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

<u>Semester-wise Credit Distribution</u>

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).		

<table>
<tr><td>Subject Code
PH 100</td><td>Physics</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">10+2</td></tr>
<tr><td>Course Objectives</td><td colspan="2">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.</td></tr>
<tr><td>Course Outcome</td><td colspan="2">1. Understanding basic concepts in Physics
2. Sound knowledge of the application aspects of modern physics in technology</td></tr>
<tr><td>Module 1</td><td>Dual nature of particle and waves</td><td>8 hours</td></tr>
<tr><td colspan="3">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,</td></tr>
<tr><td>Module 2</td><td>Quantum Mechanics</td><td>12 hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Module 3</td><td>Statistical Mechanics</td><td>5 hours</td></tr>
<tr><td colspan="3">Statistical analysis: Maxwell-Boltzman distribution function, Bose-Einstein distribution function, Fermi-Dirac distribution function, Quantum free electrons theory of metals</td></tr>
<tr><td>Module 4</td><td>Lasers, Fiber optics and Semiconductor photonic devices</td><td>10 hours</td></tr>
<tr><td colspan="3">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</td></tr>
<tr><td>Module 5</td><td>Modern Energy sources</td><td>10 hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Course Code
PH101</td><td>Physics Laboratory</td><td>Credits-2 (0-0-3)
3 hours for week</td></tr>
<tr><td colspan="2">List of Experiments</td><td></td></tr>
<tr><td colspan="3">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</td></tr>
</table>

Text /Reference Books	1. Franks S. Crawford, *Waves*, Tata Mc Graw Hills Publication 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.

<table>
<tr><td>Subject Code
ME 100</td><td colspan="2">Engineering Mechanics</td><td>Credits: 3

Total hours: 44</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">10+2</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To provide the students with a clear and thorough understanding of the theory and application of engineering mechanics covering both statics and dynamics</td></tr>
<tr><td>Unit 1</td><td colspan="2">Fundamentals of mechanics</td><td>6 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Unit 2</td><td colspan="2">Equations of equilibrium</td><td>6 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Unit 3</td><td colspan="2">Kinematics of a particle</td><td>8 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Unit 4</td><td colspan="2">Particle Dynamics</td><td>8 hours</td></tr>
<tr><td colspan="4">Introduction, rectangular coordinates, rectilinear translation, Newton's law for rectangular coordinates, rectilinear translation, cylindrical coordinates, Newton's law for cylindrical coordinates.</td></tr>
<tr><td>Unit 5</td><td colspan="2">Kinetics of Plane Motion of Rigid Bodies</td><td>8 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Unit 6</td><td colspan="2">Energy and momentum methods for a particle</td><td>8 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Text Books</td><td colspan="3">1. Irving H. Shames, Engineering Mechanics Statics And Dynamics, Pearson,2005.</td></tr>
<tr><td>Reference Books</td><td colspan="3">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.</td></tr>
</table>

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		

<table>
<tr><td colspan="2">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.</td></tr>
<tr><td>Text Books</td><td>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</td></tr>
<tr><td>Reference Books</td><td>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</td></tr>
</table>

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. Yashavanth Kanetkar, "Let us C", BPB Publications.

<table>
<tr><td>Subject Code
HU 100</td><td colspan="2">Professional Communication-I</td><td>Credits: 3 (3-0-2)
Total hours: 45</td></tr>
<tr><td>Course Prerequisite</td><td colspan="3">Basic Knowledge of English (10+2 level)</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td>Course Outcome</td><td colspan="3">At the end of this course, the students are expected to communicate effectively in English: be it written or be it oral.</td></tr>
<tr><td>Module 1</td><td colspan="2">Principles of Communication</td><td>12 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 2</td><td colspan="2">Listening and Speaking</td><td>8 hours</td></tr>
<tr><td colspan="4">Pronunciation, Word and Sentence Stress and Professional Presentation</td></tr>
<tr><td>Module 3</td><td colspan="2">Elements of Effective Writing</td><td>8 hours</td></tr>
<tr><td colspan="4">Words, Phrases, Sentences, Paragraphs, Reading Comprehension, Precis</td></tr>
<tr><td>Module 4</td><td colspan="2">Report Writing and Presentation</td><td>10 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 5</td><td colspan="2">Business Letters and Correspondences</td><td>7 hours</td></tr>
<tr><td colspan="4">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)</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Text Books</td><td colspan="3">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</td></tr>
<tr><td>Reference Books</td><td colspan="3">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</td></tr>
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<table>
<tr><td>Subject Code
ME 101</td><td colspan="2">Engineering Drawing</td><td>Credits: 3 (1-0-3)
Total hours: 52</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">10+2</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To express the novel ideas through an engineering language.
• To improve the visualization skills.
• Learn basic Auto Cad skills.</td></tr>
<tr><td>Unit 1</td><td>Introduction to Engineering Graphics</td><td colspan="2">4 hours</td></tr>
<tr><td colspan="4">Drawing instruments and their use – Different types of lines - Lettering & dimensioning. Projection of points.</td></tr>
<tr><td>Unit 2</td><td>Orthographic Projections</td><td colspan="2">8 hours</td></tr>
<tr><td colspan="4">Introduction to orthographic projections- Horizontal, vertical and profile planes – First angle and third angle projections.</td></tr>
<tr><td>Unit 3</td><td>Projection of lines</td><td colspan="2">8 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Unit 4</td><td>Projection of planes</td><td colspan="2">8 hours</td></tr>
<tr><td colspan="4">Projection of plane lamina of geometric shapes inclined to one of the reference planes – inclined to both the planes, Traces of planes</td></tr>
<tr><td>Unit 5</td><td>Projection of solids</td><td colspan="2">8 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Unit 6</td><td>Sections of Solids</td><td colspan="2">8 hours</td></tr>
<tr><td colspan="4">Sections of cylinders, Sections of prisms.</td></tr>
<tr><td>Unit 7</td><td>Computer Aided Drafting.</td><td colspan="2">8 hours</td></tr>
<tr><td colspan="4">Introduction to Auto CAD, Basic 2-D drawing, editing and viewing tools, Dimensioning. Orthographic and Isometric Projections.</td></tr>
<tr><td>Text Books</td><td colspan="3">1. Bhatt N D., Engineering Drawing, Charotar Publication, 2006.</td></tr>
<tr><td>Reference Books</td><td colspan="3">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.</td></tr>
</table>

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)		

Subject Code PH150	**Material Science**	**Credits: 3 (3-0-0)** **Total hours: 46**
Course Prerequisites	Physics, Mathematics and Chemistry	
Course Outcome	Understanding the nature, properties and applications of materials.	
Module 1	**Structure of Materials**	6 hours
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.		
Module 2	**Conductors and Resistors**	4 hours
The resisistivity range, The free electron theory, Conduction by free electrons, Conductor and resistor materials, Superconducting materials.		
Module 3	**Semiconductors and Dielectrics**	12 hours
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.		
Module 4	**Magnetic Materials**	6 hours
Magnetic materials, Diamagnetic materials, Paramagnetic materials, Ferromagnetic materials, Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Soft & Hard Magnetic material and applications.		
Module 5	**Superconductivity**	6 hours
Superconductivity, Meissner effect, London penetration depth, Isotope effect, The BCS theory, Type-I superconductor, Type-II superconductors, Josephson effect and applications		
Module 6	**Advanced materials**	12 hours
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.		
Text/ Reference Books	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. 4. Brain S. Mitchell “An Introduction to Materials for Engineering and science” Willey Interscience. 5. R. Balasubramanian, Materials Science and Engineering, Willey Interscience. 6. V. Raghavan, “Material Science and Engineering ” PHI Publication. 7. Edward M Purcell, “*Electricity and Magnetism*” 8. 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 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	

<table>
<tr><td>Subject Code
EE151</td><td colspan="2">Basic Electrical Science</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To expose students to basic electric devices and components characteristics and techniques of analyzing them.</td></tr>
<tr><td>Module 1</td><td colspan="2">DC circuit Analysis</td><td>12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Module 2</td><td colspan="2">Magnetic circuit Analysis and AC circuit Analysis</td><td>12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Module 3</td><td colspan="2">Semiconductor Devices and Circuits</td><td>14 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Module 4</td><td colspan="2">Elements of Digital Electronics</td><td>7 hours</td></tr>
<tr><td colspan="4">Analog and Digital Signals, Introduction to Digital Electronics, Digital Logic Gates. Introduction to memory elements, SRAM, DRAM, ROM, PROM, EPROM, EEPROM.</td></tr>
<tr><td>Text Books</td><td colspan="3">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.</td></tr>
<tr><td>Reference Books</td><td colspan="3">1. A.S. Sedra& K.C Smith, Microelectronic Circuits, Oxford Univ. Press 1999.</td></tr>
</table>

<table>
<tr><td>Subject Code EE152</td><td>Basic Electrical Science(Lab)</td><td>Credits: 2 (0-0-3)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To have hands on experience on principle of basic electronic passive and active components and their analysis.</td></tr>
<tr><td colspan="3">List of Experiments</td></tr>
<tr><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code ME 151</td><td colspan="2">Workshop Practices</td><td>Credits: 2(0-0-3)</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">10+2</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To impart knowledge and technical skills on basic manufacturing methods</td></tr>
<tr><td>Module 1</td><td>Mechanical Workshop</td><td colspan="2">36 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference Books</td><td colspan="3">1. Elements of Workshop Technology, S. K. Hajra Choudhary, S. K. Bose, A. K. Hajra Choudhary, Media promoters and publishers pvt. ltd., 2007</td></tr>
</table>

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**

<table>
<tr><td>Subject Code
CS 200</td><td colspan="2">Principles of Data Communication(PDC)</td><td>Credits: 4 (3-1-0)
Total hours:56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>8 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 6</td><td>4 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 201</td><td>Data Structures (DS)</td><td>Credits: 4 (3-1-0)
Total hours:56</td></tr>
<tr><td>Course Objectives</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">Module 1</td><td>6 Hours</td></tr>
<tr><td colspan="3">Introduction to data structures and objectives, basic concepts Arrays: one dimensional, multi-dimensional, Elementary Operations.</td></tr>
<tr><td colspan="2">Module 2</td><td>8 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="3">Linked lists: Linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation.</td></tr>
<tr><td colspan="2">Module 4</td><td>12 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 5</td><td>20 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Reference books</td><td colspan="2">(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”, 4th Edition, 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</td></tr>
</table>

<table>
<tr><td>Subject Code

CS 202</td><td>Computer Organization and Architecture (COA)</td><td>Credits: 4 (3-1-0)

Total hours:56</td></tr>
<tr><td>Course Objectives</td><td colspan="2">The course explores the hardware aspects of a computer system design.</td></tr>
<tr><td colspan="2">Module 1</td><td>8 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 2</td><td>10 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 3</td><td>8 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 4</td><td>15 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 5</td><td>15 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Reference books</td><td colspan="2">(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.</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code
MA 200</td><td colspan="2">Mathematics-III</td><td>Credits: 3
Total hours 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">Mathematics-I & II</td></tr>
<tr><td>Objectives</td><td colspan="3">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.</td></tr>
<tr><td>Module 1</td><td>Complex Analysis</td><td colspan="2">18 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Module 2</td><td>Power Series Solutions</td><td colspan="2">9 hours</td></tr>
<tr><td colspan="4">Differential Equations Power Series Method - application to Legendre equation, Legendre Polynomials, Frobenious Method, Bessel equation, Properties of Bessel functions, Sturm- Liouville BVPs, Orthogonal functions.</td></tr>
<tr><td>Module 3</td><td>Partial Differential Equations</td><td colspan="2">15 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Texts/References</td><td colspan="3">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).</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 204</td><td colspan="2">Data Structures Laboratory</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The course provides practical knowledge in implementing the standard data structures in C</td></tr>
<tr><td colspan="4">List of Experiments</td></tr>
<tr><td colspan="4">(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</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 250</td><td colspan="2">Digital Systems Design (DSD)</td><td>Credits: 3 (3-0-0)
Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To understand the working of digital systems. Hardware components of the computer can be studied in greater depth.</td></tr>
<tr><td colspan="3">Module 1</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>8 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>8 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>8 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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”, 3rdEdition 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.</td></tr>
</table>

<table>
<tr><td>Subject Code
HS 250</td><td colspan="2">Economics</td><td>Credits: 3(3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Outcome</td><td colspan="3">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.</td></tr>
<tr><td>Module 1</td><td>Introduction to Economics</td><td colspan="2">2 hours</td></tr>
<tr><td colspan="4">Constructing a Model, Optimization and Equilibrium in market demand and supply, Comparative statistics and asset allocation.</td></tr>
<tr><td>Module 2</td><td>Utility, Choice, Budget Constraint and Consumer Preference</td><td colspan="2">6 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 3</td><td>Demand, Revealed Preference & Slutsky Equation</td><td colspan="2">6 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Module 4</td><td>Consumer Surplus, Market Demand & Equilibrium</td><td colspan="2">6 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 5</td><td>Technology and Profit Maximization</td><td colspan="2">3 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 6</td><td>National Income Accounting</td><td colspan="2">2 hours</td></tr>
<tr><td colspan="4">National Income and Related concepts, Nominal or real GDP, Methods of measuring NI.</td></tr>
<tr><td>Module 7</td><td>Determinants of Equilibrium Output and IS – LM Model</td><td colspan="2">8 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 8</td><td>Money and Fiscal policy and International Linkages</td><td colspan="2">8 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 9</td><td>Aggregate Demand, Supply and Growth</td><td colspan="2">4 hours</td></tr>
<tr><td colspan="4">Aggregate demand and policies, Aggregate Supply, Fiscal and monetary policy under Alternative supply Assumption, The quantity theory and neutrality of Money.</td></tr>
<tr><td>Text Books</td><td colspan="3">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</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 251</td><td colspan="2">Systems Programming (SP)</td><td>Credits: 4 (3-1-0)
Total hours:56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To understand the relationship between system software and machine architecture to design and implement assemblers, linkers and loaders.</td></tr>
<tr><td colspan="3">Module 1</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>15Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>15 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>10 Hours</td></tr>
<tr><td colspan="4">Macro processors: Basic macro processor functions, macro definition and expansion, macro processor data structures and algorithms, implementation example, discussion of ANSI C macro language.</td></tr>
<tr><td colspan="3">Module 5</td><td>6 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 252</td><td>Object Oriented Programming (OOP)</td><td>Credits: 3 (3-0-0)
Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">This course focuses on principles of object oriented programming paradigm. The course also includes practice of writing programs in C++ and Java.</td></tr>
<tr><td colspan="2">Module 1</td><td>10 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 2</td><td>10Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 3</td><td>8 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 4</td><td>7 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 5</td><td>10 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Reference books</td><td colspan="2">(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++”, 2nded, 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”, 8thEdition, PHI private limited, 2010.</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code
CS 253</td><td>Object Oriented Programming Laboratory</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To understand the basic object oriented programming concepts (objects, classes and subclasses, methods) using C++ and Java.</td></tr>
<tr><td colspan="3">List of experiments</td></tr>
<tr><td colspan="3">(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</td></tr>
<tr><td>Reference books</td><td colspan="2">(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</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 254</td><td>Digital Systems Laboratory</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">The course provides practical knowledge in designing the digital systems</td></tr>
<tr><td colspan="3">List of Experiments</td></tr>
<tr><td colspan="3">(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</td></tr>
<tr><td>Reference books</td><td colspan="2">(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</td></tr>
</table>

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	

<table>
<tr><td>Subject Code
CS 300</td><td colspan="2">Operating Systems (OS)</td><td>Credits: 4 (3-1-0)
Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>10 Hours</td></tr>
<tr><td colspan="4">Introduction to OS, batch processing, multi-programming, interrupts, CPU scheduling, real time scheduling, concurrent processes, threads, multi-threading, inter process communication.</td></tr>
<tr><td colspan="3">Module 2</td><td>10 Hours</td></tr>
<tr><td colspan="4">Mutual exclusion, Software solution, hardware solutions, atomic test and set, LL, swap instructions, monitors, deadlocks, avoidance, prevention and detection algorithms.</td></tr>
<tr><td colspan="3">Module 3</td><td>14 Hours</td></tr>
<tr><td colspan="4">Memory management, fixed and variable paging, segmentation, virtual memory, virtual memory concept, demand paging, page replacement algorithms, trashing, and strategies to control trashing.</td></tr>
<tr><td colspan="3">Module 4</td><td>12 Hours</td></tr>
<tr><td colspan="4">File Systems, disk scheduling algorithms, LOOK, C-LOOK, SCAN, C-SCAN, I/O Hardware, I/O buffering, RAID, performance evaluation.</td></tr>
<tr><td colspan="3">Module 5</td><td>10 Hours</td></tr>
<tr><td colspan="4">Operating system security & protection, breaches, solutions, mechanisms, Inside attacks, outside attacks, case studies - the UNIX kernel and Microsoft Windows NT.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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”, 4^{th} ed., TMH, 2003. (2) Elmsari and Navathe, “Fundamentals of Database Systems”, 4^{th} ed., A. Wesley, 2004 (3) Raghu Ramakrishnan , Johannes Gehrke, “ Database Management Systems”, 3^{rd} 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	

<table>
<tr><td>Subject Code
CS 303</td><td colspan="2">Theory of Computation (TOC)</td><td>Credits: 4 (3-1-0)
Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">This course introduces models of computation: Regular languages models, Recursive and recursively enumerable sets models and context-free languages models.</td></tr>
<tr><td colspan="3">Module 1</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>10Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>15 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>15 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>6 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

<table>
<tr><td>Subject Code

CS 304</td><td>Operating Systems Laboratory</td><td>Credits: 2(0-0-3)

Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To understand the implementation of an operating system.</td></tr>
<tr><td colspan="3">List of experiments</td></tr>
<tr><td colspan="3">(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.</td></tr>
<tr><td>Reference books</td><td colspan="2">(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.</td></tr>
</table>

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<tr><td>Subject Code

CS 305</td><td colspan="2">Database Systems Laboratory</td><td>Credits: 2 (0-0-3)

Total hours:42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To obtain working knowledge of a database management system and developing applications using the databases.</td></tr>
<tr><td colspan="4">List of experiments</td></tr>
<tr><td colspan="4">(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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code

CS 306</td><td colspan="2">Microprocessor and Microcontroller Laboratory</td><td>Credits: 2 (0-0-3)

Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To practice writing programs using microprocessor.</td></tr>
<tr><td colspan="4">List of experiments</td></tr>
<tr><td colspan="4">(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</td></tr>
<tr><td>Reference books</td><td colspan="3">(1) ROM-BIOS service summary- Programmer’s Guide to the IBM PC.</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code

CS 352</td><td colspan="2">Software Engineering (SE)</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">6 Hours</td></tr>
<tr><td colspan="4">Introduction to software engineering and its objectives, S/W myths, generic view of process, S/W engineering paradigm, verification, validation.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">14 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">14 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
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<tr><td>Subject Code

CS 353</td><td colspan="2">Computer Networks (CN)</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">This course focuses on understanding the design of computer networks, assimilating hubs into a personal network.</td></tr>
<tr><td colspan="3">Module 1</td><td>6 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>17 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>9 Hours</td></tr>
<tr><td colspan="4">Link layer services, error detection and correction, multiple access protocols, ARP, Ethernet, hubs, bridges, switches, wireless links, mobility, PPP, ATM, MPLS, VLAN.</td></tr>
<tr><td colspan="3">Module 4</td><td>13 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

