and carrier current schemes, pilot relaying scheme, selection of suitable static relaying scheme for transmission lines. Implementation of over current, directional, impedance and mho relays using Microprocessor/Microcontroller.		
Reference books	1. MadhavaRao, T.S., "Power System Protection, Static Relays", McGraw Hill, New Delhi, 1991. 2. Van.C.Warrington, "Protective Relays, Their Theory and Practice", Vols. I & II, Chapman & Hall Ltd. London, 1994. 3. Ram.B., "Fundamentals of Microprocessors and Microcomputers", M/s. DhanpatRai& sons, New Delhi, 1992.	

Subject Code EE517	**Photovoltaic and its applications**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	1. Learn the fundamentals of solar energy conversion systems, available solar energy and the local and national needs, solar engineering applications, emerging technologies, 2. Understand the interdisciplinary approach for designing stand-alone PV systems, predicting performance with different systems, Implementing design with cost analysis.	

Module 1	**Hours: 5**
Solar energy: solar insolation vs world energy demand, current energy consumption from different sources, environmental and health effects. Sustainable Energy: production and storage, resources and utilization.	
Module2	**Hours: 10**
Solar thermal conversion: Low, medium and high temperature collectors, types of solar energy collectors; heat storage, storage media, steam accumulator, other storage systems, heat exchangers and applications of stored energy. Thermoelectric systems: Thermoelectricity, Peltier effect, Seebeck effect; Thermoelectric materials, Bismuth telluride, automotive thermoelectric generators, radioisotope thermoelectric generator; thermoelectric power generators, thermoelectric refrigerators and heat pumps.	
Module 3	**Hours: 10**
Photovoltaic (PV): Fundamentals of solar cells: types of solar cells, semiconducting materials, band gap theory, absorption of photons, excitation and photoemission of electrons, band engineering, Solar cell properties and design, p-n junction photodiodes, depletion region, electrostatic field across the depletion layer, electron and holes transports, device physics, charge carrier generation, recombination and other losses, I-V characteristics, output power, single junction and triple-junction solar panels, metal-semiconductor heterojunctions and semiconducting materials for solar cells. solar cell applications: pv cell interconnection, module structure and module fabrication, equivalent circuits, load matching, efficiency, fill factor and optimization for maximum power; design of stand-alone PV systems, system sizing, device structures, device construction, installation, measurements; DC to AC conversion, inverters, on-site storage and grid connections; Solar cell manufacturing processes: material resources, chemistry and environmental impacts; low cost manufacturing processes.	
Module 4	**Hours: 10**
Optical engineering: Optical design, anti-reflection coatings, beam splitters, surface structures for maximum light absorption, operating temperature Vs. conversion efficiency, types of solar energy concentrators, fresnel lenses and fresnel reflectors, operating solar cells at high incident energy for maximum power output.Cost analysis and environmental issues: Cost analysis and pay back calculations for different types of solar panels and collectors, installation and operating costs;	

environmental and safety issues, protection systems, performance monitoring.	
Module 5	**Hours: 10**
Thin film solar cells: Single crystal, polycrystalline and amorphous silicon solar cells, cadmium telluride thin-film solar cells, conversion efficiency; current trends in photovoltaic research and applications; nanotechnology applications, quantum dots, solution based processes solar cell production.Photo electrochemical cells for hydrogen production: photo electrochemical electrolysis, photoelectron chemical cells for hydrogen production, solar hydrogen efficiency, hydrogen storage, hydrogen economy.	
Reference books	(1) Jasprit Singh, "Semiconductor Devices,Basic Principles" , Wiley,(2001) (2) Jenny Nelson "The Physics of Solar Cells" , Imperial College Press (2003) (3) Stephen J. Fonash "Solar Cell Device Physics", 2nd edition ,Academic Press (2010)