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	

<table>
<tr><td>Subject Code

CS 401</td><td colspan="2">Introduction to Machine Learning (IML)</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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]</td></tr>
<tr><td colspan="3">Module 1</td><td>8 Hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 2</td><td>15 Hours</td></tr>
<tr><td colspan="4">Bayesian decision theory, classifiers, discriminant functions, decision surfaces. Error probabilities in statistical decision, non-parametric techniques in pattern classification, order statistics, windowing,</td></tr>
<tr><td colspan="3">Module 3</td><td>15 Hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 4</td><td>7 Hours</td></tr>
<tr><td colspan="4">Database systems, search & complexity, distributed, parallel and randomized processing environments, selected topics and research papers from PAMI, PY, KBS, IFS, for seminar and assignments.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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</td></tr>
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<table>
<tr><td>Subject Code
HS 400</td><td>Management</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Outcome</td><td colspan="2">Develops the ability to understand and analyze the broad aspect of management and its financial dynamism</td></tr>
<tr><td>Module 1</td><td>Principles of Accounting</td><td>5 hours</td></tr>
<tr><td colspan="3">Accounting Cycle, Assumptions, Classifications of Accounts- Journal, Cash Book, Ledger, Final Accounts-Manufacturing Account, Trading Account, P & L Account, Balance Sheet.</td></tr>
<tr><td>Module 2</td><td>Financial Statement Analysis</td><td>5 hours</td></tr>
<tr><td colspan="3">Balance sheet, Profit and Loss Account, Economic vs Accounting Profit, Changes in Financial Position, Funds flow and cash flow statement.</td></tr>
<tr><td>Module 3</td><td>Ratio Analysis</td><td>6 hours</td></tr>
<tr><td colspan="3">Nature of Ratio Analysis, Liquidity Ratio, Leverage Ratio, Activity Ratio, Profitability Ratio, DuPont Analysis, Comparative statement and Trend Analysis, Inter-firm Analysis.</td></tr>
<tr><td>Module 4</td><td>Working Capital</td><td>6 hours</td></tr>
<tr><td colspan="3">Concept of working Capital, Operating and Cash conversion Cycle, Permanent and Variable working Capital, Balance working capital position and Issues.</td></tr>
<tr><td>Module 5</td><td>Time Value of Money</td><td>5 hours</td></tr>
<tr><td colspan="3">Time preference for money, Future value, Annuity, Perpetuity, Sinking fund factor, Present value, Annuity, Perpetuity, capital recovery factor, Multiple period Compounding.</td></tr>
<tr><td>Module 6</td><td>Capital Budgeting</td><td>8 hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Module 7</td><td>Financial System</td><td>6 hours</td></tr>
<tr><td colspan="3">Introduction to Indian Financial System, Financial Institutions and Financial Markets.</td></tr>
<tr><td>Module 8</td><td>Industrial Engineering & Project Management</td><td>4 hours</td></tr>
<tr><td colspan="3">Work Study, Time Study, Industrial Psychology, Project Management (PERT, CPM)</td></tr>
<tr><td>Text Books</td><td colspan="2">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</td></tr>
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<tr><td>Subject Code
CS 402</td><td>Seminar</td><td>Credits: 2 (0-0-2)</td></tr>
<tr><td>Course Objectives</td><td colspan="2">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.</td></tr>
</table>

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

<table>
<tr><td>Subject Code

CS 500</td><td colspan="2">Object Oriented Analysis and Design (OOAD)</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>8 Hours</td></tr>
<tr><td colspan="4">An overview of object oriented systems development, object basics, object oriented systems development life cycle.</td></tr>
<tr><td colspan="3">Module 2</td><td>13 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>12 Hours</td></tr>
<tr><td colspan="4">Identifying use cases, object analysis, classification, identifying object relationships, attributes and methods, design axioms, designing classes, access layer, object storage, and object interoperability.</td></tr>
<tr><td colspan="3">Module 4</td><td>12 Hours</td></tr>
<tr><td colspan="4">Designing interface objects, software quality assurance, system usability, measuring, user satisfaction, mini project.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code
CS 502</td><td>Advanced Computer Architecture (ACA)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">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</td></tr>
<tr><td colspan="2">Module 1</td><td>9 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 2</td><td>9 Hours</td></tr>
<tr><td colspan="3">Advanced Processors: Advanced processor technology, instruction-set architectures, CISC scalar processors, RISC scalar processors, superscalar processors, VLIW architectures, vector and symbolic processors.</td></tr>
<tr><td colspan="2">Module 3</td><td>9 Hours</td></tr>
<tr><td colspan="3">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</td></tr>
<tr><td colspan="2">Module 4</td><td>9 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 5</td><td>9 Hours</td></tr>
<tr><td colspan="3">Parallel Models, languages and compilers: Latency-Hiding techniques environment, synchronization and multiprocessing modes, shared variable program structures, message passing programming development</td></tr>
<tr><td>Reference books</td><td colspan="2">(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</td></tr>
</table>

<table>
<tr><td>Subject Code

CS503</td><td>Advanced Microprocessors (AMP)</td><td>Credits:3 (3-0-0)

Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">Module 1</td><td>9 Hours</td></tr>
<tr><td colspan="3">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).</td></tr>
<tr><td colspan="2">Module 2</td><td>10 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 4</td><td>8 Hours</td></tr>
<tr><td colspan="3">Intel I960, Intel IA32, MIPS R8000, MIPS R10000 , Motorola 88110, Ultra SPARC processor- SPARC version 8 , SPARC version, DSP processors.</td></tr>
<tr><td colspan="2">Module 5</td><td>8 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Reference books</td><td colspan="2">(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</td></tr>
</table>

<table>
<tr><td>Subject Code

CS 504</td><td colspan="2">Principles of Programming Languages (PPL)</td><td>Credits: 3 (3-0-0)

Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>9 Hours</td></tr>
<tr><td colspan="4">Lambda calculus and semantic environment and rules.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

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"**,** 2^{nd} 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.		

<table>
<tr><td>Subject Code
CS 506</td><td colspan="2">Advanced Database Systems (ADBS)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 507</td><td colspan="2">E-Commerce (EC)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To provide principles of e-commerce from a business perspective.</td></tr>
<tr><td colspan="3">Module 1</td><td>12 Hours</td></tr>
<tr><td colspan="4">Infrastructure and tools for e-commerce, current trends in e-commerce applications development, the business of internet commerce, enterprise level e-commerce.</td></tr>
<tr><td colspan="3">Module 2</td><td>12 Hours</td></tr>
<tr><td colspan="4">Security and encryption, electronic payment systems, search engines, intelligent agents in e-commerce, on-line auctions, data mining for e-commerce.</td></tr>
<tr><td colspan="3">Module 3</td><td>12 Hours</td></tr>
<tr><td colspan="4">Web metrics, recommended systems, knowledge management, mobile e-commerce, legal, ethical and social issues.</td></tr>
<tr><td colspan="3">Module 4</td><td>9 Hours</td></tr>
<tr><td colspan="4">Seminars and mini projects.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 508</td><td>Advanced Operating Systems (AOS)</td><td>Credits: 3(3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To provide comprehensive and up-to-date coverage of the major developments in distributed operating system, multi-processor operating system and database operating system.</td></tr>
<tr><td colspan="2">Module 1</td><td>9 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 2</td><td>9 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 3</td><td>12Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 4</td><td>8 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 5</td><td>7 Hours</td></tr>
<tr><td colspan="3">Multiprocessor OS, database OS, database systems, a concurrency control model, problem, serializability theory, distributed database systems, concurrency control algorithms.</td></tr>
<tr><td>Reference books</td><td colspan="2">(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.</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code
CS 510</td><td colspan="2">Information Theory (IT)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>15 Hours</td></tr>
<tr><td colspan="4">Over view of probability theory & statistics, analysis and discrete mathematics, measure of information using probability, digitization and Shannon's model for information storage/transmission</td></tr>
<tr><td colspan="3">Module 2</td><td>10 Hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 4</td><td>10 Hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Reference books</td><td colspan="3">(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</td></tr>
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<tr><td>Subject Code

CS511</td><td colspan="2">Optimization Techniques in Computing (OT)</td><td>Credits: 3 (3-0-0)

Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The main goal of this course is to provide the students with a background, foundation, and insight into the several dimensions of Optimization Techniques.</td></tr>
<tr><td colspan="3">Module 1</td><td>15 Hours</td></tr>
<tr><td colspan="4">Basic OR techniques, requirements, networks, design, role and methods, unconstrained optimization methods- Newton like methods, conjugate direction methods.</td></tr>
<tr><td colspan="3">Module 2</td><td>15 Hours</td></tr>
<tr><td colspan="4">Constrained optimization: Linear programming, theory of constrained optimization, Non-linear programming. Databases, compilers, optimization and performance in web computing, internet application.</td></tr>
<tr><td colspan="3">Module 3</td><td>15 Hours</td></tr>
<tr><td colspan="4">Performance measurement tools, case studies, Implementation of an optimization technique for Computer Science applications</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 512</td><td colspan="2">Soft Computing (SC)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The course explores the soft computing approaches to consider uncertainty that is inherent in pattern analysis tasks.</td></tr>
<tr><td colspan="3">Module 1</td><td>8 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>8 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>9 Hours</td></tr>
<tr><td colspan="4">Membership functions, interference in fuzzy logic, fuzzy if-then rules, fuzzy implications and fuzzy algorithms, fuzzyfication and defuzzificataion, fuzzy controller, industrial applications</td></tr>
<tr><td colspan="3">Module 5</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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</td></tr>
</table>

<table>
<tr><td>Subject Code

CS513</td><td colspan="2">Applied Algorithms (AA)</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The course provides an overview of some of the essential numerical techniques which are commonly used in the scientific enterprise.</td></tr>
<tr><td colspan="3">Module 1</td><td>15 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>11 Hours</td></tr>
<tr><td colspan="4">String Matching algorithms: Rabin-Karp algorithm, Knuth Morris pratt algorithm. Parallel algorithms: Designing parallel algorithms; combinatorial algorithms.</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">Network flows: Bellman ford algorithm. divide-and-conquer, closest points problem. external memory algorithms, online algorithms.</td></tr>
<tr><td colspan="3">Module 4</td><td>9 Hours</td></tr>
<tr><td colspan="4">Graph Algorithms, internet algorithms and security- cryptography algorithms. basics of randomized algorithms. basics of approximation algorithms.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

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	

<table>
<tr><td>Subject Code
CS 516</td><td colspan="2">Cyber Laws & Security Standards(CLSS)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>15 Hours</td></tr>
<tr><td colspan="4">Perimeter barrier standards, cyber laws, cyber security issues, FGIB cyber security proposals.</td></tr>
<tr><td colspan="3">Module 2</td><td>15 Hours</td></tr>
<tr><td colspan="4">NRIC cyber security recovery best practices, creation of new practices.</td></tr>
<tr><td colspan="3">Module 3</td><td>15 Hours</td></tr>
<tr><td colspan="4">NRIC physical security practices.</td></tr>
<tr><td>Reference books</td><td colspan="3">(1) www. Bell-labs.com/user/krauscher/nric/#intraduction%20TO%20NRIC
(2) Hacking exposed scambrey mcclure, kartz tata-mcgrawhill</td></tr>
</table>

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	

<table>
<tr><td>Subject Code
CS 518</td><td colspan="2">Web Engineering(WE)</td><td>Credits: 3(3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To apply the concepts, principles, and methods of Web engineering to Web applications development</td></tr>
<tr><td colspan="3">Module 1</td><td>10 Hours</td></tr>
<tr><td colspan="4">Web Engineering Fundamentals: Requirements specification and analysis, web-based systems development methodologies and techniques, migration of legacy systems to web environments.</td></tr>
<tr><td colspan="3">Module 2</td><td>10 Hours</td></tr>
<tr><td colspan="4">Web-application development: Web-based real-time applications development, testing, verification and validation, quality assessment, control and assurance, configuration and project management.</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">Web metrics: generating metrics for estimation of development efforts, performance specification and evaluation, update and maintenance.</td></tr>
<tr><td colspan="3">Module 4</td><td>15 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(1) Journal of Web Engineering, Rinton Press, IEEE & ACM Publications
(2) Cato and John, “ User centered web design”, Pearson Education, 2001</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 519</td><td colspan="2">Software Project Management (SPM)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>11 Hours</td></tr>
<tr><td colspan="4">Introduction, project definition, contract management, activities covered by software project management.</td></tr>
<tr><td colspan="3">Module 2</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>11 Hours</td></tr>
<tr><td colspan="4">Software management disciplines, iterative process planning, project organizations & responsibilities, process automation, project control & process instrumentation, tailoring the process.</td></tr>
<tr><td colspan="3">Module 4</td><td>12Hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Reference books</td><td colspan="3">(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</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code
CS 521</td><td colspan="2">Computer Vision (CV)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>11 Hours</td></tr>
<tr><td colspan="4">Stereopsis: Reconstruction; human stereo; Binocular fusion; using color camera.</td></tr>
<tr><td colspan="3">Module 4</td><td>11 Hours</td></tr>
<tr><td colspan="4">Segmentation by clustering: Human vision, applications, segmentation by graph theoretic clustering. Segmentation by fitting a model, Hough transform; fitting lines, fitting curves;</td></tr>
<tr><td>Reference books</td><td colspan="3">(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</td></tr>
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<table>
<tr><td>Subject Code

CS522</td><td colspan="2">Artificial Intelligence (AI)</td><td>Credits: 3 (3-0-0)

Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>15 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>10 Hours</td></tr>
<tr><td colspan="4">Planning and making decisions, learning, distributed AI, communication, web based agents. introduction &design of expert systems, various applications;</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">Negotiating agents, artificial intelligence applications and programming. introduction to fuzzy logic systems, natural language processing;</td></tr>
<tr><td colspan="3">Module 4</td><td>10 Hours</td></tr>
<tr><td colspan="4">Heuristic search techniques, knowledge based systems. problem solving by search; uninformed search, informed ("heuristic") search, constrained satisfaction problems, adversarial search,</td></tr>
<tr><td>Reference books</td><td colspan="3">(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</td></tr>
</table>

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<tr><td>subject Code

CS523</td><td colspan="2">Multimedia & Virtual Reality (MVR)</td><td>Credits: 3 (3-0-0)

Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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</td></tr>
<tr><td colspan="3">Module 1</td><td>11Hours</td></tr>
<tr><td colspan="4">Introduction to multimedia technology and its applications, multimedia hardware and software essentials. multimedia graphics fundamentals. multimedia audio - sound card fundamentals</td></tr>
<tr><td colspan="3">Module 2</td><td>12Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>11Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>11Hours</td></tr>
<tr><td colspan="4">VR on CAD / CAM processing : Virtual banks, compression and decompression techniques, CASE study of multimedia workstations</td></tr>
<tr><td>Reference books</td><td colspan="3">(1) The Winn L. Rosch “Multimedia Bibble”, SAMS Publishing
(2) D. P. Kothari & Anshu, “Hypermedia: From multimedia to V. R.” , PHI, 2004.</td></tr>
</table>

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<tr><td>Subject Code

CS524</td><td colspan="2">Software Quality Assurance (SQA)</td><td>Credits: 3 (3-0-0)

Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>15 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>10 Hours</td></tr>
<tr><td colspan="4">Software requirements and SQA, requirements defects, writing quality requirements, quality attributes of requirements document, software design model and software design defects</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 4</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 525</td><td colspan="2">Protocol Engineering(PE)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">Characterize protocol engineering. Compare and contrast various Internet protocols such as TCP/IP, DNS, DHCP, LDAP, and IPsec.</td></tr>
<tr><td colspan="3">Module 1</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>11 Hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 4</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(1) Web sites, IEEE, ISO and ITU-T sites.
(2) P. Venkatram & S. S. Manavi, “Protocol Engineering”, PHI, 2004.</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code
CS528</td><td>Information Security(IS)</td><td>Credits: 3 (3-0-0)
Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">Module 1</td><td>9Hours</td></tr>
<tr><td colspan="3">Security properties, threat models, examples; control hijacking attacks and defences.</td></tr>
<tr><td colspan="2">Module 2</td><td>9 Hours</td></tr>
<tr><td colspan="3">Tools for robust code, exploitation techniques and fuzzing, dealing with legacy code, least privilege, access control</td></tr>
<tr><td colspan="2">Module 3</td><td>9 Hours</td></tr>
<tr><td colspan="3">Operating system security, cryptography overview, basic web security model</td></tr>
<tr><td colspan="2">Module 4</td><td>9 Hours</td></tr>
<tr><td colspan="3">Web application security; session management and user authentication, HTTPS: goals and pitfalls</td></tr>
<tr><td colspan="2">Module 5</td><td>9 Hours</td></tr>
<tr><td colspan="3">Mobile platform security models: Android, iOS, mobile threats and malware, the trusted computing architecture</td></tr>
<tr><td>Reference books</td><td colspan="2">(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”</td></tr>
</table>

<table>
<tr><td>Subject Code

CS529</td><td colspan="2">Network Security(NS)</td><td>Credits: 3 (3-0-0)

Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To provide extensive, detailed and critical understanding of the concepts, issues, principles and theories of network security.</td></tr>
<tr><td colspan="3">Module 1</td><td>15 Hours</td></tr>
<tr><td colspan="4">Introduction to network security and associated techniques, Firewall design principles: Packet filtering, Gateways: Circuit-level gateways; application-level gateways,</td></tr>
<tr><td colspan="3">Module 2</td><td>10 Hours</td></tr>
<tr><td colspan="4">Firewall Configurations, Intrusion Control: Detection; Anomaly-Based IDS Intrusion Recovery; Vulnerability Scanners; Login, Audit, and Sniffers,</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">Communication Security Network Access Layer;- Internet Layer - Transport Layer;</td></tr>
<tr><td colspan="3">Module 4</td><td>10 Hours</td></tr>
<tr><td colspan="4">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,</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

<table>
<tr><td>Subject Code
CS 530</td><td colspan="2">Parallel Algorithms (PA)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To introduce techniques for the design of efficient parallel algorithms and their implementation.</td></tr>
<tr><td colspan="3">Module 1</td><td>10 Hours</td></tr>
<tr><td colspan="4">Parallel processing, parallel models, performance of parallel algorithms, complexity measure for parallel algorithms.</td></tr>
<tr><td colspan="3">Module 2</td><td>11Hours</td></tr>
<tr><td colspan="4">Techniques for designing parallel algorithms, pointer jumping technique, divide and conquer, partitioning strategy, pipelining, accelerated cascading, symmetry breaking.</td></tr>
<tr><td colspan="3">Module 3</td><td>12Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>12Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code
CS 532</td><td>Web Services & Cloud Computing (WSCC)</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">Module 1</td><td>11 Hours</td></tr>
<tr><td colspan="3">Basic concepts, enabling infrastructure, core functionality and standards.</td></tr>
<tr><td colspan="2">Module 2</td><td>12 Hours</td></tr>
<tr><td colspan="3">Service semantics, web service composition, service development and recent research trends.</td></tr>
<tr><td colspan="2">Module 3</td><td>11 Hours</td></tr>
<tr><td colspan="3">Introduction to cloud computing, cloud computing delivery models.</td></tr>
<tr><td colspan="2">Module 4</td><td>11 Hours</td></tr>
<tr><td colspan="3">Open Source and Industry case Studies of cloud, Map Reduce, Apache VCL, Amazon, IBM and Eucalyptus, Hadoop, Security issues in cloud</td></tr>
<tr><td>Reference books</td><td colspan="2">(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.</td></tr>
</table>

<table>
<tr><td>Subject Code

CS533</td><td colspan="2">Computer Security Audit and Assurance (CSAA)</td><td>Credits: 3 (3-0-0)

Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>15 Hours</td></tr>
<tr><td colspan="4">·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.</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">· 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 .</td></tr>
<tr><td colspan="3">Module 4</td><td>10 Hours</td></tr>
<tr><td colspan="4">· 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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code

CS 535</td><td colspan="2">Business Intelligence (BI)</td><td>Credits: 3(3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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 .</td></tr>
<tr><td colspan="3">Module 1</td><td>15 Hours</td></tr>
<tr><td colspan="4">Overview of managerial, strategic and technical issues associated with business intelligence and data warehouse, analytics and DSS.</td></tr>
<tr><td colspan="3">Module 2</td><td>15Hours</td></tr>
<tr><td colspan="4">Design, implementation and utilization, data as the basis for decision making, business reporting and visualization.</td></tr>
<tr><td colspan="3">Module 3</td><td>15 Hours</td></tr>
<tr><td colspan="4">Data warehouse architecture, OLAP, data cubes, Reporting tools, Balance Scorecard, dash board design, and implementation. Case studies.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

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		**15 Hours**
Definition of software security, threats and vulnerabilities, risk management, security requirements.		
Module 2		**10 Hours**
Principles of secure design and patterns, secure programming, validation of the data.		
Module 3		**10 Hours**
Secure usage of cryptography, code reviews and static analysis.		
Module 4		**10 Hours**
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.	

<table>
<tr><td>Subject Code

CS 537</td><td colspan="2">Computer Graphics (CG)</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To have an introduction to computer graphics to develop abilities to comprehend contemporary issues and address them.</td></tr>
<tr><td colspan="3">Module 1</td><td>6 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>13 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>15 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

<table>
<tr><td>Subject Code

CS 538</td><td colspan="2">Graph Theory (GT)</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>9 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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</td></tr>
</table>

<table>
<tr><td>Subject Code

CS 539</td><td>Distributed Computing Systems (DCS)</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">Module 1</td><td>9 Hours</td></tr>
<tr><td colspan="3">Introduction Distributed Systems and applications, Distributed vs parallel systems, models of distributed systems, Message Passing mechanisms IPC and RPC.</td></tr>
<tr><td colspan="2">Module2</td><td>11 Hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 3</td><td>13 Hours</td></tr>
<tr><td colspan="3">Leader election algorithms, global states, global predicates, termination detection, Control of distributed computation, disjunctive predicates, performance evaluation of leader election algorithms on simulated environments.</td></tr>
<tr><td colspan="2">Module 4</td><td>12 Hours</td></tr>
<tr><td colspan="3">Distributed File Systems and Services, Shared data, Synchronization Transaction and Concurrency Control. Distributed databases, Name service, Timing & Coordination, Replication, Security and Fault Tolerance.</td></tr>
<tr><td>Reference books</td><td colspan="2">(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”</td></tr>
</table>

<table>
<tr><td>Subject Code:
HU 501& HU 502</td><td colspan="2">Professional Communication-II and Language Lab</td><td>Credits: 4 (2-0-3)
Total hours: 56</td></tr>
<tr><td>Course Prerequisite</td><td colspan="3">Knowledge of English</td></tr>
<tr><td>Course Objectives</td><td colspan="3">This course aims at Personality Development</td></tr>
<tr><td>Course Outcome</td><td colspan="3">At the end, the students should possess a Saleable Image with employability skills</td></tr>
<tr><td>Module 1</td><td colspan="2">Principles of Soft Skills and Practice</td><td>12 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 2</td><td colspan="2">Group Discussion, Extempore, JAM and Survey</td><td>16 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 3</td><td colspan="2">Interview</td><td>14 hours</td></tr>
<tr><td colspan="4">Types of Interview, Interview Ethics, Questions and Mock-Interview Sessions</td></tr>
<tr><td>Module 4</td><td colspan="2">Business Presentation and Seminars</td><td>14 hours</td></tr>
<tr><td colspan="4">Business Presentation and Students' Seminar</td></tr>
<tr><td>Texts:</td><td colspan="3">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)</td></tr>
<tr><td>Reference</td><td colspan="3">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</td></tr>
</table>

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-N junction 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.	

<table>
<tr><td>Subject Code

EE152/EC 152</td><td>Basic Electrical Science Laboratory</td><td>Credits: 2 (0-0-3)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To have hands on experience on principle of basic electronic passive and active components and their analysis.</td></tr>
<tr><td colspan="3">List of Experiments</td></tr>
<tr><td colspan="3">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.</td></tr>
</table>

Second Year Course Contents

<table>
<tr><td>Subject Code

EC201</td><td colspan="2">Analog Electronics</td><td>Credits: 3(3-0-0)

Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 13</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 08</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code

EC202</td><td colspan="2">Signals And Systems</td><td>Credits: 4 (3-1-0)

Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>6 hours</td></tr>
<tr><td colspan="4">Motivation and introduction to the course, Basic concepts of signals and systems, signal transformations, continuous and discrete time systems, basic systems properties.</td></tr>
<tr><td colspan="3">Module2</td><td>8 hours</td></tr>
<tr><td colspan="4">Linear time invariant (LTI) systems: Discrete and continuous – time LTI systems, convolution, properties of LTI systems, system described by differential and difference equations.</td></tr>
<tr><td colspan="3">Module 3</td><td>10 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>14 hours</td></tr>
<tr><td colspan="4">Fourier Transform of aperiodic signals: Continuous and discrete time Fourier transform, properties of transforms, convolution and multiplication property, duality, time-frequency characterization, sampling.</td></tr>
<tr><td colspan="3">Module 5</td><td>14 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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.

<table>
<tr><td>Subject Code
MA 200</td><td colspan="2">Mathematics-III</td><td>Credits: 3
Total hours 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">Mathematics-I & II</td></tr>
<tr><td>Objectives</td><td colspan="3">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.</td></tr>
<tr><td>Course Outcome</td><td colspan="3">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.</td></tr>
<tr><td>Module 1</td><td>Complex Analysis</td><td colspan="2">18 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Module 2</td><td>Power Series Solutions</td><td colspan="2">9 hours</td></tr>
<tr><td colspan="4">Differential Equations Power Series Method - application to Legendre equation, Legendre Polynomials, Frobenious Method, Bessel equation, Properties of Bessel functions, Sturm- Liouville BVPs, Orthogonal functions.</td></tr>
<tr><td>Module 3</td><td>Partial Differential Equations</td><td colspan="2">15 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Texts/References</td><td colspan="3">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).</td></tr>
</table>

<table>
<tr><td>Subject Code

EC205</td><td>Analog Electronics Laboratory</td><td>Credits: 2(0-0-3)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To provide experience on design, testing, and analysis of basic Analog Electronic Circuits.</td></tr>
<tr><td colspan="3">List of Experiments</td></tr>
<tr><td colspan="3">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</td></tr>
</table>

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.

<table>
<tr><td>Subject Code

EC251</td><td colspan="2">Digital Electronics</td><td>Credits: 3-0-0 (3)

Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• 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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 9</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">1. Wakerly J F, “Digital Design: Principles and Practices”, Prentice-Hall, 2nd Ed., 2002
2. Mano M. M., “Digital Logic Design”, Prentice Hall 1993.</td></tr>
</table>

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.

<table>
<tr><td>Subject Code

EC253</td><td colspan="2">Devices</td><td>Credits: 3(3-1-0)

Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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 .</td></tr>
<tr><td colspan="3">Module 1 :</td><td>Hours 14</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours 13</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 13</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 16</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

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	

<table>
<tr><td>Subject Code

MA 250</td><td colspan="2">Mathematics - IV (Probability, Statistics And Random Processes)</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">6 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module2</td><td colspan="2">15 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">6 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">6 hours</td></tr>
<tr><td colspan="4">Statistics :Elements of estimation theory: linear minimum mean-square error and Orthogonality principle in estimation; Parameter Estimation.</td></tr>
<tr><td colspan="2">Module 5</td><td colspan="2">12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
<tr><td></td><td colspan="3"></td></tr>
</table>

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.	

<table>
<tr><td colspan="2">Module 5</td><td>Hours : 12</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Reference books</td><td colspan="2">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</td></tr>
</table>

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", 4th Edition, John Wiley & Sons, Inc.	

<table>
<tr><td>Subject Code

EC 302</td><td colspan="2">Control Systems</td><td>Credits: 4 (3-1-0)
Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code

EC 303</td><td colspan="2">Digital Signal Processing</td><td>Credits: 4 (3-1-0)

Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>8 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>15 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>16 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>9 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>8 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

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<tr><td>Subject Code

EC304</td><td colspan="2">Microprocessors and Microcontrollers</td><td>Credits: 3(3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• 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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 12</td></tr>
<tr><td colspan="4">Introduction: History of Microprocessors, Basics of computer architecture, CISC and RISC; 8085 Microprocessor Family Overview, 8085 Architecture, Assembly Language Programming (ALP), and Program development.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 11</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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.

<table>
<tr><td>Subject Code

EC352</td><td colspan="2">Linear Integrated Circuits</td><td>Credits: 3(3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• 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</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 11</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
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<tr><td>Subject Code

EC 353</td><td colspan="2">Digital Communication</td><td>Credits: 4 (3-1-0)

Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To enable students to understand and compare the performance of different digital communication systems (BER, SNR etc).</td></tr>
<tr><td colspan="3">Module 1</td><td>5 Hours</td></tr>
<tr><td colspan="4">Review of Random Processes. Gaussian Process. Correlation Functions and Power Spectra.</td></tr>
<tr><td colspan="3">Module2</td><td>16 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>17 Hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 4</td><td>18 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">1. Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering", John Wiley, 1965.<br>2. Proakis J.G., ``Digital Communications", 4th Edition, McGraw Hill, 2000.
3. Simon Haykin, “Digital Communication Systems”, Wiley India Private Ltd.</td></tr>
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<table>
<tr><td>Subject Code

EC 354</td><td colspan="2">Communication Networks</td><td>Credits: 4 (3-1-0)

Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To enable students to understand layers of TCP/IP model, understand different protocols and their use in network design and implementation.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">9 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module2</td><td colspan="2">13 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">13 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 5</td><td colspan="2">9 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code

EC355</td><td>Linear Integrated Circuits Laboratory</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To provide experience on design and analysis of various electronic circuits using op-amp and other linear IC's</td></tr>
<tr><td colspan="3">List of Experiments</td></tr>
<tr><td colspan="3">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</td></tr>
</table>

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	

<table>
<tr><td>Subject Code

EC 402</td><td colspan="2">Information Theory and Coding</td><td>Credits: 4 (3-1-0)

Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To enable students to analyze fundamental parameters of information theory, to explain source and channel coding and to find capacity for simple channels.</td></tr>
<tr><td colspan="3">Module 1</td><td>9 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>8 Hours</td></tr>
<tr><td colspan="4">Conditional Entropy, Relative Entropy, Relations between them, Chain rules of Entropy, Convex Functions, Jensen’s Inequality, Log Sum Inequality, Data Processing Inequality, Differential Entropy.</td></tr>
<tr><td colspan="3">Module 3</td><td>15 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>15 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>9 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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.

<table>
<tr><td>Subject Code

EC405</td><td colspan="2">Digital System Design</td><td>Credits: 3(3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• 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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 11</td></tr>
<tr><td colspan="4">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).</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 12</td></tr>
<tr><td colspan="4">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).</td></tr>
<tr><td>Reference books</td><td colspan="3">1. C.H. Roth, “Digital system design using VHDL”, PWS Publishing, 1998.
2. J. Bhasker, “A VHDL Synthesis Primer”, B.S. Publications, 2001.</td></tr>
</table>

<table>
<tr><td>Subject Code

EC406</td><td colspan="2">Computer Architecture and Organization</td><td>Credits: 3(3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">Digital Electronics</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To understand and Implement the Basic Architecture of Computers.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">Hours 09</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module2</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">ARM Instruction sets: Register, Memory Access and Data Transfer, Arithmetic and Logic Instruction, Branch Instructions, Assembly languages, I/O operations, Subroutine, Program Examples.</td></tr>
<tr><td>Reference books</td><td colspan="3">1. John P Hayes, “ Computer Architecture and Organization”, (Third Edition) MCGraw Hill.
2. Carl Hamacher, Zvonkovranesic, Safat Z., “Computer Organization”, McGraw-Hill.</td></tr>
</table>

<table>
<tr><td>Subject Code

EC 407</td><td colspan="2">Advanced Digital Signal Processing</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>1 hours</td></tr>
<tr><td colspan="3">Motivation and Review of fundamental of DSP</td><td></td></tr>
<tr><td colspan="3">Module 2</td><td>10 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>10 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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

<table>
<tr><td>Subject Code

EC 409</td><td colspan="2">DSP Algorithm and Architecture</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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..</td></tr>
<tr><td colspan="3">Module 1</td><td>6 hours</td></tr>
<tr><td colspan="4">Introduction to Digital Signal Processing 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.</td></tr>
<tr><td colspan="3">Module2</td><td>3 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>9 hours</td></tr>
<tr><td colspan="4">Digital signal Processor specific Assembly language programming
Instruction types; Addressing modes. Assembly language programming for specific fixed / floating points DSP processor; Pipelining.</td></tr>
<tr><td colspan="3">Module 5</td><td>4 hours</td></tr>
<tr><td colspan="4">DSP Algorithms: Algorithmic Considerations; Convolution; FIR and IIR systems and FFT; Methods for generation of elementary functions; Pseudo-random number generation.</td></tr>
<tr><td colspan="3">Module 6</td><td>12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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</td></tr>
</table>

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

<table>
<tr><td>Subject Code

EC 411</td><td colspan="2">Image And Video Processing</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>2 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>5 hours</td></tr>
<tr><td colspan="4">Lossless Image Compression
Image Compression; Elements of Source Coding; Huffman Coding; Arithmetic Coding; Arithmetic and Lempel-Ziev Coding; Estimation of Source Probability.</td></tr>
<tr><td colspan="3">Module 3</td><td>9 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>17 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code

EC 412</td><td colspan="2">Biomedical Signal Processing</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>9 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>6 hours</td></tr>
<tr><td colspan="4">Review of Digital Signal Processing</td></tr>
<tr><td colspan="3">Module 3</td><td>9 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>9 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">1. Metin Akay, “Biomedical Signal Processing”, Academic Press 1994
2. L. Cromwell, F. Weibell, E. A. Pfiffer “Biomedical Instrument and Measurement”, Prentice Hall, 1980.</td></tr>
</table>

<table>
<tr><td>Subject Code

EC 413</td><td colspan="2">Error Control Coding</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To enable students to understand and use appropriately different error control techniques.</td></tr>
<tr><td colspan="3">Module 1</td><td>13 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>9 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>13 Hours</td></tr>
<tr><td colspan="4">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).</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

<table>
<tr><td>Subject Code

EC 414</td><td colspan="2">Spread Spectrum Communication</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To enable students to understand different spread spectrum techniques and their commercial applications.</td></tr>
<tr><td colspan="3">Module 1</td><td>14 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>8 Hours</td></tr>
<tr><td colspan="4">Code Division Multiple Access Systems: Cellular Radio Concept, CDMA Digital Cellular Systems, IS 95.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code

EC 415</td><td colspan="2">Optical Communication</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The objective is to understand concepts related to optical components, links and systems.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">14 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module2</td><td colspan="2">14 Hours</td></tr>
<tr><td colspan="4">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).</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">9 Hours</td></tr>
<tr><td colspan="4">Optical Amplifiers: Basic Applications and Types of Optical Amplifiers, Semiconductor Optical Amplifiers, Erbium-Doped Fibre Amplifiers, Amplifier Noise, Optical SNR, Raman Amplifiers.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">8 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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.

<table>
<tr><td>Subject Code

EC 417</td><td colspan="2">Antennas and Propagation</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To impart the basic concepts of radiating structures and their arrays.
To give idea about basic propagation.</td></tr>
<tr><td colspan="3">Module 1</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>12 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">1. C.A Balanis , Antenna Theory, John Wiley, 1996.
2. Electromagnetic waves & Radiating Systems– Jordan & Balman, Prentice Hall India.</td></tr>
</table>

<table>
<tr><td>Subject Code

EC418</td><td colspan="2">Satellite Communication</td><td>Credits:(3-0-0) 3

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">11hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">10 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">16 hours</td></tr>
<tr><td colspan="4">Communication link design, Frequency bands used, Antenna parameters, Transmission Equations, Noise considerations, Link design , Very Small Aperture Terminals (VSAT) - VSAT design issues.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">8 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(1) Richharia M., “Satellite Communication Systems”, Macmillan Press Ltd.

(2) Ha T.T., “Digital Satellite Communication”

(3)T. Pratt, “Satellite Communications”.</td></tr>
</table>

<table>
<tr><td>Subject Code

EC419</td><td colspan="2">Microwave Engineering</td><td>Credits:(3-0-0) 3

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">10 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

<table>
<tr><td>Subject Code

EC420</td><td colspan="2">Radar & Navigation Systems</td><td>Credits:(3-0-0) 3

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To give the basic ideas about the working of radar and navigation systems</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">15 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">15 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">15 hours</td></tr>
<tr><td colspan="4">Electronic counter measure, Hyperbola system of navigation, Instrument landing system, Microwave landing systems, Satellite navigation systems.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
</table>

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.		

<table>
<tr><td colspan="2">Module 8</td><td>5 hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 9</td><td>5hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Reference books</td><td colspan="2">1. Gonzalez R. C. And Woods R. E., “Digital Image Processing”, Second Edition, Pearson Education
2. Anil K. Jain, “Fundamentals of Digital Image Processing”</td></tr>
</table>

<table>
<tr><td>Subject Code

EC 422</td><td colspan="2">Active Filters and Data Converters</td><td>Credits: 3 (3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To understand the design and analysis of various active filters.
• To develop skills to design various circuits using different data conversion systems.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 15</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours 15</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 15</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

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.