Subject Code EE 518	**Power System Restructuring**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To provide in-depth understanding of operation of deregulated electricity market systems and examine topical issues in electricity markets and how these are handled world-wide in various markets. To analyse various types of electricity market operational and control issues using new mathematical models	
Module 1		**Hours 08**
Introduction: Market models, entities , key issues in regulated and deregulated power markets, electricity markets, California market, New England ISO, Midwest ISO, Nordic pool, power market in China. components of restructured system		
Module 2		**Hours 10**
Operational and planning activities of a generation company: electricity pricing and forecasting, price based unit commitment design, security constrained unit commitment design. , ancillary services for restructuring, Automatic Generation Control.		
Module 3		**Hours 10**
Open access Transmission system: transmission pricing in open access system, open transmission system operation, congestion management in open access transmission systems, FACTS in congestion management, open access, coordination strategies, power wheeling transmission		
Module 4		**Hours 07**
Cost allocation methods open access distribution, changes in distribution operations, the development of competition, maintaining distribution planning		
Module 5		**Hours 10**
Power Market Development: Electricity Act, 2003, key issues and solution, developing power exchanges suited to the Indian market, challenges and synergies in the use of it in power, competition, Indian power market, Indian energy exchange, Indian power exchange, infrastructure model for power exchanges, congestion management, day ahead market, online power trading.		
Reference books	1. Loi Lei Lai, "Power System Restructuring and Deregulation", John Wiley & son LTD, New York, 2001. 2. Mohammad Shahidehpour, HatimYamin, "Market operations in Electric power systems", John Wiley & son LTD, Publication, 2002. 3. LorrinPhilipson, H. Lee Willis, "Understanding Electric Utilities and Deregulation" Taylor & Francis, New York 2006. 4. MohammadShahidehpour, MuwaffaqAlomoush, "Restructured Electrical Power Systems", Marcel Dekker, INC., New York, 2001.	

Subject Code EE 519	**Distribution automation and Smart Grid**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To understanding the distribution automation and smart grid architecture, working.	
Module 1		**4 hours**
Distribution system Planning and forecasting techniques, load characteristics, definitions, tariffs and metering of energy, distribution transformers, types, distribution sub-stations and primary system.		
Module2		**12 hours**
Voltage drop and power loss calculations, distribution feeder costs, capacitors in distribution systems, justification for capacitors, distribution system automation, automation communication systems.		
Module 3		**12 hours**
Introduction to smart grid, smart grid functions, advantages, Indian smart grid, key challenges for smart grid, smart grid architecture, components, architecture of smart grid design - transmission & distribution.		
Module 4		**12 hours**
Automation computational intelligence techniques, distribution generation technologies, introduction to renewable energy technologies, Micro grids, storage technologies, Electric vehicles and plug in hybrids, synchrophasor measurement Units (PMUs), Wide Area Measurement Systems (WAMS), control of smart power grid system.		
Module 5		**5 hours**
Renewable Integration, Electric Vehicles and plug - in hybrids, indian smart grid. Case studies		
Reference books	1. TuranGonen, "Electric Power Distribution Systems", CRC Press, 2006. 2. Pabla, A. S, "Electric Power Distribution", 6th Edition, Tata McGraw-Hill Education, 2011. 3. M. V. Deshpande, "Electrical Power System Design", Tata McGraw-Hill Education, 2001. 4. Gil Masters, "Renewable and Efficient Electric Power System", Wiley-IEEE Press, 2004. 5. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer Edition, 2010.	

Subject Code EE520	Power Quality	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To study the various issues affecting power quality, their production, monitoring and suppression. To understand about the concepts of power quality problems and mitigation techniques. To be familiarise with various control strategies and controllers.	