<table>
<tr><td>Subject Code

EC 424</td><td>Low-Power VLSI Circuit Design</td><td>Credits: 3(3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">Module 1</td><td>Hours 10</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module2</td><td>Hours 12</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 3</td><td>Hours 11</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 4</td><td>Hours 12</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Reference books</td><td colspan="2">Gary K. Yeap, “Practical Low Power Digital VLSI Design”, KAP, 2002
Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI Circuit Design” Wiley, 2000.
Rabaey, Pedram, “Low Power Design Methodologies” Kluwer Academic</td></tr>
</table>

<table>
<tr><td>Subject Code

EC 425</td><td colspan="2">Logic Synthesis and Optimization</td><td>Credits: 3(3-0-0)

Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 12</td></tr>
<tr><td colspan="4">Introduction: Microelectronic design style, Design of Microelectronic circuits, Computer aided Synthesis and optimization. Background: Graphs, Graphs Optimization problems and Algorithms, Boolean Algebra and applications.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours 14</td></tr>
<tr><td colspan="4">Hardware Modelling: Hardware Modelling Languages, Abstract Models, Compilation and Behaviour Optimization. Two level Combinational level Optimization. Sequential Logic Optimization.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 11</td></tr>
<tr><td colspan="4">Architecture Level Synthesis and Optimization: Circuit Specification for Architecture Synthesis, Area and Performance Estimation, Data Path Synthesis and Control Path Synthesis.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 08</td></tr>
<tr><td colspan="4">Cell Library Binding: Problem Formulation and Analysis, Algorithms for Library Binding, Rule Based Library Binding.</td></tr>
<tr><td>Reference books</td><td colspan="3">Giovanni De Micheli, “Synthesis and Optimization of Digital Circuits”, McGraw Hill, 1994.
S. Hassoun and T. Sasao, “Logic Synthesis and Verification”, Kluwer Academic publishers, 2002.
Srinivas Devadas, Abhijith Ghosh and Kurt Keutzer, “Logic Synthesis”, Kluwer Academic, 1998.</td></tr>
</table>

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	Credit s
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**

<table>
<tr><td>Subject Code

MA 200</td><td colspan="2">Mathematics-III</td><td>Credits: 3 (3-0-0)

Total hours 42</td></tr>
<tr><td>Objectives</td><td colspan="3">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.</td></tr>
<tr><td>Module 1</td><td colspan="2">Complex Analysis</td><td>18 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Module 2</td><td colspan="2">Power Series Solutions</td><td>9 hours</td></tr>
<tr><td colspan="4">Differential Equations Power Series Method - application to Legendre equation, Legendre Polynomials, Frobenious Method, Bessel equation, Properties of Bessel functions, Sturm- Liouville BVPs, Orthogonal functions.</td></tr>
<tr><td>Module 3</td><td colspan="2">Partial Differential Equations</td><td>15 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Texts/References</td><td colspan="3">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).</td></tr>
</table>

<table>
<tr><td>Subject Code
EE200</td><td>Electromagnetic Theory</td><td>Credits: 4 (3-1-0)
Total hours: 56</td></tr>
<tr><td>Course Objective</td><td colspan="2">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.</td></tr>
<tr><td colspan="2">Module 1</td><td>20 hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 2</td><td>12 hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 3</td><td>10 hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 4 14 hours</td><td></td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Reference books</td><td colspan="2">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.</td></tr>
</table>

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.

<table>
<tr><td>Subject Code
EE202</td><td colspan="2">Circuit Theory</td><td>Credits: 4 (3-1-0)
Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours : 12</td></tr>
<tr><td colspan="4">Network Theorems and topology: Thevenin’s theorem, 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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours : 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>Hours : 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code
EE203</td><td colspan="2">Electrical Measurements and Instrumentation</td><td>Credits: 4 (3-1-0)
Total hours:56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours:14</td></tr>
<tr><td colspan="4">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).</td></tr>
<tr><td colspan="3">Module2</td><td>Hours:12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours: 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours: 10</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 5</td><td>Hours:10</td></tr>
<tr><td colspan="4">Cathode ray oscilloscope, theory and working, measurements using CRO, types of CRO, time base generator circuit, applications.</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

<table>
<tr><td>Subject Code
EE204</td><td>Circuit Theory Lab</td><td>Credits: 2 (0-0-3)
Total hours:45hr</td></tr>
<tr><td>Course Objective</td><td colspan="2">Laboratory exercises and assignments based on experiments and PSPICE and/or MATLAB simulation to supplement EE200.</td></tr>
<tr><td></td><td colspan="2">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</td></tr>
<tr><td>Reference books</td><td colspan="2">1. William H. Hayt, Jack E. Kemmerly, Steven M. Durbin, “Engineering Circuit Analysis,” TMH, 6th Edition, 2002.
2. Muhammad H.Rashid, “Introduction to PSPICE using ORCAD for Circuits and Electronics”, PHI, 2008.</td></tr>
</table>

<table>
<tr><td>Subject Code
EE205</td><td>Electrical Measurements and Instrumentation Lab</td><td>Credits: 2 (0-0-3)
Total Hours:45 Hrs</td></tr>
<tr><td>Course Objective</td><td colspan="2">Laboratory exercises and assignments to supplement EE253.</td></tr>
<tr><td></td><td colspan="2">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</td></tr>
<tr><td>Reference books</td><td colspan="2">(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</td></tr>
</table>

Subject Code MAT250	**Numerical Methods**	Credits: 3(3-0-0) Total hours: 42
Course Objective	To get familiarized with the numerical solution of linear and non-linear systems, Numerical solution of ordinary differential equations and partial differential equations.	
Module 1		**Hours : 10**
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.		
Module 2		**Hours : 12**
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.		
Module 3		**Hours : 11**
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.		
Module 4		**Hours : 12**
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		
Reference Books	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.	

<table>
<tr><td>Subject Code

EE250</td><td colspan="2">Digital Electronics</td><td>Credits: 3-0-0 (3)

Total hours:42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module2</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">1. Wakerly J F, “Digital Design: Principles and Practices”, Prentice-Hall, 2nd Ed., 2002
2. Mano M. M., “Digital Logic Design”, Prentice Hall 1993.</td></tr>
</table>

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.

<table>
<tr><td>Subject Code
EE 252</td><td colspan="2">Electrical Machines-I</td><td>Credits: 4 (3-1-0)
Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">Hours 15</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">Hours 15</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">Hours 15</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">Hours 11</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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 shunt motor 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.	

<table>
<tr><td>Subject Code
EE254</td><td>Analog and Digital Electronics Lab</td><td>Credits: 2 (0-0-3)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">Laboratory exercises and assignments based on hardware and SPICE simulation to supplement EE251 and EE252.</td></tr>
<tr><td></td><td colspan="2">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 $f0 \leq 10$ KHz
6. Testing for the performance of BJT – Hartley &Colpitts Oscillators for RF range $f0 \geq 100$KHz.
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</td></tr>
<tr><td>Reference books</td><td colspan="2">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</td></tr>
</table>

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.

<table>
<tr><td>Subject Code
EE 301</td><td colspan="2">Electrical Machines-II
(Induction Machines & Synchronous Machines)</td><td>Credits: 4 (3-1-0)
Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To learn the basic concepts about the different types of induction and synchronous machines. To understand the speed control and the starting operations.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">Hours 15</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">Hours 15</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">Hours 15</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">Hours 11</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code

EE303</td><td colspan="2">Microprocessors and Microcontrollers</td><td>Credits: 3(3-0-0)

Total hours:42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 10</td></tr>
<tr><td colspan="4">Introduction: History of Microprocessors, Basics of computer architecture, CISC and RISC; 8085 Microprocessor Family Overview, 8085 Architecture, Assembly Language Programming (ALP), and Program development.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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.	

<table>
<tr><td colspan="2">Module 5</td><td>Hours : 12</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Reference books</td><td colspan="2">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</td></tr>
</table>

<table>
<tr><td>Subject Code
EE350</td><td colspan="2">Switchgear and Protection</td><td>Credits: 4 (3-1-0)
Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours : 14</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours : 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Referenc e books</td><td colspan="3">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</td></tr>
</table>

<table>
<tr><td>Subject Code
EE 351</td><td colspan="2">Power System Analysis</td><td>Credits: 4 (3-1-0)
Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="2">Module 5</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

<table>
<tr><td>Subject Code
EE 352</td><td colspan="2">Power Electronics</td><td>Credits: 4 (4-0-0)
Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 10</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

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.

<table>
<tr><td>Subject Code
EE354</td><td>Electrical Simulation Lab</td><td>Credits: 2 (0-0-3)
Total Hours:45 Hrs</td></tr>
<tr><td>Course Objective</td><td colspan="2">Laboratory exercises and assignments based on hardware and MATLAB simulation to supplement EE352.</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Reference books</td><td colspan="2">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</td></tr>
</table>

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		

<table>
<tr><td>Subject Code
EE401</td><td>Power Electronics and Drives Lab</td><td>Credits: 2 (0-0-3)
Total Hours:45 Hrs</td></tr>
<tr><td>Course Objective</td><td colspan="2">Laboratory exercises and assignments based on hardware and MATLAB simulation to supplement EE303.</td></tr>
<tr><td></td><td colspan="2">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 inverter with 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</td></tr>
<tr><td>Reference books</td><td colspan="2">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.</td></tr>
</table>

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.	

<table>
<tr><td>Subject Code
EE502</td><td colspan="2">Electronic Instrumentation</td><td>Credits: 3(3-0-0)
Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To understand the basic principles of instruments and measurements and various practical issues related to measurement.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">Hours 14</td></tr>
<tr><td colspan="4">Measurement of voltage, current, power, noise, resistance, capacitance, inductance, time, frequency, charge and pulse energy</td></tr>
<tr><td colspan="2">Module2</td><td colspan="2">Hours 7</td></tr>
<tr><td colspan="4">Designing for EMC: EMC regulations, typical noise path, methods of noise coupling, and methods of reducing interference in electronic systems.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">Hours 14</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code
EE 503</td><td colspan="2">Elements of Analog and Digital Communication</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To give a basic insight to Basic Communication Engineering</td></tr>
<tr><td colspan="3">Module 1 Introduction to Analog and Digital Communication</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2 Digital and data communication</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3 Serial and parallel interface</td><td>Hours 09</td></tr>
<tr><td colspan="4">Computer network configurations and protocols, OSI reference model, Internet protocol, IP protocol: forwarding and addressing in the internet, routing algorithms, packet switching.</td></tr>
<tr><td colspan="3">Module 5 Satellite ,Mobile and optical fibre communication</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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.

<table>
<tr><td>Subject Code
EE505</td><td>Digital Computer Organization and Architecture (COA)</td><td colspan="2">Credits: 3 (3-0-0)
Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To develop an understanding of the nature and characteristics of the architecture and design of the modern computer systems.</td></tr>
<tr><td colspan="3">Module 1</td><td>6 Hours</td></tr>
<tr><td colspan="4">Introduction to computer architecture and organization: digital components, Von Neumann machine 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.</td></tr>
<tr><td colspan="3">Module 2</td><td>13Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>12 Hours</td></tr>
<tr><td colspan="4">Pipelining: Pipeline structure, pipeline performance measures, pipeline types, memory organization, memory device characteristics, RAM organization, virtual memory, paging and segmentation, high speed memories.</td></tr>
<tr><td colspan="3">Module 4</td><td>14 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
</table>

<table>
<tr><td>Referenc e books</td><td>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.</td></tr>
</table>

<table>
<tr><td>Subject Code
EE 506</td><td colspan="2">Advanced Control Systems</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">Hours 11</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

<table>
<tr><td>Subject Code
EE507</td><td colspan="2">Travelling Waves on Transmission System</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To understand the various types of travelling waves on transmission system.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours : 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours : 13</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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 .</td></tr>
</table>

<table>
<tr><td>Subject Code
EE 508</td><td colspan="2">Utilisation of Electrical Energy</td><td>Credits: 3 (3-0-0)
Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">Understand concept of illumination systems, heating and welding systems. Learn the requirements of traction systems.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">Hours 14</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">Hours 7</td></tr>
<tr><td colspan="4">Illumination: definition, illumination standards, laws of illumination, lighting calculations, polar curves, Rousseau's construction, illumination measuring devices, various illumination devices.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
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<table>
<tr><td>Subject Code
EE509</td><td colspan="2">Introduction to Database management Systems</td><td colspan="2">Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="4">This course covers the relational database systems RDBS - the predominant system for business, scientific and engineering applications at present.</td></tr>
<tr><td colspan="3">Module 1</td><td colspan="2">6 Hours</td></tr>
<tr><td colspan="5">Introduction & need for database systems, views of data, data models, database system architecture, database users and administrator.</td></tr>
<tr><td colspan="3">Module 2</td><td colspan="2">10 Hours</td></tr>
<tr><td colspan="5">Entity relationship model (E-R model), E-R diagrams, introduction to relational databases, keys, relational algebra,domain, relational calculus, tuple relational calculus.</td></tr>
<tr><td colspan="3">Module 3</td><td colspan="2">15 Hours</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td colspan="3">Module 4</td><td colspan="2">14 Hours</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td>Reference books</td><td colspan="4">(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.</td></tr>
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<table>
<tr><td>Subject Code
EE 510</td><td colspan="2">Computer Networks</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">This course focuses on understanding the design of computer networks, assimilating hubs into a personal network.</td></tr>
<tr><td colspan="3">Module 1</td><td>8 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>16 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>10 Hours</td></tr>
<tr><td colspan="4">Link layer services, error detection and correction, multiple access protocols, ARP, ethernet, hubs, bridges, switches, wireless links, mobility, PPP, ATM, MPLS, VLAN.</td></tr>
<tr><td colspan="3">Module 4</td><td>11 Hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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, 5thEdn, 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”, 3rdEd., TMH.</td></tr>
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<table>
<tr><td>Subject Code
EE 511</td><td colspan="2">Embedded Systems</td><td>Credits: 3(3-0-0)
Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To give ideas about embedded systems and system development.
To impart knowledge about real time operating systems and microcontrollers</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours 8</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 15</td></tr>
<tr><td colspan="4">System design examples : system design using ARM/PSoC/MSP430 processor</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
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<table>
<tr><td>Subject Code
EE512</td><td colspan="2">High Voltage DC (HVDC) Transmission</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours : 8</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours : 8</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours :9</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
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<tr><td>Subject Code
EE513</td><td colspan="2">Flexible AC Transmission Systems</td><td>Credits: 3 (3-0-0)
Total hours: 56</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours : 9</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours : 9</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours : 9</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>Hours : 8</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

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.

<table>
<tr><td>Subject Code
EE515</td><td colspan="2">Renewable Energy Systems</td><td>Credits: 3 (3-0-0)
Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To explain concept of various forms of renewable energy and to outline the utilization of renewable energy sources for both domestic and industrial applications</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours: 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours: 9</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours: 9</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours:9</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>Hours: 8</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">(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.</td></tr>
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<tr><td>Subject Code
EE 516</td><td colspan="2">Static Relays</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 09</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
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<table>
<tr><td>Subject Code
EE517</td><td colspan="2">Photovoltaic and its applications</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours: 5</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module2</td><td>Hours: 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours: 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours: 10</td></tr>
<tr><td colspan="4">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;</td></tr>
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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)	

<table>
<tr><td>Subject Code
EE 518</td><td colspan="2">Power System Restructuring</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 08</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 10</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 07</td></tr>
<tr><td colspan="4">Cost allocation methods open access distribution, changes in distribution operations, the development of competition, maintaining distribution planning</td></tr>
<tr><td colspan="3">Module 5</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code
EE 519</td><td colspan="2">Distribution automation and Smart Grid</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To understanding the distribution automation and smart grid architecture, working.</td></tr>
<tr><td colspan="3">Module 1</td><td>4 hours</td></tr>
<tr><td colspan="4">Distribution system Planning and forecasting techniques, load characteristics, definitions, tariffs and metering of energy, distribution transformers, types, distribution sub-stations and primary system.</td></tr>
<tr><td colspan="3">Module2</td><td>12 hours</td></tr>
<tr><td colspan="4">Voltage drop and power loss calculations, distribution feeder costs, capacitors in distribution systems, justification for capacitors, distribution system automation, automation communication systems.</td></tr>
<tr><td colspan="3">Module 3</td><td>12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>12 hours</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>5 hours</td></tr>
<tr><td colspan="4">Renewable Integration, Electric Vehicles and plug - in hybrids, indian smart grid. Case studies</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code
EE520</td><td colspan="2">Power Quality</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours : 12</td></tr>
<tr><td colspan="4">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,</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours : 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours : 13</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code
EE521</td><td colspan="2">Real Time Control of Power System</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours : 8</td></tr>
<tr><td colspan="4">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).</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours : 14</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours : 11</td></tr>
<tr><td colspan="4">Distributed Control Systems (DCS), difference between SCADA system and DCS, architecture, local control unit, Programming language, communication facilities, operator interface, engineering interfaces.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours : 12</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code
EE 522</td><td colspan="2">Optimization Techniques</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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</td></tr>
<tr><td colspan="3">Module 1 Linear models</td><td>Hours 12</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="3">Module 2 Network models and Dynamic programming</td><td>Hours 09</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3 Nonlinear programming-Unconstrained</td><td>Hours 12</td></tr>
<tr><td colspan="4">Single variable optimization, region elimination methods, point estimation methods, gradient based methods, multivariable optimization, direct search methods and gradient search methods</td></tr>
<tr><td colspan="3">Module 4 Nonlinear programming-Constrained</td><td>Hours 12</td></tr>
<tr><td colspan="4">Constrained optimization, Kuhn Tucker conditions, transformation methods, Lagrangian multiplier methods, penalty function methods, gradient projection method, Applications of non-linear programming in Engineering design</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

<table>
<tr><td>Subject Code
EE 523</td><td colspan="2">Simulation and Modelling of Power Converters</td><td>Credits: 3 (3-0-0)
Total hours:45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">Computer simulation of continuous time dynamic systems using transfer function models: electromechanical, hydraulic and pneumatic systems. Introduction to simulation tools.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">Solution of nonlinear equations, methods to the solution of electrical networks, general-purpose circuit simulators, introduction to machine modelling : induction, DC, and synchronous machines</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">Hours 12</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">Hours 9</td></tr>
<tr><td colspan="4">Interaction between power electronic converters and rotating machines</td></tr>
<tr><td>Reference books</td><td colspan="3">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</td></tr>
</table>

<table>
<tr><td>Subject Code
EE 524</td><td colspan="2">Poly-phase Systems and component Transformation</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">An overview of poly-phase circuits combined fault analysis and system working in unbalanced load conditions.</td></tr>
<tr><td colspan="3">Module 1</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 2</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 3</td><td>Hours 08</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 4</td><td>Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="3">Module 5</td><td>Hours 07</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

<table>
<tr><td>Subject Code
EE 525</td><td colspan="2">Power system Dynamics</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 1</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">Modelling: Dynamic modelling requirements, angle stability, equal area criterion, critical fault clearing time and angle, numerical integration techniques.</td></tr>
<tr><td colspan="2">Module 2</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="2">Module 3</td><td colspan="2">Hours 10</td></tr>
<tr><td colspan="4">Dynamics of Synchronous machines: Mechanical relationships and electrical transient relationships, adjustment of machine models, Park’s equation in the operational form.</td></tr>
<tr><td colspan="2">Module 4</td><td colspan="2">Hours 08</td></tr>
<tr><td colspan="4">Dynamics of Induction machines: Induction motor equivalent circuits and parameters, free acceleration characteristics, dynamic performance, effect of three phase short circuit and unbalanced faults.</td></tr>
<tr><td colspan="2">Module 5</td><td colspan="2">Hours 07</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Reference books</td><td colspan="3">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.</td></tr>
</table>

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.