Module 1	**Hours : 12**
Introduction to power quality: terms and definitions: overloading, under voltage, over voltage. Concepts of transients: short duration variations such as interruption, long duration variation such as sustained interruption. Voltage sag, voltage swell, voltage imbalance, voltage fluctuation, over voltages, under voltages, power frequency variations. Harmonics: harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics: harmonics Vs transients. Effect of harmonics, harmonic distortion, voltage and current distortion, harmonic indices, inter harmonics, resonance. Harmonic distortion evaluation, devices for controlling harmonic distortion, passive and active filters. IEEE and IEC standards of power quality,	
Module 2	**Hours : 10**
Introduction to APF technology, solutions for mitigation of harmonics, classification of power filters- passive filters, active filters, hybrid filters; active filters applications depending on power quality issues; selection of power filters; categorization of active power filter: converter based categorization, topology based categorization, supply system based categorization, selection considerations of APFS; technical and economic considerations.	
Module 3	**Hours : 10**
Introduction to active power filter control strategies. shunt active filter basic compensation principle, Clark's transformations, parks transformations, active power filter control strategies, signal conditioning, current control techniques for derivation of gating signals, generation of gating signals to the devices of the APF, hysteresis current control scheme and adaptive hysteresis current control scheme, derivation of compensating signals, compensation in frequency domain, compensation in time domain.	
Module 4	**Hours : 13**
Control strategies Instantaneous active and reactive power (p-q) control strategy, Instantaneous active and reactive current (I_d-I_q) control strategy, and perfect harmonic cancellator. Introduction to Dc link voltage regulation: Dc link voltage regulation with PI Controller, Type-1 fuzzy logic controller, Type-2 fuzzy logic controller, and neural networks.	

Reference books	1) H. Akagi, "Instantaneous Power Theory and Applications to Power Conditioning," IEEE Press, 2007. 2) G.T. Heydt, "Electric Power Quality," 2nd Edition, West Lafayette, IN, Stars in a Circle Publications, 1994. 3) M.H.J Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions," NewYork: IEEE Press, 1999.

Subject Code EE521	**Real Time Control of Power System**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	To learn basics of SCADA and to develop skills to work on SCADA features. Aims to build good understanding about the basics of industrial automation using SCADA, PLC and HMI.	
Module 1		**Hours : 8**
Introduction to Factory & Process Automation, PLC, Networking standards. Vertical Integration of Industrial Automation, field bus and Ethernet. HMI Systems: Necessity and Role in Industrial Automation, Text display, operator panels, Touch panels, Panel PCs, Integrated displayers (PLC & HMI).		
Module 2		**Hours : 14**
Supervisory Control and Data Acquisition (SCADA), introduction to SCADA: grid operation and Control. remote terminal unit (RTU) and communication practices: Major Components. Sub-load dispatch center (SUB-LDC): Work Stations, FEPS: Function of FEPS (Front End Processors), Routers. Real time software: classification of programs. computer control of electrical power systems. southern regional load dispatch center (SRLDC): functions and responsibilities of SRLDC. Developer and runtime packages, architecture, tools, tag, internal & external graphics, alarm logging, tag logging, structured tags, trends, history, report generation, VB & C Scripts for SCADA application.		
Module 3		**Hours : 11**
Distributed Control Systems (**DCS**), difference between SCADA system and DCS, architecture, local control unit, Programming language, communication facilities, operator interface, engineering interfaces.		
Module 4		**Hours : 12**
Applications of SCADA & DCS, Case studies of process plants using SCADA & DCS, advanced features / options in SCADA & DCS, role of PLC in DCS and SCADA, comparison, field devices (Transducers, drives etc.) in DCS/SCADA.		
Reference books	1) John W. Webb, Ronald A. Reis, "Programmable Logic Controllers," Prentice Hall of India, New Delhi, 1995. 2) Michael P. Lukas, "Distributed Control Systems," Van NostrandReinfold Company, 1995. 3) Hassan Bevrani, "Robust Power System Frequency Control Power Electronics and Power Systems," Springer, 2009. 4) T. Cegrell, "Power System Control - Technology," Prentice Hall International Ltd., 1986.	

Subject Code EE 522	**Optimization Techniques**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	Students will be able to state the different types of optimization problems, their formulation and solution techniques. Students will be able to understand the mechanisms of various traditional and modern optimization techniques. Students will be able to apply the optimization techniques for practical applications	
Module 1 Linear models		**Hours 12**
Introduction to optimisation ,classification of optimisation problems, linear programming, problem formulation, maximization and minimization problems, graphical method, simplex method, Big M, two phase method, duality in linear programming, dual simplex method, sensitivity analysis		
Module 2 Network models and Dynamic programming		**Hours 09**
Shortest path, maximum flow and minimum cost problems, dynamic programming: multistage decision processes, linear programming as a case of dynamic programming, application of dynamic programming in resource allocation, production scheduling.		
Module 3 Nonlinear programming-Unconstrained		**Hours 12**
Single variable optimization, region elimination methods, point estimation methods, gradient based methods, multivariable optimization, direct search methods and gradient search methods		
Module 4 Nonlinear programming-Constrained		**Hours 12**
Constrained optimization, Kuhn Tucker conditions, transformation methods, Lagrangian multiplier methods, penalty function methods, gradient projection method, Applications of non-linear programming in Engineering design		
Reference books	1. S.S.Rao , "Engineering Optimization", New Age International Publishers,Third edition,2013 2. Fletcher, "Optimization techniques", John Wiley and Sons. 3. K.V.Mittal, "Optimization Methods", Wiley Eastern, 2003. 4. H.A.Taha, "Operations Research", Pearson, 2007. 5. Kalyanmoy Deb, "Optimization for Engineering Design",PHI	

Subject Code EE 523	**Simulation and Modelling of Power Converters**	**Credits: 3 (3-0-0)** **Total hours:45**
Course Objectives	To study the basics of static and dynamic models of power electronic switches. And learn usage of the software tools like MATLAB, PSPICE & PSIM for various power electronic devices. Understand the different types of power electronic converters using the simulation tools.	
Module 1		**Hours 12**
Computer simulation of continuous time dynamic systems using transfer function models: electromechanical, hydraulic and pneumatic systems. Introduction to simulation tools.		
Module 2		**Hours 12**
Solution of nonlinear equations, methods to the solution of electrical networks, general-purpose circuit simulators, introduction to machine modelling : induction, DC, and synchronous machines		
Module 3		**Hours 12**
Simulation and modelling of single phase and three-phase converters: rectifier, ac voltage controllers and inverters. Power electronic converters in power distribution systems, simulation and modelling of dc to dc converters		
Module 4		**Hours 9**
Interaction between power electronic converters and rotating machines		
Reference books	1. N. Mohan, T.M. UdelandandP. Robbins, "Power Electronics: Converters, Applications, and Design," J. Wiley, New York, 1994. 2. P.C. Krause, "Analysis of electric machinery", McGraw Hill, New York, 1986. 3. Louis G Birta and GilberArbez, "Modelling and Simulation(Exploring Dynamic System behavior)" Springer Verlag, 2007 4. M. B. Patil, V. Ramanarayanan, V. T. Ranganathan "Simulation of Power Electronic Circuits", Narosa publications 5. Muhammad H. Rashid, Hasan M. Rashid "Spice for Power Electronics and Electric Power", 2nd Edition, Taylor & Francis	

Subject Code EE 524	**Poly-phase Systems and component Transformation**	**Credits: 3 (3-0-0)** **Total hours: 45**
Course Objectives	An overview of poly-phase circuits combined fault analysis and system working in unbalanced load conditions.	