<table>
<tr><td>Subject Code
EE 527</td><td>High Voltage Engineering</td><td>Credits: 3 (3-0-0)
Total hours: 45</td></tr>
<tr><td>Course Objectives</td><td colspan="2">Introducing the dynamics of HV generation, transmission and working, HV testing, measurement.</td></tr>
<tr><td colspan="2">Module 1</td><td>6 hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module2</td><td>10 hours</td></tr>
<tr><td colspan="3">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</td></tr>
<tr><td colspan="2">Module 3</td><td>10 hours</td></tr>
<tr><td colspan="3">Measurement of high currents, impulse currents, dielectric breakdown in gases, liquids, solids, dielectric strength, dielectric partial discharges, corona discharges.</td></tr>
<tr><td colspan="2">Module 4</td><td>10 hours</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="2">Module 5</td><td>09 hours</td></tr>
<tr><td colspan="3">Causes of over voltage, types, over voltages effects on power system components, surge diverters, EMI and EMC protection against over voltages, insulation coordination.</td></tr>
<tr><td>Reference books</td><td colspan="2">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.</td></tr>
</table>

<table>
<tr><td>Subject Code:
HU 501&
HU 502</td><td colspan="2">Professional Communication-II and Language Lab</td><td>Credits: 4 (2-0-3)
Total hours: 56</td></tr>
<tr><td>Course Prerequisite</td><td colspan="3">Knowledge of English</td></tr>
<tr><td>Course Objectives</td><td colspan="3">This course aims at Personality Development</td></tr>
<tr><td>Course Outcome</td><td colspan="3">At the end, the students should possess a Saleable Image with employability skills</td></tr>
<tr><td>Module 1</td><td colspan="2">Principles of Soft Skills and Practice</td><td>12 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 2</td><td colspan="2">Group Discussion, Extempore, JAM and Survey</td><td>16 hours</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>Module 3</td><td colspan="2">Interview</td><td>14 hours</td></tr>
<tr><td colspan="4">Types of Interview, Interview Ethics, Questions and Mock-Interview Sessions</td></tr>
<tr><td>Module 4</td><td colspan="2">Business Presentation and Seminars</td><td>14 hours</td></tr>
<tr><td colspan="4">Business Presentation and Students’ Seminar</td></tr>
<tr><td>Texts:</td><td colspan="3">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)</td></tr>
<tr><td>Reference</td><td colspan="3">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</td></tr>
</table>

Academic Handbook

B.Tech Program

Academic Affairs

(2018-2019)

NATIONAL INSTITUTE OF TECHNOLOGY GOA

Academic Handbook

for

Bachelor of Technology Programme

in

Mechanical Engineering

National Institute of Technology Goa

Farmagudi, Ponda, Goa - 403 401

Programme Structure Summary

Categories of the Courses

The Bachelor of Technology (B.Tech.) program in the Dept. of Mechanical Engineering at National Institute of Technology Goa (NIT Goa) will have 171 credits as the lower limit for the award of degree. These courses are grouped in a number of categories as shown below:

Sl. No.	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)	6*	✓ Environmental Studies -1 Credit ✓ Professional Communication -II and Language Lab -3 Credits ✓ Physical Education -1 Credit ✓ Value Education -1 Credit
Total Credits		**171**	**165 credits are counted for CGPA**

<u>Semester-wise Credit Distribution</u>

Semester	Total Credits
I	22
II	21+1*
III	23
IV	22+1*
V	20+1*
VI	21+3*
VII	18
VIII	18
Total Credits	**165+6***

Semester-Wise Distribution of the Courses

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		**21+1***

III Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	MA200	Mathematics-III	3-0-0	3
2	ME200	Mechanics of Solids	3-0-0	3
3	ME201	Materials and Metallurgical Engineering	3-0-0	3
4	ME202	Fluid Mechanics	3-0-0	3
5	ME203	Electrical and Electronics Technology	3-0-0	3
6	ME204	Basic Thermodynamics	3-0-0	3
7	ME205	Machine Drawing	1-0-3	3
8	ME206	Electrical and Electronics Technology Lab	0-0-3	2
			Total Credits	**23**

IV Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	MA250	Mathematics-IV (Numerical Methods and Statistics)	3-0-0	3
2	ME250	Applied Thermodynamics	3-0-0	3
3	ME251	Power Plant Engineering	3-0-0	3
4	ME252	Manufacturing Technology-I	3-0-0	3
5	ME253	Mechanics of Machinery	3-0-0	3
6	ME254	Measurements and Metrology	3-0-0	3
7	ME255	Mechanics of Solids Lab	0-0-3	2
8	ME256	Fluid Mechanics Lab	0-0-3	2
9	VE200	Value Education	1-0-0	1*
			Total Credits	**22+1***

V Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	ME300	Manufacturing Technology-II	3-0-0	3
2	ME301	CAD/CAM	3-0-0	3
3	ME302	Turbo Machinery	3-0-0	3
4	ME303	Machine Design-I	3-0-0	3
5	ES301	Environmental Studies	1-0-0	1*
6	HS300	Economics	3-0-0	3
7	ME304	Mechanical Lab-1	0-0-3	2
8	ME305	Measurements and Metrology Lab	0-0-3	2
9	ME306	Mechanical Workshop-I	0-0-3	1
			Total Credits	**20+1***

VI Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	ME350	Heat Transfer	3-0-0	3
2	ME351	Automobile Engineering	3-0-0	3
3	ME352	Machine Design-II	3-0-0	3
4	ME5**	Elective-I	3-0-0	3
5	HS350	Management	3-0-0	3
6	HU350	Professional Communication-II and Languages Lab	2-0-3	3*
7	ME353	Mechanical Workshop-II	0-0-3	1
8	ME354	Mechanical Lab-II	0-0-3	2
9	ME355	CAD/CAM Lab	0-0-3	2
10	ME356	Mini Project/Industrial training	0-0-3	1
			Total Credits	**21+3***

VII Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	ME400	Production and Operations Management	3-0-0	3
2	ME401	Automatic Control	3-0-0	3
3	ME5**	Elective-II	3-0-0	3
4	ME5**	Elective-III	3-0-0	3
5	ME402	Seminar	0-0-2	2
6	ME449	Major Project-I	0-0-4	4
		Total Credits		**18**

VIII Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	ME450	Industrial Engineering and Operation Research	3-0-0	3
2	ME5**	Elective-IV	3-0-0	3
3	ME5**	Elective-V	3-0-0	3
4	ME5**	Elective-VI	3-0-0	3
5	ME499	Major Project – II	0-0-6	6
		Total Credits		**18**

List of Electives

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	ME500	Metal Removal Processes	3-0-0	3
2	ME501	Metal Casting	3-0-0	3
3	ME502	Material Joining	3-0-0	3
4	ME503	Material Forming	3-0-0	3
5	ME504	Composite Materials	3-0-0	3
6	ME505	Computer Integrated Manufacturing	3-0-0	3
7	ME506	Non-Destructive Testing	3-0-0	3
8	ME507	Quality and Reliability	3-0-0	3
9	ME508	Supply Chain Management	3-0-0	3
10	ME509	Optimization Techniques	3-0-0	3
11	ME510	Industrial Safety	3-0-0	3
12	ME511	Maintenance Engineering and Management	3-0-0	3
13	ME512	Lean Manufacturing	3-0-0	3
14	ME513	Fluid Power Control	3-0-0	3
15	ME514	Mechatronics Engineering	3-0-0	3
16	ME515	Integrated Product Design and Prototyping	3-0-0	3
17	ME516	Micro Electro Mechanical Systems	3-0-0	3
18	ME517	Automation Technologies	3-0-0	3
19	ME518	Synthesis of Mechanisms	3-0-0	3
20	ME519	Industrial Robotics	3-0-0	3
21	ME520	Tribology	3-0-0	3
22	ME521	Machine Dynamics	3-0-0	3
23	ME522	Fracture Mechanics	3-0-0	3
24	ME523	Finite Element Methods	3-0-0	3
25	ME524	Refrigeration and Air Conditioning	3-0-0	3
26	ME525	Cryogenic Engineering	3-0-0	3
27	ME526	Computational Fluid Dynamics	3-0-0	3
28	ME527	Renewable Energy Systems	3-0-0	3
29	ME528	Internal Combustion Engines	3-0-0	3
30	ME529	Energy Audit and Management	3-0-0	3

31	ME530	Aerodynamics	3-0-0	3
32	ME531	Heating Ventilation and Air Conditioning	3-0-0	3
33	ME532	Advanced Thermodynamics	3-0-0	3
34	ME533	Experimental Methods in Fluid flow and Heat Transfer	3-0-0	3

Classification of Electives into Streams

Manufacturing and Industrial Engineering	Automation/ Mechatronics	Design	Thermal
ME500	ME513	ME518	ME524
ME501	ME514	ME519	ME525
ME502	ME515	ME520	ME526
ME503	ME516	ME521	ME527
ME504	ME517	ME522	ME528
ME505		ME523	ME529
ME506		ME530	ME531
ME507			ME532
ME508			ME533
ME509			
ME510			
ME511			
ME512			

Detailed Syllabus of Courses

III Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	MA200	Mathematics-III	3-0-0	3
2	ME200	Mechanics of Solids	3-0-0	3
3	ME201	Materials and Metallurgical Engineering	3-0-0	3
4	ME202	Fluid Mechanics	3-0-0	3
5	ME203	Electrical and Electronics Technology	3-0-0	3
6	ME204	Basic Thermodynamics	3-0-0	3
7	ME205	Machine Drawing	1-0-3	3
8	ME206	Electrical and Electronics Technology Lab	0-0-3	2
			Total Credits	**23**

<table>
<tr><td>Subject Code
MA200</td><td>Mathematics-III</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Mathematics-I & II</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• 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.</td></tr>
<tr><td colspan="3">Complex Analysis: 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.

Power Series Solutions: Differential Equations Power Series Method - application to Legendre equation, Legendre Polynomials, Frobenious Method, Bessel equation, Properties of Bessel functions, Sturm- Liouville BVPs, Orthogonal functions.

Partial Differential Equations: 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.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">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).</td></tr>
</table>

<table>
<tr><td>Subject Code
ME200</td><td>Mechanics of Solids</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To build the concept of variety of stresses, strain and deformation due to external acting loads on deformable bodies
• To study the behavioral pattern of beams, struts, columns, cylinders etc.
• To make the students comfortable in analyzing shear force and bending moment diagrams of various beams
• To solve problems relating to torsional deformation of bars and other simple structures
• To study various failure theories and energy methods</td></tr>
<tr><td colspan="3">Introduction to stress and strain: Simple flexure theory, bending stress and shearing stress distribution across sections Macaulay's method for deflection of statically determinate beams.

Compound stresses: Analytical method, Graphical method (Mohr's Circle). Torsion, Transmission of Power through hollow and solid shafts, Beams of Uniform strength, Springs, Combined bending and Torsion, Strain energy, Thick and thin pressure vessels, Theory of failures.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. F. L. Singer, “Strength of Materials”, 3rd Edition, Harper and Row Publishers, New York, 1980
2. E. J. Hearn, “Mechanics of Materials”, Pergaman Press, England, 1972
3. F. P. Beer, E. R. Johnston, J. T. Dewolf, “Mechanics of Materials”, 3rd Edition, Tata McGraw Hill, New-Delhi, 2007
4. L. S. Srinath, “Advanced Mechanics of Solids”, Tata McGraw Hill Publishing Company Ltd., 2009
5. S. P. Timoshenko, J. N. Goodier, “Theory of Elasticity” McGraw Hill Education; 3rd edition, 2010
6. I. Shames, “Introduction to Solid Mechanics”, Prentice Hall of India; 3rd Edition, 2003
7. S. M. A. Kazimi, “Solid Mechanics”, Tata McGraw Hill Education, 1st Edition, 1982
8. P. N. Singh, P. K. Jha, “Elementary Solid Mechanics”, New Age International (P) Ltd. Delhi, 2011</td></tr>
</table>

<table>
<tr><td>Subject Code
ME201</td><td>Materials and Metallurgical Engineering</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To impart knowledge on crystal structure, classification of materials, understand the methods of determining mechanical properties and their suitability for applications
• To develop knowledge to classify various types of steels and study their applications, Interpret the phase diagrams of materials and select suitable heat-treatment process to achieve desired properties of metals
• To understand the applications of various metals and non-metallic materials, identify, test and select suitable materials for various engineering applications</td></tr>
<tr><td colspan="3">Metals - Solidification, Alloys and Phase diagrams
Iron carbon equilibrium diagram
Heat treatment of ferrous and non-ferrous alloys
Ceramics, Polymers and composite materials
Testing of Engineering materials, Fracture and failure of materials
Structure- property correlation of Engineering materials</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Avner H., Introduction to Physical Metallurgy– McGraw Hill, New York, 1987.
2. Raymond A. Higgins, Engineering Metallurgy –Part 1: Applied Physical Metallurgy, ELBS, London, 1988.
3. Callister W.D., Material Science and Engineering-An Introduction, John Wiley & Sons, Inc., New York, 2003.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME202</td><td>Fluid Mechanics</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To familiarize with the properties of fluids and the applications of fluid mechanics.
• To formulate and analyze problems related to calculation of forces in fluid structure interaction.
• To understand the concept of fluid measurement, types of flows and dimensional analysis.</td></tr>
<tr><td colspan="3">Fundamentals of fluid properties, pressure measurement, hydrostatic forces on surfaces, Buoyancy and floatation, Kinematics of fluid flow, Fluid dynamics, Compressible flow, gas nozzles, Flow of real fluids, Boundary layer theory, Flow around immersed bodies, Flow through pipes, Impact of jets, Hydraulic Machines, pumps, Turbines, Hydraulic systems.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Kumar K.L. Fluid Mechanics, Eurasis Publishing House, New Delhi, 1995.
2. Yahya S.M., Turbomachines, Satya Prakashan, New Delhi, 1972.
3. F .M. White, Fluid Mechanics, Springer-Verlag. New York. 1999.</td></tr>
</table>

Subject Code ME203	# Electrical and Electronics Technology	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To provide foundation about few of the basic electrical machines • To understand the basics of their operating principles • To analysis the functioning and operation of energy conversion systems	

Transformers: Principle, construction (single phase, three phase), development of equivalent circuit through coupled circuit approach, phasor diagram, regulation, efficiency, autotransformers,

Induction machines: Principle, construction, classification, equivalent circuit, phasor diagram, characteristics, starting techniques, speed control, operation under unbalanced supply conditions and harmonics,

DC Machines: Construction, classification, emf and torque equation, characteristics of DC motors, speed control, brushless DC motor, stepper motor, servomotor.

Synchronous machines: Construction, prime- mover and excitation control systems. Operational Amplifier & Linear Applications: Difference amplifiers, Instrumentation amplifiers, voltage to current converters, Filters.

Microprocessors: Introduction to Microprocessor Systems. System Architecture, operation and application of microprocessors; microprocessor programming;

Text/Reference Books

1. Albert E. Clayton and V.N. Hancock, Performance and Design of Direct Current Machines
2. Charles V Jones, Unified theory of Electrical Machines, Butterworth, 1967
3. O I Elgerd, Patrick D Van der Puije, Electric Power Engineering, 2nd edition, Chapman &Hall,1998.
4. M.G. Say, Performance and Design of Alternating Current Machines, CBS, 1983.
5. Fitzgerald, Kingsley, Umans, Electric Machinery, 5th Edition, McGraw-Hill, 1992
6. Arthur R. Bergen, and Vijay Vittal, Power System Analysis, 1st Edition, Pearson Education Asia, 2001.
7. Sergio Franco, Design with OPAMPS and Linear Integrated circuits, Tata McGraw Hill, 2002.
8. Sedra and Smith, Microelectronics Circuits, Oxford Univ. Press, 2004
9. Coughlin, Driscoll, OP-AMPS and Linear Integrated Circuits, Prentice Hall, 2001.
10. Douglas V. Hall, Microprocessors & Interfacing, McGraw Hill International Edition, 1992.
11. Jonathan W Valvano, Embedded Microcomputer Systems: Real Time Interfacing, Cengage Learning, Jan- 2011.
12. Steve Furber, ARM System Architecture, Edison Wesley Longman, 1996.
13. William Hohl, ARM Assembly Language- Fundamentals and Techniques, CRC Press, 2009.

Subject Code ME204	Basic Thermodynamics	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To provide the foundation for analysis of energy conversion systems. • To analyze the relations governing thermodynamic properties and its application. • To assess the performance of engineering systems and processes based on laws of thermodynamics. • To apply the concepts of entropy and energy in engineering analysis.	

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. 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, Pure substance, Entropy, Available and unavailable energy, Analysis of cycles, Helmholtz and Gibbs Functions and its applications, Ideal and Real gases, Non-reactive mixtures, properties of air and water vapour.

Text/Reference Books

1. Spalding and Cole, Engineering Thermodynamics, ELBS Edition Longmans, 1987.
2. Arora C.P. Thermodynamics, TMH, 1998.
3. Gordan J. Van Wylen and Richard E.Sountag, Fundamentals of Classical Thermodynamics, 4th Edition, Wiley, 1994.
4. P. K. Nag, Basic and Applied Thermodynamics, Tata McGraw Hill. 3rd Edition, 2005.
5. Yunus A Cengel and Michael A. Boles, Thermodynamics: An Engineering approach, Tata Mcgraw Hill, 7th Edition.

<table>
<tr><td>Subject Code
ME205</td><td>Machine Drawing</td><td>Credits: 3 (1-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand various sectional views, fasteners, joints, represent tolerances and the levels of surface finish of machine elements
• To draw an assembly drawing from various working drawing
• To construct an assembly drawing using various part drawings of machine components using conventional drafting as well as 3D modeling software</td></tr>
<tr><td colspan="3">Machine components done using conventional drawing board and AutoCAD

Assembly drawing from working drawing: Swivel bearing, Machine Swivel vice, Tool head of shaper, Tailstock, Fuel pump, Fuel Injector, Rams bottom safety valve, Stop valve, Blow-off cock, Screw Jack, Centrifugal pump

Part drawing from assembly drawing: Foot step bearing, Eccentric, connecting rod, square tool post, Drill jig, Feed check valve</td></tr>
<tr><td>Reference Books</td><td colspan="2">1. Bhat N. D, Machine Drawing, Charotar Publishing House, Anand, India, 1984.
2. Gopalkrishna K. R. Machine Drawing, Subhas Publication, Bangalore, 1999.
3. Narayana K. L, Kannaiah P, Venkat Reddy K, Machine Drawing 3rd Edition, New Age International Ltd, 2006.
4. Goutam Pohit, Goutam Ghosh, Machine drawing with AutoCAD, Pearson Education, 2007.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME206</td><td>Electrical and Electronics Technology Lab</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To see the practical operation of electrical machines and electronics
• To understand the basics of their operating principles</td></tr>
<tr><td colspan="3">Experiments on OPAMPS Linear application: Voltage follower, Non-inverting amplifier and Non-inverting summing amplifier, Inverting amplifier, Inverting summing amplifier, Difference amplifier, Instrumentation amplifier, Voltage to current converter. Inverting integrator, Filters, Use of electrical meters, Load test on different Electrical motors and generators, Load test on transformers</td></tr>
<tr><td>Reference Books</td><td colspan="2">1. Albert E. Clayton and V.N. Hancock, Performance and Design of Direct Current Machines
2. Charles V Jones, Unified theory of Electrical Machines, Butterworth, 1967
3. I Elgerd, Patrick D Van der Puije, Electric Power Engineering,2nd edition, Chapman &Hall,1998.
4. M.G. Say, Performance and Design of Alternating Current Machines, CBS, 1983.
5. Fitzgerald, Kingsley, Umans, Electric Machinery, 5th Edition, McGraw-Hill, 1992
6. Arthur R. Bergen, and Vijay Vittal, Power System Analysis, 1st Edition, Pearson Education Asia, 2001.
7. Sergio Franco, Design with OPAMPS and Linear Integrated circuits, Tata McGraw Hill, 2002.
8. Sedra and Smith, Microelectronics Circuits, Oxford Univ. Press, 2004
9. Coughlin, Driscoll, OP-AMPS and Linear Integrated Circuits, Prentice Hall, 2001.
10. Douglas V. Hall, Microprocessors & Interfacing, McGraw Hill International Edition, 1992.
11. Jonathan W Valvano, Embedded Microcomputer Systems: Real Time Interfacing, Cengage Learning,Jan- 2011.
12. Steve Furber, ARM System Architecture, Edison Wesley Longman, 1996.
13. William Hohl, ARM Assembly Language- Fundamentals and Techniques, CRC Press, 2009.</td></tr>
</table>

IV Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	MA250	Mathematics-IV (Numerical Methods and Statistics)	3-0-0	3
2	ME250	Applied Thermodynamics	3-0-0	3
3	ME251	Power Plant Engineering	3-0-0	3
4	ME252	Manufacturing Technology-I	3-0-0	3
5	ME253	Mechanics of Machinery	3-0-0	3
6	ME254	Measurements and Metrology	3-0-0	3
7	ME255	Mechanics of Solids Lab	0-0-3	2
8	ME256	Fluid Mechanics Lab	0-0-3	2
9	VE200	Value Education	1-0-0	1
			Total Credits	**22+1**

<table>
<tr><td>Subject Code
MA 250</td><td>Mathematics-IV (Numerical Methods and Statistics)</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• 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.</td></tr>
<tr><td colspan="3">Module1: 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: 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.