Module 1	**Hours 10**
Balanced poly phase circuits: generation of poly phase voltages, phase sequence, three phase 3 wire and 4 wire systems, wye and delta connections, the n-phase star and mesh, power calculations in balanced systems, general n-wire balanced systems, harmonics in wye and delta systems.	
Module 2	**Hours 10**
Unbalanced poly phase circuits**:** unbalanced loads, wye-wye system with and without neutral connections, neutral shift, the wye-delta system, phase sequence effects, methods of checking voltage phase sequence, three wattmeter/two wattmeter methods of measuring three phase power, the use of (n,1) watt meters for measuring n-wire power, power factor in unbalanced three phase systems, extensions to non-sinusoidal behaviour.	
Module 3	**Hours 08**
Introduction to symmetrical components: A brief historical review, fundamental principles, symmetrical component systems, resolution of three vectors into symmetrical components, independence of sequences in symmetrical systems, sequence impedances.	
Module 4	**Hours 10**
Calculation of unbalanced faults: sequence networks, connection of networks to represent faults, outline of short circuit calculations, analysis of transformer connections, measurement of sequence voltages and currents,measurement of sequence power quantities, flow of power due to unbalance.	
Module 5	**Hours 07**
Multiphase systems: resolution of multiphase systems into symmetrical components, 2-phase and 4-phase systems, Irregular systems, analysis of poly phase circuits, Impedances of symmetrical poly phase systems, Harmonics.	

Reference books	1. C.F. Wagner, R.D. Evans, "Symmetrical Components", McGraw,Hill, 1933. 2. J.L. Blackburn, "Symmetrical Components for Power System Engineering", Marcel,Dekker ,1993. 3. Edith Clarke, "Circuit Analysis of AC Power Systems – Volumes I and II", John Wiley and Sons, 1950.

Subject Code EE 525	**Power system Dynamics**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	To investigate and understand the stability of power system, with the main focus on stability theories and power system modelling. To study the steady and transient stability problems. To examine the power system modelling using simulation tools.	
Module 1		**Hours 10**
Modelling: Dynamic modelling requirements, angle stability, equal area criterion, critical fault clearing time and angle, numerical integration techniques.		
Module 2		**Hours 10**
Synchronous machines: Park's transformation, flux linkage equations, formulation of normalized equations, state space current model, simplified models of the synchronous machine ,turbine, generator, steady state equations and phasor diagrams.		
Module 3		**Hours 10**
Dynamics of Synchronous machines: Mechanical relationships and electrical transient relationships, adjustment of machine models, Park's equation in the operational form.		
Module 4		**Hours 08**
Dynamics of Induction machines: Induction motor equivalent circuits and parameters, free acceleration characteristics, dynamic performance, effect of three phase short circuit and unbalanced faults.		
Module 5		**Hours 07**
Stability: Transient and dynamic stability, linear model of unregulated synchronous machine and its oscillation modes, distribution of power impacts, effects of excitation on stability, supplementary stabilization signals.		
Reference books	1. Elgerd, O.I., "Electric Energy Systems Theory", TMH, New Delhi, 2nd edition ,1991 . 2. Anderson, P.M. and Fouad, A.A., "Power System Control and Stability", Galgotia Publ., New Delhi, 2003. 3. Krause, P.C, "Analysis of Electric Machinery" McGraw,Hill International Editions, 2000. 4. K.R. Padiyar, "Power System Stability and Control", Interline, 1996. 5. PrabhaKundur, "Power System Stability and Control", TMH, 1994.	

Subject Code EE 526	**Advanced Power Electronics**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	Understand the concept of resonant switch converters, multilevel inverters, pulse width modulation techniques and inductor design.	

Module 1	**Hours 15**
DC-DC converters: Basic topologies of buck, boost, buck-boost converters, Cuk, flyback, forward, push-pull, half bridge, full bridge & isolated Cuk converters, input & output filter design, zero voltage and zero current switching, classification of resonant converters, basic resonant circuit concepts, types of resonant converters, converter transfer functions, applications.	
Module 2	**Hours 10**
Design concepts : Design of inductors, transformers, selection of core, core loss, copper loss, and skin effect proximity effect, design of capacitors, selection of capacitors for different applications, power semiconductor selection and its drive circuit design, controller design, stability considerations.	
Module 3	**Hours 12**
Inverters: Single phase half and full bridge inverters, voltage control of single phase inverters using various PWM techniques, three phase voltage source inverters, 180^0 and 120^0 mode of operation, selective harmonic elimination, sinusoidal and space vector modulation PWM techniques, .	
Module 4	**Hours 08**
Multilevel Inverters: Introduction, multilevel concept, diode clamped, flying capacitor, H-bridge, cascaded multilevel inverters, applications.	

Reference books	1. Ned Mohan, et.al, "Power Electronics converters, Applications and Design", Wiley India, New Delhi, 3rd, Edition 2003 2. M.H. Rashid, Power Electronics - Circuits, Devices and Applications, PHI, 2002.

Subject Code EE 527	**High Voltage Engineering**	Credits: 3 (3-0-0) Total hours: 45
Course Objectives	Introducing the dynamics of HV generation, transmission and working, HV testing, measurement.	
Module 1		**6 hours**
Electro static fields: Electric field intensity, electric strength. generation of high dc and ac voltages, cockcroftwalton voltage multiplier circuit, insulation protection, impulse and switching voltages, generation of high impulse currents, applications.		
Module2		**10 hours**
High voltage transmission, ratings, protection mechanism, cost advantage, measurement of high ac, dc, impulse voltages, definitions, measurement accuracy, sphere gap method, peak voltmeters method, potential divider method, rod gap method, high speed CRO, digital techniques measurement techniques		
Module 3		**10 hours**
Measurement of high currents, impulse currents, dielectric breakdown in gases, liquids, solids, dielectric strength, dielectric partial discharges, corona discharges.		
Module 4		**10 hours**
high voltage testing of circuit breakers, insulators, bushings and surge diverters, standards and specifications, high voltage testing of electrical equipment, non-destructive test techniques, high voltage Schering bridge, breakdown mechanism of gaseous liquid and solid insulating materials, introduction, Townsend's first ionization coefficient.		
Module 5		**09 hours**
Causes of over voltage, types, over voltages effects on power system components, surge diverters, EMI and EMC protection against over voltages, insulation coordination.		
Reference books	1. C.L. Wadhwa, "High voltage engineering", Wiley Eastern Limited, New Delhi, 1994. 2. M.S. Naidu, and V.Kamaraju,, "High Voltage Engineering" Tata McGraw Hill Publishing Company, New Delhi, 2nd Edition, 1994. 3. E Kuffel, and W.S. Zaengl "High Voltage Engineering Fundamentals" Pergamon press, Oxford, London, 1986.	

Subject Code: HU 501& HU 502	**Professional Communication-II and Language Lab**	**Credits: 4 (2-0-3) Total hours: 56**
Course Prerequisite	Knowledge of English	
Course Objectives	This course aims at Personality Development	
Course Outcome	At the end, the students should possess a Saleable Image with employability skills	
Module 1	**Principles of Soft Skills and Practice**	12 hours
Definition of Soft Skills and Personality, Attitude, Dress Code, Body Language, Individual and Group Behaviour, Personality Test, C.V Writing and the difference between CV & Resume		
Module 2	**Group Discussion, Extempore, JAM and Survey**	16 hours
Topics: Is Cloning Ethical, Shopping Mall vs Retailer, Should Animals be used for Drug-Test, Effects of Advertisement on Youth, Google vs Social Networking Sites, Newspaper is the thing of Past, Diversity in Indian Culture, Gender Discrimination, Who is Smarter: Human Beings or Computer and so on		
Module 3	**Interview**	14 hours
Types of Interview, Interview Ethics, Questions and Mock-Interview Sessions		
Module 4	**Business Presentation and Seminars**	14 hours
Business Presentation and Students' Seminar		
Texts:	1.W.B. Martin, *Ethics in Engineering* Tata McGraw Hill, India 2. Patnaik,Priyadarshi, *Group Discussion and Interview Skills*, New Delhi: CUP, (Video CD) 3..Downes, Colm, *Cambridge English for Job Hunting*,2009, New Delhi,CUP (2 Audio CDs)	
Reference	TV News (Headlines Today, ND TV and BBC), Chat-Shows on TV, Magazines like India Today, Outlook, The Week and English Dailies. Reader's Digest for Expressive Skill, English Films & English Comics	