Module2: 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.

Module4: 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</td></tr>
<tr><td>Text/Reference books</td><td colspan="2">1. M. K. Jain, S. R. K. Iyenger and R.K. Jain, "Numerical Methods for Scientific and Engineering Computation, "New Age Publishers, 6th Edition, 2012.
2. E. Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India Pvt. Ltd., 2010.
3. R. L. Burden and J. D. Faires, "Numerical Analysis", 9th Edition, Brooks/Cole, 2012.
4. S. C. Gupta, and V.K. Kapoor, "Fundamentals of Mathematical Statastics", 7th Edition, Sultan Chand and Sons, 1980.
5. A. Papoulis, and P. Unnikrishnan, "Probability, Random Variable and Stochastic Process", 4th Edition, Tata McGraw-Hill, 2002.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME250</td><td>Applied Thermodynamics</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand the significance of thermodynamic cycles w.r.to. Steam power plant.
• To understand the principles and applications of refrigeration systems
• To analyze air-conditioning processes using the principles of psychrometry</td></tr>
<tr><td colspan="3">Compressors, reciprocating and rotary, Steam nozzles and steam turbines, Air standard cycles, Vapour power cycles, Gas turbine cycles, performance testing of IC engines, Refrigeration cycles, vapour absorption system, Psychrometric processes.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Holman J. P., Thermodynamics, McGraw Hill International Student Edition. Newyork, 1969.
2. Rajput R.K, Thermal Engineering, Laxmi Publications (Pvt.) Ltd., New Delhi. 6th Edition, 2007.
3. Eastop and McConkey, Applied Engineering Thermodynamics, ELBS, 1995</td></tr>
</table>

<table>
<tr><td>Subject Code
ME251</td><td>Power Plant Engineering</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Basic Thermodynamics</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To Understand functions of the components of various power plants
• To Evaluate the design layout, working of hydroelectric power plants, economic feasibility and its implications on power generating units
• To gain knowledge on various Non-conventional or Renewable energy sources</td></tr>
<tr><td colspan="3">Conventional Energy Sources: Hydel, Steam, Gas turbine, Diesel and Nuclear Power Plant, Layout, function of different components and types, Power plant Economics

Non-conventional or Renewable energy sources: Solar energy, application of solar energy, Wind, Ocean, Geothermal, Biomass Energies, Energy Conversion Principles and types</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Houghton E.L., Carruthers, Aerodynaimcs for Engineers students, Butterworth-Hinemann Ltd., 2006
2. Sukathme S.P., Solar Energy Principles of Thermal Collection and Storage, 2nd Ed., TMC New Delhi,1984
3. M.M. El. Wakil, Power Plant Techniques, McGraw Hill, New York, 1985.
4. G.D. Rai, Non-Conventional Energy, Dhanpat Rai & Sons, New Delhi, 1998.
5. P.K Nag, Power Plant Engineering, McGraw Hill, 2017
6. G. R. Nagpal and S. C. Sharma, Power Plant Engineering, Khanna Publishers; Sixteenth edition (1995)</td></tr>
</table>

<table>
<tr><td>Subject Code
ME252</td><td><h1>Manufacturing Technology-I</h1></td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To understand various metal casting, joining and removal processes</td></tr>
<tr><td colspan="3">Metal casting processes, special casting processes, casting defects, rising and gating design, solidification mechanisms, melting practices;

Metal joining process: Gas Welding, Arc Welding, Advanced Welding processes, Welding defects, Brazing, Soldering;

Metal removal Processes: Introduction to machine tools and classification, Lathe, Drilling Machine, Shaping Machine, Milling Machine, Advanced machine tools.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">Ghosh and Mallick, Manufacturing Science, Prentice Hall PTR, 2001
Paul Degramo, Materials and Processes in Manufacturing, 9th Edition, John Wiley & sons, 2003.
Rao P. N, Manufacturing Technology Vol I and II, 2nd Edition, TMH education, 2006.
P. K Mishra, Non-Conventional Machining, 6th Edition Narosa Publishing house, 1997.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME253</td><td><h1>Mechanics of Machinery</h1></td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To learn how to analyze the mechanisms of machine linkages, motions, and analyze forces in machine components
To study the dynamics of motion of machine components and design of gears, gear trains, cams, and linkages, simultaneous
To understand the basic concepts and kinematics of toothed gear trains</td></tr>
<tr><td colspan="3">Basics of Kinematics: Links, kinematic pair, mobility, basic mechanisms and its inversions. Position, Velocity and Acceleration analysis, Static force analysis, Inertia forces in machines,

Synthesis of Mechanisms: Type, number and dimensional synthesis, Coupler curves,

Gear and gear trains: Helical, Spiral, Worm and Worm Wheel, Bevel gears.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">R.L. Norton, “Design of Machinery”, McGraw Hill Boston, 1999
J. J. Uicker, Jr, G. R. Pennock and J. E. Shigley & Shigley, “Theory of Machines and Mechanisms”, Oxford University Press, 2003
J. S. Rao, R. V. Dukkipati, “Mechanism and Machine Theory”, Wiley Eastern Limited, 1989
S.S. Rattan, “Theory of Machines”, McGraw-Hill Education (India) Pvt Ltd., 4^{th} Edition, 2014
H. H. Mabe and C.F. Rainbotten, “Mechanism and Design”, John Wiley, 1987
V Ramamurti, “Mechanics of Machines”, CRC press, 2010A. G. Erdman, “Mechanism Design –Analysis and Synthesis”, Vol. I, Prentice Hall, New Jersey, 1997</td></tr>
</table>

Subject Code ME254	Measurements and Metrology	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To Identify techniques to minimize the errors in measurement • To Identify methods and devices for measurement of length, angle, gear & thread parameters, surface roughness and geometric features of parts	
Standards, Errors in measurement, calibration, Linear, angular measurement, Quality control fundamentals, Standard deviation, normal curve pattern of variations, control charts for variables, Comparators, Limits and Tolerances, statistical aspect of tolerances and setting tolerances, Surface finish terminology and measurement, Optical measuring instruments, Measurement of screw thread and Gear elements, Acceptance test for machines.		
Text/Reference Books	1. I.C. Gupta, Engineering Metrology, Dhanpat Rai Publications, New Delhi, 1994. 2. Grant, Statistical Quality Control, Mc Graw Hill Publication. 6th Edition, 1988 3. R.K. Rajput, Mechanical Measurements and Instrumentation (Including Metrology and Control Systems), S.K. Kataria and Sons, 2013	

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 • At the end, the students should be a complete human being in every respect	
Ethics in Engineering: Concepts of Values and Ethics, History and Purposes, Utilitarianism, Duties, Rights, Responsibility, Virtue, Honesty, Moral Autonomy, Obligations of Engineering Profession and moral Propriety **Engineer's Moral responsibility:** Engineer's Moral responsibility for Safety and Human Rights, Risk Assessment and Communication, Product Liability, Engineers-Employers Liaison, Whistle-Blowing and Its Moral Justification **Computer Ethics:** Social Impact of Computer, Gender-Issues and Privacy, Cyber Crime, Ethical use of Software **Intellectual property:** 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		
Text/Reference Books	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" 5. Case Studies from Newspapers	

<table>
<tr><td>Subject Code
ME255</td><td>Mechanics of Solids Lab</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To understand the practical aspects of the theoretical knowledge gained.</td></tr>
<tr><td colspan="3">Tension tests on mild steel and cast iron, Compression tests on mild steel and cast iron, Shear tests, Bending test on mild steel, Torsion test, Hardness test and Impact test. Demonstration on fatigue test and springs.</td></tr>
<tr><td>Reference Books</td><td colspan="2">1. Hearn, E.J., Mechanics of Materials, Pergaman Press, England, 1972.
2. Beer and Johnston E. R. Mechanics of Materials, 3rd Edition, Tata McGraw Hill, New-Delhi, 2007.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME256</td><td>Fluid Mechanics Lab</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To understand the practical aspects of the theoretical knowledge gained.</td></tr>
<tr><td colspan="3">Calibration of notches, Venturimeter, Orifice meter, Water meter. Friction in pipes. Impact of jet on vanes. Tests on centrifugal pump, reciprocating pump, Pelton wheel, Kaplan turbine.</td></tr>
<tr><td>Reference Books</td><td colspan="2">1. Modi, P.N and Seth, S.M., Hydraulics and Fluid Mechanics, Standard Book House.</td></tr>
</table>

V Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	ME300	Manufacturing Technology-II	3-0-0	3
2	ME301	CAD/CAM	3-0-0	3
3	ME302	Turbo Machinery	3-0-0	3
4	ME303	Machine Design-I	3-0-0	3
5	ES301	Environmental Studies	1-0-0	1
6	HS300	Economics	3-0-0	3
7	ME304	Mechanical Lab-I	0-0-3	2
8	ME305	Measurements and Metrology Lab	0-0-3	2
9	ME306	Mechanical Workshop-I	0-0-3	1
			Total Credits	**20+1**

<table>
<tr><td>Subject Code
ME300</td><td>Manufacturing Technology-II</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Manufacturing Technology-I</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To Understand in detail of metal cutting process, machining processes
• To impart the knowledge of various Non - Conventional machining processes
• To understand various metal forming processes</td></tr>
<tr><td colspan="3">Metal cutting: Metal Cutting Mechanics, mechanics of chip formation, types of chips produced - orthogonal and oblique cutting, velocity relationships, cutting forces, cutting power, temperature in cutting – single point and multipoint tools, tool geometry, tool designation, cutting variables, tool wear and tool life, machinability, cutting tool materials, cutting fluids, economics of machining.

Machining Processes: Turning , lathes and lathe operations, material removal rate, cutting force, Milling , up milling and down milling, types of milling machines, power, torque, cutting forces, drilling and allied machines, drill geometry, cutting forces, broaching, tapping, boring, planning, shaping, slotting, grinding – cylindrical and surface grinding, grinding wheels, wheel wear.

Introduction to Non - Conventional machining processes

Metal Forming: Press working operations, types of presses, press selection, press working terminology, forming, principles, cutting forces, dies and punches, clearance, constructional features, simple, compound, combination &progressive dies, strippers, scrap strip layout, centre of pressure, press tonnage, drawing, drawing forces, blank holding pressure, bending force, die blank size estimation, forging, forgeability, open and closed die forging, forging force, grain flow, extrusion, explosive forming, electro hydraulic forming, electromagnetic forming, rolling, extrusion.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Serope Kalpakjaian, Steven R. Schmid., Manufacturing Engineering and Technology, Pearson, New Delhi.
2. PN Rao, Manufacturing Technology- Volume II, Metal Cutting and Machining Tools by TMH.
3. M.P.Groover, Principles of Modern Manufacturing, John Wiley 5th Edition
4. P C Pandey and H S Shan, Modern Machining Processes, Tata McGraw-Hill Education Pvt. Ltd.,1980
5. Sharma. P C, A Text book of Production Engineering, S. Chand & Co, 2006
6. Jain.R K, Production Technology, Khanna Publishers. 17th edition edition (1976)
7. Ghosh & Mallick, Manufacturing science, East-West Press, 2010.
8. J Pualo Davim Modern Machining technology, Elsevier, 2011.
9. HMT, Production Technology, Tata McGraw Hill Pvt. Ltd.
10. ASTME, Fundamentals of Tool Design, Prentice Hall of India, Society of Manufacturing Engineers; 6th Revised edition edition, 2010</td></tr>
</table>

<table>
<tr><td>Subject Code
ME301</td><td>CAD/CAM</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand geometric transformation techniques in CAD
• To impart knowledge on Geometric Modelling of Curves, surfaces, data exchange formats and applications
• To develop CNC programs to manufacture industrial components and understand group technology concepts</td></tr>
<tr><td colspan="3">Introduction to CAD/CAM: Fundamentals of CAD/CAM, hardware and software requirements, CAD process.

Transformations of geometry: Translation, Scaling, Reflection, Rotation, Homogeneous representation of transformation, Concatenation of transformations.

Geometric Modelling of Curves: 3D Wire frame modeling, modelling of cubic spline, Bezier and B-spline curves.

Geometric Modelling of Surfaces: Basic surfaces entities, Surface of revolution, blends, intersections, Modelling of analytical and sculptured surfaces. Geometric Modelling of Solids: Solid entities, Boolean operations, B-rep of Solid Modelling, CSG approach of solid modelling.

Data Exchange Formats and Applications: CAD standards, Data exchange formats, Rapid prototyping.

Computer Aided Manufacturing (CAM): Introduction to Computer Numerical Control (CNC), Structure of NC machine tools, Designation of axes, Drives & actuation systems, Feedback devices, CNC tooling, Automatic tool changers & Work holding devices.

CNC Programming: Part programming fundamentals, Manual Part Programming, APT Programming.

Introduction to Group technology, Computer Aided Process Planning (CAPP) and Flexible Manufacturing System (FMS)</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Groover and Zimmer, CAD/ CAM, Pearson Education; 1 edition 2003
2. Rao, P.N., CAD / CAM Principles and Applications, McGraw Hill Publishers, New Delhi, 2010.
3. Groover, Automation, Production Systems and Computer-Integrated manufacturing, Pearson Education; Fourth edition (22 July 2016)
4. Yoram Koren, Computer Control of Manufacturing Systems, McGraw Hill Publications, 2005.
5. Ibrahim Zeid and R. Sivasubramanian, CAD/CAM: Theory & Practice, McGraw Hill Education; 2nd Edition (25th June 2009)</td></tr>
</table>

<table>
<tr><td>Subject Code
ME302</td><td>Turbo Machinery</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Fluid Mechanics</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• The course aims at giving an overview of different types of turbo machinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic and steam turbines.
• It will focus on application of turbo machinery in power generation, power absorption and transportation sectors.</td></tr>
<tr><td colspan="3">Introduction: Definition and components of turbo machines, Classification, Dimensionless parameters and their significance, Effect of Reynolds number, Unit and specific quantities, model studies.

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor

General Analysis of Turbo machines: Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Theoretical head – capacity relationship, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, condition for maximum utilization factor

Hydraulic Turbines: Classification, various efficiencies. Pelton turbine – velocity triangles, design parameters, Maximum efficiency. Francis turbine - velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. Kaplan turbines - velocity triangles, design parameters.

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems. Axial flow Compressors: Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Kadambi and Manohar Prasad, "An Introduction to Energy Conversion, Volume III, Turbo machinery", New Age International Publishers, reprint 2008.
2. S. M. Yahya, "Turbines, Compressors & Fans", Tata McGraw Hill Co. Ltd., 2nd edition, 2002.
3. D. G. Shepherd, "Principals of Turbo machines", The Macmillan Company (1964).
4. S. L. Dixon, "Fluid Mechanics & Thermodynamics of Turbo machines", Elsevier (2005).</td></tr>
</table>

<table>
<tr><td>Subject Code
ME303</td><td>Machine Design-I</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.
• Detailed study of mechanical components such as fasteners, shafts, couplings etc. and emphasize the need to continue learning.
• To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.
• To teach students how to apply computer-based techniques in the analysis, design and/or selection of machine components.</td></tr>
<tr><td colspan="3">Introduction to design process: Factor of safety, strength, rigidity, fracture, material considerations. Stress concentration

Static consideration in design: levers, curved members

Flexible power drives: belt drives and chain drives

Design: for fatigue, joints, shafts and keys, Design of couplings, Design of helical springs and multi leaf springs.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. J. E. Shigley, “Mechanical Engineering Design”, Metric McGraw Hill, 1989.
2. V. B. Bhandari, “Design of Machine Elements”, TMH, 2010
3. R. L. Norton, “Machine Design: An Integrated Approach”, Pearson Publications 2nd Edition, 2006
4. Design Data, PSG Tech, Coimbatore, 1995</td></tr>
</table>

Subject Code ES301	Environmental Studies	Credits: 1 (1-0-0) Total hours: 14
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.	

Introduction: Multi-disciplinary nature of environmental studies: Definition, scope and importance, Need for public awareness.

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.

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).

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.

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.

Text/Reference Books	1. Erach Bharucha, Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education (online book -UGC Website), , University Grants Commission ,India. 2. Anil Agarwal, Dying Wisdom, Publisher: Centre for Science and Environment, Edi:1st,1997, ISBN-139788186906200; ISBN-108186906207 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

<table>
<tr><td>Subject Code
HS300</td><td colspan="2">Economics</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">• Basic concept of macroeconomic & Indian Economy.</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To develop the ability to understand and analyze the broad macroeconomic scenario and its dynamism</td></tr>
<tr><td colspan="4">Introduction to Economics: Constructing a Model, Optimization and Equilibrium in market demand and supply, Comparative statistics and asset allocation.

Budget Constraint and Consumer Preference: 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.

Choice and Demand: Optimal Choice, Consumer demand, Implication of MRS conditions, Normal and Inferior Goods, Income Offer Curves and Engel Curves, The Price Offer Curve

Technology: From 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

Profit Maximization: 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.

Cost Function: Cost Minimization, Revealed Cost Minimization, Returns to Scale and the Cost Function, Average Costs, Marginal Costs, Marginal Costs and Variable Costs.

Markets: Monopoly, Maximizing Profits, Linear Demand Curve and Monopoly, Markup Pricing, Oligopoly and Choosing a Strategy, Price Leadership, Comparing Price Leadership and Quantity Leadership.

National Income Accounting: National Income and Related concepts, Nominal or real GDP, Methods of measuring NI.

Determinants of Equilibrium Output: Aggregate demand and Equilibrium output, Consumption function and aggregate demand, Multiplier, Govt. sector, Budget and Full employment

Money, Interest and Income: The goods market and is curve, The Asset market and LM Curve, Equilibrium in Goods band asset market and Adjustment towards equilibrium.

Monetary and Fiscal Policy: Monetary policy, Fiscal Policy, crowding out, Composition of output and policy mix and implementation</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. Varian, Hal R.: Intermediate Microeconomics, W.W. Norton & Co., New work (ISBN:0393978303)
2. Koutsoyiannis, A.: Modern Microeconomics, 2nd ELBS/Palgrave Macmillan, London (ISBN:0333778219)
3. Dornbusch and Stanley Fisher: Macroeconomics, Mc Graw Hill
4. Barro Robert J. “Macroeconomics, New York, John Wiley.</td></tr>
</table>

Subject Code ME304	# Mechanical Lab-I	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	To understand the practical aspects of the theoretical knowledge gained.	

List of Experiments

1. The first law of thermodynamics on petrol engine.
2. The second law of thermodynamics on petrol engine.
3. Performance Test on Petrol Engine (2 stroke)
4. Performance Test on Petrol Engine (4 stroke)
5. Performance Test on Petrol Engine Diesel engine (4 stroke)
6. Performance Test on Single stage Reciprocating Air Compressor test rig.
7. Performance Test on Two stage Reciprocating Air Compressor test rig.
8. Performance Test on Centrifugal blower
9. Performance Test on Vapour Compression test rig
10. Performance Test on Vapour Absorption Refrigeration test rig
11. Performance evaluation of Air Conditioning system
12. Estimation of Cooling load of Simple Air Conditioning system
13. Performance Test on Heat Pump Test rig

Subject Code ME305	Measurements and Metrology Lab	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	To understand the practical aspects of the theoretical knowledge gained.	

List of Experiments

1. Linear Measurement: Using Vernier Calliper (Dial, Digital and Plain), Vernier Height Gauge
2. Linear/Circular Measurement using Micrometer Screw Guage (Digital and Plain)
3. Angular Measurement: Sine bar/Sine center, Bevel Protractor, Height Gauge.
4. Use of Dial Gauge as Mechanical Comparator.
5. Measurement of straightness and roundness using Dial Gauge.
6. Measurement of Surface Roughness using Surface Roughness Tester.
7. Measurement of various elements of screw thread using Tool Makers Microscope.
8. Measurement of Screw thread parameters using Floating Carriage Micrometer.
9. Measurement of Gear tooth thickness using Gear tooth Vernier caliper and Span Micrometer.
10. Linear and angular measurement using Profile Projector.
11. Calibration of Linear /Circular measurement tools

Subject Code ME306	Mechanical Workshop-I	Credits: 1 (0-0-3) Total hours: 42
Course Objectives	To understand the practical aspects of the theoretical knowledge gained.	

List of Experiments

- Sand Molding using 2- and 3-piece patterns
- Hot Forging (1 Job)
- Plumbing and pipe fitting
- Gas and Spot Welding (1 Job each)
- 3 Jobs covering all lathe operations

VI Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	ME350	Heat Transfer	3-0-0	3
2	ME351	Automobile Engineering	3-0-0	3
3	ME352	Machine Design–II	3-0-0	3
4	ME5**	Elective-I	3-0-0	3
5	HS350	Management	3-0-0	3
6	HU350	Professional Communication-II and Languages Lab	2-0-3	3
7	ME353	Mechanical Workshop-II	0-0-3	1
8	ME354	Mechanical Lab-II	0-0-3	2
9	ME355	CAD/CAM Lab	0-0-3	2
10	ME356	Mini Project/Industrial training	0-0-3	1
			Total Credits	**21+3**

Subject Code ME350	**Heat Transfer**	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• Applying the knowledge of mathematics, and analyze the different situations in which heat transfer is involved. • To calculate heat transfer rate, time required for heating or cooling and obtaining the temperature distribution with respect to the domain of analysis under different situations.	

Introduction to Heat Transfer and Concepts: Thermodynamics versus Heat Transfer, Modes of heat Transfer, Basic laws of Heat Transfer.

Conduction: General heat conduction equation in cartesian, cylindrical & spherical coordinates, Initial and Boundary conditions, One dimensional steady state conduction: plane walls & composite plane walls, hollow and composite cylinders and spheres, Thermal contact resistance, Critical radius of Insulation - spheres & cylinders.

Conduction with Heat Generation: Plane wall with uniform heat generation, Cylinder with uniform heat generation, sphere with uniform heat generation.

Heat Transfer from Extended Surfaces: Generalized Fin Equation, Heat dissipation from fins: infinitely long fin, insulated fin, fin losing heat at the tip, Fin effectiveness & efficiency.

Natural Convection: Physical Mechanism of Natural Convection – Grashof's number, Natural Convection over surfaces – natural convection correlations, Natural Convection inside enclosures – effective thermal conductivity, Natural convection from finned surfaces.

Forced Convection: Physical Mechanism of forced Convection, Velocity boundary layer – laminar & turbulent flows, Reynolds number, Thermal Boundary layer, Flow over flat plates – laminar flow, turbulent flow, Combined Laminar & turbulent flow, Flow across Cylinders & spheres –the Drag coefficient, the heat transfer coefficient, Flow in tubes.

Radiation Heat Transfer: Thermal Radiation, Blackbody radiation, Radiation properties, Planck's law, Stefan Boltzman's Law, Wien's Displacement Law, Kirchoff's law, Gray body & selective emitters, Intensity of Radiation & Lambert's Cosine Law, Atmospheric and solar radiation.

Radiation Exchange between Surfaces: The view factor, View Factor Algebra, Radiation heat transfer – black surfaces, diffuse and gray surfaces, Surface and space resistance, Electrical approach between for radiation heat exchange, Radiation shields.

Boiling and Condensation: Boiling heat transfer, pool boiling regime, condensation heat transfer, film condensation – vertical plate, sphere, horizontal cylinders, Drop wise condensation.

Heat Exchangers: Classification of Heat Exchangers, Overall heat transfer coefficient, The LMTD Method for Heat exchanger analysis, Correction for LMTD for use with cross flow &multi pass exchangers, e – NTU method for heat exchanger analysis.

Text/Reference Books	1. N. M. Ozisik, "Heat transfer - A basic approach" McGraw Hill Publication; 1985. 2. J. P. Holman; "Heat Transfer", McGraw Hill Publication; 10^{th} edition, 1996. 3. S.P. Sukhatme, "A Text book on Heat Transfer", Universities Press, 4^{th} Edition, 2012 4. Y. A. Cengel, "Heat transfer - A Practical Approach"; McGraw Hill Publication; 5^{th} edition 1998.

<table>
<tr><td>Subject Code
ME351</td><td>Automobile Engineering</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To Understand the basic lay-out of an automobile
• To understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
• To understand the principles of transmission, suspension, steering and braking systems.</td></tr>
<tr><td colspan="3">Introduction, Automotive Chassis layout, frame and body construction, Fuel System, Ignition System and Electrical system, Lubricating system and cooling systems, Transmission system, Steering System, Braking and suspension system, Automotive air conditioning, Wheels and tyres, Automotive Restraint Systems, Engine testing, automotive Safety aspects. Advancements in Automobile Engineering.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Kirpal Singh, “Automobile Engineering Vol. I& II”,8th edition, Standard Publishers Distributors, Delhi, 1999
2. Joseph Heitner, “Automotive mechanics Principles and Practices”, 2nd edition, D. Van Nostrand Company, 1967.
3. William H Crouse and Donald L Anglin, “Automotive Mechanics”, 10th edition, Pearson Higher Education, 1993.
4. William H Crouse and Donald L Anglin, “Automotive engine”, 8th edition, McGraw-Hill, 1994.
5. William H Crouse and Donald L Anglin, “Automotive fuel - lubricating and cooling systems”, 6th edition, McGraw-Hill, 1981.
6. William H Crouse and Donald L Anglin, “Automotive chassis and body”, 5th edition, McGraw-Hill, 1975.
7. William H Crouse, Automotive electrical equipment, 8th edition, McGraw-Hill, 1976.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME352</td><td>Machine Design-II</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To teach students how to formulate the design and manufacturing problem for simple systems and mechanical components
• To demonstrate the methodology of designing under real life situations through problem solving
• To elaborate the design process, material selection, calculation of stresses and stress concentrations under dynamic loading.
• To enable the student to apply engineering tools and techniques to product design.</td></tr>
<tr><td colspan="3">Design of Gears: Lubrication and Wear consideration in Design;

Design and selection of Bearings: Hydrodynamic lubrication theory, Hydrostatic and Hydrodynamic bearings, Journal and Rolling Element Bearings; Mechanical Vibrations and Machine Dynamics,

Systems Approach to Design: Decision Making, Simulation of mechanical systems using CAD tools, Sensitivity analysis of design parameters, Value Analysis and Value Addition to designed components and systems; Exercises of mechanical systems design with examples; Overview of Optimization in Design; Reliability and Robust Design; Communicating the Design.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. V. B. Bhandari, “Design of Machine Elements”, TMH, 2010
2. Design Data, PSG Tech, Coimbatore, 1995
3. M. F. Spotts, “Design of Machine Elements”, 6th ed., Prentice Hall, 1985
4. R. L. Norton, “Machine Design: An Integrated Approach” Pearson Publications, 2nd Edition, 2006
5. S. S. Rao, “Mechanical Vibrations”, Pearson Publications, 5th Edition, 2011
6. G. K. Grover, “Mechanical Vibrations”, Nem Chand, 1983
7. J. E. Shigley and JJ Uicker, “Theory of Machines and Mechanisms”. McGraw-Hill, 1995
8. S. S. Rattan, “Theory of Machines”, American Heritage Publishing</td></tr>
</table>

<table>
<tr><td>Subject Code
HS350</td><td>Management</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Basic concept of monetary economic, financial concepts and Basic statistics.</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To develop the ability to understand and analyze the broad aspect of management and its financial dynamism</td></tr>
<tr><td colspan="3">Principles of Accounting: Accounting Cycle, Assumptions, Classifications of Accounts- Journal, Cash Book, Ledger, Final Accounts-Manufacturing Account, Trading Account, P & L Account, Balance Sheet.

Financial Statement Analysis: Balance sheet, Profit and Loss Account, Economic vs Accounting Profit, Changes in Financial Position, Funds flow and cash flow statement.

Ratio Analysis: Nature of Ratio Analysis, Liquidity Ratio, Leverage Ratio, Activity Ratio, Profitability Ratio, DuPont Analysis, Comparative statement and Trend Analysis, Inter-firm Analysis.

Working Capital: Concept of working Capital, Operating and Cash conversion Cycle, Permanent and Variable working Capital, Balance working capital position and Issues.

Time Value of Money: Time preference for money, Future value, Annuity, Perpetuity, Sinking fund factor, Present value, Annuity, Perpetuity, capital recovery factor, Multiple period Compounding.

Capital Budgeting: 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, and decision points.

Financial System: Introduction to Indian Financial System, Financial Institutions and Financial Markets.

Industrial Engineering & Project Management: Work Study, Time Study, Industrial Psychology, Project Management (PERT, CPM)</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. I.M Pandey, Financial Management, 10th edition, Vikish Publication
2. Brealey Y Myers, Principles of Corporate Finance, McGraw-Hill
3. Rajiv and Anil, Financial Management, 2nd Edition, Oxford University Press
4. L.M Bhole, Financial Institutions and Markets, Tata McGraw-hill</td></tr>
</table>

<table>
<tr><td>Subject Code
HU300</td><td>Professional Communication-II and Languages Lab</td><td>Credits: 3 (2-0-3)
Total hours: 42</td></tr>
<tr><td>Course Prerequisite</td><td colspan="2">• Knowledge of English</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• This course aims at Personality Development. Towards the end of the course, the students should possess a Saleable Image with employability skills.</td></tr>
<tr><td colspan="3">Principles of Soft Skills and Practice: Definition of Soft Skills and Personality, Attitude, Dress Code, Body Language, Individual and Group Behavior, Personality Test, C.V Writing and the difference between CV & Resume

Group Discussion, Extempore, JAM and Survey: 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

Interview: Types of Interview, Interview Ethics, Questions and Mock-Interview Sessions

Business Presentation and Seminars: Business Presentation and Students' Seminar</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">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)
4. 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</td></tr>
</table>

Subject Code ME353	Mechanical Workshop-II	Credits: 1 (0-0-3) Total hours: 42
Course Objectives	To understand the practical aspects of the theoretical knowledge gained.	

List of Experiments

1. Milling- Slab Milling, face milling, end milling, gear cutting
2. Shaper- surface machining, keyway/groove cutting
3. Hole making- Drilling and allied process.
4. Grinding – Cylindrical and Surface (1 Job each)
5. 1 Job on CNC machining center.
6. Micro machining

Reference Books

1. James Anderson, Shop Theory, Tata McGraw-Hill Education.
2. PN Rao, Manufacturing Technology- Volume I and II, TMH

Subject Code ME354	Mechanical Lab-II	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	To understand the practical aspects of the theoretical knowledge gained.	

List of Experiments

1. Study of various components and systems of an automobile
2. Thermal Conductivity of a plane and/or composite wall.
3. Analysis of a parallel and counter flow heat exchanger.
4. Estimation of Natural and Forced Convection heat transfer coefficient.
5. Estimation of Stefan Boltzman Constant.
6. Determination of natural frequency of single DOF systems - spring mass system and/or simple pendulum and/or single rotor system.
7. Determine the damping ratio in a damped single degree of freedom system
8. Static and dynamic balancing of rotating masses
9. Verification of Gyroscopic Rule
10. Speed Control using governors.

<table>
<tr><td>Subject Code
ME355</td><td>CAD/CAM Lab</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To understand the practical aspects of the theoretical knowledge gained.</td></tr>
</table>

List of Experiments

- CAD: Graphics programming, drafting techniques, Solid modeling and FEA of machine parts using commercial solid modelling and analysis software
- CAM: CNC Programming on turning and milling centers.
- Interfacing CAD and CAM.

VII Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	ME400	Production and Operations Management	3-0-0	3
2	ME401	Automatic Control	3-0-0	3
3	ME5**	Elective-II	3-0-0	3
4	ME5**	Elective-III	3-0-0	3
5	ME402	Seminar	0-0-2	2
6	ME449	Major Project-I	0-0-4	4
		Total Credits		**18**

<table>
<tr><td>Subject Code
ME400</td><td colspan="2">Production and Operations Management</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">• Manufacturing Technology-I & II</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To understand the different stages of production process and control.
• To ensure quality production.</td></tr>
<tr><td colspan="4">Introduction to Production and Operations Management: Product Design & Development Process Planning, Types of Production System, Tools for selecting the process. Operations function, globalization, factors affecting operation management, new trends in operation management. Operations strategy – forming operation strategies, strategy deployment, world class manufacturing practices,

Economic analysis: Break Even analysis and Profit Volume Chart

Forecasting: Qualitative and Quantitative methods.

Facility Capacity, Location and Layout: Long-range capacity planning, definition, measurement, Economies of scale; Facility location - analysing industrial facility locations; Facility layout - types, new trends, analyzing manufacturing facility layouts, systematic layout design procedure, CRAFT.

Aggregate Planning and Master Production Scheduling: Approaches to aggregate planning - graphical, empirical, optimization and parametric. Development of a master production schedule, Make-to-stock, assemble-to-order, make-to-order/engineer-to-order, materials requirement planning (MRP-I) manufacturing resource planning (MRP-II) and ERP.

Inventory Analysis and Control: Need for inventory, continuous and periodic review policies, lot sizing techniques, EOQ, EMQ models, Inventory model with purchase discounts, inventory models with uncertain demand and lead times; Selective inventory control techniques, ABC and other classification of materials; vendor managed inventory.

Sequencing and Scheduling: Objectives in scheduling, single machine models, SPT and EDD sequences, mean flow time, weighted mean flow time, number of tardy jobs and mean tardiness, Parallel machine models, minimizing make span and weighted mean flow time, Flow shop models, Johnson’s algorithm, Job shop models - branch and bound approach.

Lean Production and JIT: Elements of lean production, MRP Vs JIT, cycle time, takt time, KANBAN, SMED, 5S, theory of constraints - drum, buffer and rope, Agile manufacturing.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. Samuel Eilon, “Elements of Production Planning and Control”, Mc Millon Company 1962.
2. E S Buffa, “Modern Production/ Operations Management”, John Wiley, 1983.
3. R. Pannerselvam, “Production and Operations Management”, PHI learning, 2006.
4. K. Aswathappa, K. Sridhar Bhat, “Production and Operations Management”, Himalaya Publishing 2018.
5. WJ Stevenson, “Operations Management”, MH Educations, 2018.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME401</td><td colspan="2">Automatic Control</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">Mathematics-I & II</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• Provides a background of control principles in various engineering applications.
• Applications of mathematical tools such as Laplace transform, transfer function, block diagram, signal flow graph, mathematical modeling of dynamic systems, time response analysis, stability of linear system, root locus and frequency domain analysis are done
• To model a complicated system into a more simplified form to interpret different physical and mechanical systems for analysis.
• To employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system</td></tr>
<tr><td colspan="4">Introduction: Feedback systems, mathematical modelling of physical systems; Laplace transforms, block diagrams, signal flow graphs, state-space models;

Time domain analysis: Performance specifications, steady state error, transient response of first and second order systems;

Stability analysis: Routh-Hurwitz stability criterion, relative stability; proportional, integral, PI, PD, and PID controllers; Lead, lag, and lag-lead compensators; Root-locus method: analysis, design;

Frequency response method: Bode diagrams, Nyquist stability criterion, performance specifications, design;

State-space methods: Analysis, design; Physical realizations of controllers: hydraulic, pneumatic, and electronic controllers.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. K Ogata, Modern Control Engineering, 4th ed, Pearson Education Asia, 2002.
2. B C Kuo and F. Golnaraghi, Automatic Control Systems, 8th ed, John Wiley (students ed.), 2002.
3. M Gopal, Control Systems: Principles and Design, 2nd ed, TMH, 2002.
4. M Gopal, Modern Control System Theory, 2nd ed., New Age International, 1993.
5. R. C. Dorf and R. H. Bishop, Modern Control Systems, 8th ed., Addison Wesley, 1998.
6. P. Belanger, Control Engineering: A modern approach, Saunders College Publishing, 1995.</td></tr>
</table>

VIII Semester Details

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	ME450	Industrial Engineering and Operation Research	3-0-0	3
2	ME5**	Elective- IV	3-0-0	3
3	ME5**	Elective- V	3-0-0	3
4	ME5**	Elective- VI	3-0-0	3
5	ME499	Major Project – II	0-0-6	6
		Total Credits		**18**

<table>
<tr><td>Subject Code
ME450</td><td>Industrial Engineering and Operation Research</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Production and Operations Management</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand the different stages of production process and control.
• To ensure quality production.</td></tr>
<tr><td colspan="3">Introduction: Introduction to industrial engineering; Productivity; Work study -- method study, principles of motion economy, ergonomics, work measurement

Project management: CPM, PERT, project crashing.

Quality Management: Understanding quality, quality, competitiveness and customers, building quality chains, managing quality, quality in all functions, models and frame works for total quality management, Early TQM frameworks - quality award models - the four Ps and three Cs of TQM - a new model for TQM

Logistics and Supply Chain Management: Definition of logistics and supply chain management, decision phases in a supply chain, objectives of SCM, examples of supply chains, supply chain drivers, supply chain integration, supply chain performance measures

Maintenance Management: Objective, types of maintenance, statistics of failure, Time to failure and probability distributions, reliability, bath tub curve, Weibull’s probability distribution

Design of Experiments and Simulation: ANOVA, Normality analysis and Hypothesis testing, Manufacturing system simulation and its performance measurement

Operations Research: Introduction to concepts of operations research, Linear programming -- problems formulation, graphical method, simplex method, Primal-dual problems; Transportation model; Assignment model.

Information Technology: Digital product development, PLM, ERP, use of CAD/CAM/CAE, automated process planning, planning of resources, tomorrow’s industry – AI, ANN</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. K. George, “Introduction to Work Study by ILO”, Universal Book Corporation, Bombay, 2011.
2. W. J. Stevenson, “Operation Management”, McGraw Hill Education (India) Pvt. Ltd., 12th Edition, 2018.
3. Besterfield D H et al, “Total Quality Management”, Pearson Education Private Limited, 2004.
4. Chopra S and Meindl P, “Supply Chain Management: Strategy, Planning, and Operation”, Prentice Hall India Pvt. Ltd, New Delhi, 2007.
5. H. A. Taha, “Operations Research --- An Introduction”, Dorling Kindersley (India) Pvt. Ltd., 8th Edition, 2008.
6. Ravindran, D. T. Philips and J. J. Solberg, “Operations Research, Principles and Practice”, John Wiley & Sons, 2005.
7. F. S. Hillier, G. J. Lieberman, B. Nag, P. Basu, “Introduction to Operations Research”, McGraw Hill Education (India) Pvt. Ltd., 10th Edition, 2017.
8. Chary S N, “Production and Operations Management”, Tata McGraw Hill Publishing Company Limited, 2004.
9. Panneerselvam, R, "Operations Research”, Prentice – Hall of India, New Delhi, 2002.</td></tr>
</table>

ELECTIVES

Sl. No.	Sub. Code	Subjects	L-T- P	Credits
1	ME500	Metal Removal Processes	3-0-0	3
2	ME501	Metal Casting	3-0-0	3
3	ME502	Material Joining	3-0-0	3
4	ME503	Material Forming	3-0-0	3
5	ME504	Composite Materials	3-0-0	3
6	ME505	Computer Integrated Manufacturing	3-0-0	3
7	ME506	Non-Destructive Testing	3-0-0	3
8	ME507	Quality and Reliability	3-0-0	3
9	ME508	Supply Chain Management	3-0-0	3
10	ME509	Optimization Techniques	3-0-0	3
11	ME510	Industrial Safety	3-0-0	3
12	ME511	Maintenance Engineering and Management	3-0-0	3
13	ME512	Lean Manufacturing	3-0-0	3
14	ME513	Fluid Power Control	3-0-0	3
15	ME514	Mechatronics Engineering	3-0-0	3
16	ME515	Integrated Product Design and Prototyping	3-0-0	3
17	ME516	Micro Electro Mechanical Systems	3-0-0	3
18	ME517	Automation Technologies	3-0-0	3
19	ME518	Synthesis of Mechanisms	3-0-0	3
20	ME519	Industrial Robotics	3-0-0	3
21	ME520	Tribology	3-0-0	3
22	ME521	Machine Dynamics	3-0-0	3
23	ME522	Fracture Mechanics	3-0-0	3
24	ME523	Finite Element Methods	3-0-0	3
25	ME524	Refrigeration and Air Conditioning	3-0-0	3
26	ME525	Cryogenic Engineering	3-0-0	3
27	ME526	Computational Fluid Dynamics	3-0-0	3
28	ME527	Renewable Energy Systems	3-0-0	3
29	ME528	Internal Combustion Engines	3-0-0	3

30	ME529	Energy Audit and Management	3-0-0	3
31	ME530	Aerodynamics	3-0-0	3
32	ME531	Heating Ventilation and Air Conditioning	3-0-0	3
33	ME532	Advanced Thermodynamics	3-0-0	3
34	ME533	Experimental Methods in Fluid flow and Heat Transfer	3-0-0	3

Classification of Electives into Streams

Manufacturing and Industrial Engineering	Automation/ Mechatronics	Design	Thermal
ME500	ME513	ME518	ME524
ME501	ME514	ME519	ME525
ME502	ME515	ME520	ME526
ME503	ME516	ME521	ME527
ME504	ME517	ME522	ME528
ME505		ME523	ME529
ME506		ME530	ME531
ME507			ME532
ME508			ME533
ME509			
ME510			
ME511			
ME512			

<table>
<tr><td>Subject Code
ME500</td><td>Metal Removal Processes</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Manufacturing Technology-I</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To perform different machining operations like turning, drilling, milling and finishing.
• To predict tool life and tool failure
• To select suitable cutting fluid for respective materials</td></tr>
<tr><td colspan="3">Mechanism of chip formation, Determination of shear plane angle, forces on the chips, forces in orthogonal cutting, Merchant circle diagram and analysis, Theory of Lee & Shaffer, co-efficient of friction, power & energy relationship, velocity relationship, shear-strain, forces and power, Tool Materials and their properties, Friction in metal cutting, Mechanisms of tool wear, tool failure criteria, tool life equations, effect of process parameters on tool life, tool life tests, machinability index, Machining with controlled contact tools, shear angle in controlled contact machining, Thermal Aspects in metal cutting, temperature in chip formation, temperature distribution and analysis, Economics of Machining, element of total production cost, optimum cutting speed and tool life for minimum cost, optimum cutting speed and tool life for maximum production. High speed machining abrasive processes, machining of polymers, ceramics, glasses and composites. Difficult to machine materials, Dry machining.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. M.C Shaw, “Metal Cutting Principles”, Oxford Publication, Second edition, 2012.
2. Trent Edward M. Et.Al, “Metal Cutting”, Elsevier India, Fourth Edition, 2013.
3. Geoffrey Boothroyd, “Fundamentals of Metal Machining & machine tools”, McGraw-Hill Inc.,US, 1975.
4. P N Rao, “Manufacturing Technology: Metal cutting and machine tools”, Mc Graw Hill Education, 2015.
5. Ghosh and Amitabha, “Manufacturing Science”, Affiliated East-West Press (Pvt.) Ltd., 2006.
6. A. Bhattacharya, “Metal Cutting: Theory and Practice”, New Central Book Agency, 1899.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME501</td><td>Metal Casting</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Manufacturing Technology-I</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To know the basic concepts of metal casting technology and to apply them to produce of new materials.</td></tr>
<tr><td colspan="3">Introduction to casting and foundry industry Basic principles of casting processes; sequence in foundry operations; patterns; moulding practice; ingredients of moulding sand and core sand, sand testing; different moulding processes

Types of furnaces Furnace used in foundry; furnaces for melting; melting practice for steel, cast iron, aluminium alloys, copper alloys and magnesium alloys; safety considerations; fluxing, degassing and inoculation

Sand casting Permanent mould casting, die casting, centrifugal casting, plaster mould casting, investment casting, continuous casting, squeeze casting, full mould process, strip casting

Overview of pouring and solidification Concept of shrinkage, Chvorinov’s rule, chilling; gating systems, functions of riser, types of riser, bottom pouring and top pouring, yield calculations, visualization of mould filling (modeling), methoding

Concepts of solidification Directional solidification, role of chilling; filtration of liquid metals; consumables; details of inoculation and modification – with respect to cast irons and Al-Si system; casting defects; soundness of casting and its assessment.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Heine R. W., Loper C. R., Rosenthal P. C., “Principles of Metal Casting”, Tata McGraw Hill Publishers, 2nd Edition, 1985
2. Jain P. L., ‘Principles of Foundry Technology’, Tata McGraw Hill, 3rd Edition, 1995
3. Srinivasan N. K., “Foundry Technology”, Khanna Publications, 1986</td></tr>
</table>

<table>
<tr><td>Subject Code
ME502</td><td>Metal Joining</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Manufacturing Technology-I</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To know the concepts of different materials joining technology and emphasis on underlying science and engineering principle of every processes</td></tr>
<tr><td colspan="3">Introduction: Classification of welding processes, energy sources used in welding, working principle, advantages, limitations of arc welding processes –MMAW, GTAW, GMAW, SAW, ESW & EGW

Welding Process: Working principle, advantages and limitations of solid-state welding processes. Friction, friction stir, explosive, diffusion and ultrasonic welding. Working principle, advantages and limitations of power beam processes: Plasma arc welding, electron beam & laser beam welding.

Principles of operation, process characteristics, types and applications – Resistance welding, Gas welding, brazing, soldering and joining of non-metallic materials.

Welding metallurgy: Introduction, thermal cycles, prediction of peak temperature, pre heat and cooling rate, PWHT. Weldability of carbon steel, stainless steel & aluminum. Hot & cold cracking phenomenon, weld defects, causes and their remedies

Applications: Application of welding in heavy engineering, oil & gas industries, Nuclear Power, automotive industries, shipbuilding & Aerospace Industry.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Parmer R. S., “Welding processes”, Khanna Publishers, 1997
2. Robert W Messler, Jr. “Principles of welding, Processes, physics, chemistry and metallurgy”, Wiley,2004
3. Larry Jeffus, “Welding Principles and Applications” Thomson, Fifth edition, 2002
4. Carry B., “Modern Welding Technology”, Prentice Hall Pvt Ltd., 2002.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME503</td><td colspan="2"><h1>Material Forming</h1></td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">• Manufacturing Technology-I</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To apply basic of metal forming processes to shape products to their desired forms without any defects.</td></tr>
<tr><td colspan="4">Brief introduction to the Theory of Elasticity, Elastic stress-strain, relations, Plasticity, Plastic stress-strain relations, Yield conditions, Graphical representations of yield criteria, Work hardening, Forming – fundamentals, classification, flow stress, flow curves, effect of parameters such as strain rate and temperature, workability, anisotropy. Deformation zone geometry, uniform deformation energy method, and slab analysis, friction and lubrication, residual stress. Forging: Classification of forging processes, Hammer or drop forging, Press forging, Open-die forging, Closed- die forging, Calculation of forging loads, Effect of forging on microstructure, Residual stresses in forgings, Typical forging defects. Extrusion: Introduction/objectives, Classification of extrusion processes, Extrusion equipment, Presses, dies and tools, Hot extrusion, Deformation, lubrication, and defects in extrusion, Analysis of the extrusion process, Cold extrusion and cold forming, Hydrostatic extrusion, Extrusion of tubing, Production of seamless pipe and tubing. Rolling: Introduction/objectives, Rolling mills, Classification of rolling processes, Hot rolling, Cold rolling, Forces and geometry relationships in rolling, Simplified analysis of rolling load: Rolling variables, Problems and defects in rolled products, Rolling-mill control, Theories of cold rolling, Theories of hot rolling, Torque and power. Drawing of rods, wires and tubes: Introduction/objectives, Rod and wiredrawing, Analysis of wiredrawing, Tube drawing processes, Analysis of tube drawing, Residual stress in rod, wire and tubes.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. George E., “Mechanical Metallurgy”, S.I. Metric edition, Dieter, McGraw Hill Book Company, 1989.
2. William F. Hosford, and Robert M.Caddell, “Metal Forming: Mechanics and Metallurgy”, PTR Prentice Hall,USA, 1993.
3. R.H.Wagoner and J.L.Chenot, “Metal Forming Analysis”, Cambridge University Press, New York, U.S.A., 2001.
4. Heinz Tschaetsch, “Metal Forming Practice”, Springer-Verlag, Berlin Heidelberg, 2010.
5. Samuel H. Talbert and Betzalel Avitzur, “Elementary Mechanics of Plastic Flow in Metal Forming”, John Wiley and Sons, New York, 1996.
6. B.L. Juneja, “Fundamentals of Metal Forming Processes”, New Age International, Publishers, New Delhi, 2000.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME504</td><td colspan="2">Composite Materials</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">• Materials and Metallurgical Engineering</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To understand the properties of composite materials
• To classify the composites based on properties
• To design metal matrix composite.</td></tr>
<tr><td colspan="4">Introduction to Composites, Classification of composite materials, Matrix Materials, Dispersed Phase, Dispersion strengthened, particle-reinforced and fiber-reinforced composites, Micro and Macro mechanics of Laminates, Classical Laminated theory, ABD Matrix, Design, Joining and Testing of composite materials, Failure modes, laminates, Self-healing composites, Processing of Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon Carbon Composites, Nano-composites, Injection molding, Compression molding and 3D printing of advanced composites, Laboratory Practice, Testing methodologies. Fatigue and environmental effects. 3D, 4D composites.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. F.L. Matthews and R.D. Rawlings, “Composite materials: Engineering and science”, Wood head publishing limited; New edition, 1999.
2. RoberM.Jones, “Mechanics of composite Materials”, McGraw Hill Kogakusha Ltd., Second Edition, 2015.
3. Krishnan K Chawla, “Composite material science and Engineering”, Springer Publishing, Third edition, 2012.
4. P.K.Mallik, “Fibre reinforced composites”, Third edition, CRC Press, 2007.
5. M M Schwartz, “Composite Materials Hand book”, McGraw Hill, Second edition, 1992.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME505</td><td>Computer Integrated Manufacturing</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• CAD/CAM</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To gain knowledge in Engineering product specification and CAD/CAM Integration
• To impart knowledge in CAD software package for modeling, assembly, FEA of mechanical components and CNC programming for Milling/Turning</td></tr>
<tr><td colspan="3">CIM: CIM evaluation, hardware and software of CIM, concurrent engineering, advance modeling techniques.

Numerical Control: Concepts and features, Classification, Input media, Design considerations, Functions of MCU, CNC concepts, Point-to-point and Contouring systems, Interpolators, Feedback devices, DNC, Adaptive Control, ACO and ACC systems.

Part programming: Manual part programming, preparatory, miscellaneous functions, computed aided part programming, post processors, APT programming.

Manufacturing: Cellular manufacturing, Group Technology, Flexible Manufacturing Systems Configurations, Workstations, Control systems, Applications and benefits

Materials handling and Storage Systems: Types of material handling systems, storage systems, Automated storage and retrieval systems, Robotics technology-control systems, Programming, Applications, Automated inspection and testing, Coordinate measuring machines.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Paul Ranky, “Computer Integrated Manufacturing”, Prentice Hall, 2005.
2. YoramKoren, "Computer Control of Manufacturing Systems", McGraw Hill Book co. New Delhi, 1986.
3. Mikell P Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall, 2007
4. Donatas T I junclis, Keith E Mekie, “Manufacturing High Technology Hand Book”, Marcel Decker.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME506</td><td>Non-Destructive Testing</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Materials and Metallurgical Engineering</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To study and understand various Non-Destructive Evaluation and Testing methods, theory and their industrial applications</td></tr>
<tr><td colspan="3">Overview of NDT: NDT Versus Mechanical testing, Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT. Visual inspection – Unaided and aided.

Surface NDE Methods: Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Thermography and Eddy Current Testing: Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

Ultrasonic Testing (UT) and Acoustic Emission: Ultrasonic Testing Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications

Radiography: Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrometers, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009
2. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010
3. ASM Metals Handbook, “Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17
4. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005
5. Charles, J. Hellier, “Handbook of Nondestructive evaluation”, McGraw Hill, New York 2001.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME507</td><td colspan="2">Quality and Reliability</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">• Production and Operations Management</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To identify and analyze failures of components and subcomponents of mechanical and electronic items.
• To distinguish different concepts in maintenance and explore in order to increase service life of the products/machines
• To list various safety measures concerned with environment described for a safety engineer</td></tr>
<tr><td colspan="4">Introduction: Introduction to quality assurance and quality control, Statistical concepts in quality, Central limit theorem, Quality control tools

Control Charts: Control charts for variables and attributes, process capability studies, Sampling Inspection, Quality System standards

Reliability: Reliability, Failure Rate, Mean Time Between Failures (MTBF), Mean Time To Failure (MTTF), Bathtub curve, analysis using exponential, normal and Weibull distribution, system reliability, Series, Parallel, complex structures, Redundancy, Reliability Allocation, Mechanical Reliability, Fault tree analysis, Down time, Repair time, maintainability, Availability, Failure Mode and Effect Analysis.

Safety: Importance of Safety, Fundamental Concepts and Terms, Workers' Compensation, Product Liability, Hazards and their Control, Walking and Working Surfaces, Electrical Safety -Tools and Machines, Materials Handling.

Fire Protection and Prevention: Explosions and Explosives, Radiation, Biohazards, Personal Protective Equipment, Managing Safety and Health.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. David J Smith, Butterworth-Heinemann, “Reliability Maintainability and Risk; Practical methods for engineers”, New Delhi, 2001
2. E.L.Grant and Leavenworth, “Statistical Quality Control”, McGraw-Hill Inc, Sixth Edition, 1988.
3. Charles E Ebeling “An Introduction to Reliability and Maintainability Engineering”
4. B.S. Dhillon, “Maintainability, Maintenance and Reliability for Engineers”, CRC Press, 2006
5. Roger L. Brauer, “Safety and Health for Engineers”, John Wiley Sons, 2006
6. Hoang Pham, “Handbook of Reliability engineering”, Springer Publication, 2003
7. B.S. Dhillon, “Engineering maintenance; a modern approach”, CRCPress, 2002</td></tr>
</table>

<table>
<tr><td>Subject Code
ME508</td><td colspan="2">Supply Chain Management</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">• Production and Operations Management</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To provide an insight on the fundamentals of supply chain strategy, logistics, sourcing and outsourcing supply chain networks, tools and techniques</td></tr>
<tr><td colspan="4">Evolution of supply chain: Essentials of SCM, structure of supply chain, examples process views, decision phases, issues, aligning supply chain with business strategy –supply chain decision variables, performance measures, new challenges, reverse logistics.

Supply chain configuration design: Factors involved, sourcing, models for strategic alliances, supplier selection, outsourcing and procurement process, facility location and capacity allocation, modeling approaches LP, MILP, network design in uncertain environment, evaluation using simulation models.

Demand forecasting: Collaborative forecasting models, bullwhip effect, information sharing, aggregate planning in supply chain, strategies, multi echelon inventory planning, models, discounting, risk pooling, centralized versus decentralized systems.

Roles of transportation: tradeoffs in transportation design, modes of transportation and their design, vehicle routing and scheduling, models, packaging, pricing and revenue management.

Role of IT in supply chain: IT infrastructure, CRM, SRM, e-business, RFID, supply chain collaboration, Decision Support System (DSS) for supply chain, selection of DSS for supply chain.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. Sunil Chopra, Pet`1er Meindl, Edith Simchi-Levi, “Supply Chain Management: Strategy, Planning and Operations”, Prentice Hall India, 3rd ed., 2007.
2. David Simchi-Levi, Philip Kaminsky, “Designing and Managing the Supply Chain: Concepts, Strategies, and Cases” Tata McGraw Hill, 3rd ed, 2007
3. J. Shapiro, “Modeling the supply chain”, Thomson, 2nd ed., 2002</td></tr>
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<table>
<tr><td>Subject Code
ME509</td><td colspan="2">Optimization Techniques</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">• Mathematics-I & II</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To perform different optimization techniques to solve various engineering problems</td></tr>
<tr><td colspan="4">Introduction: Introduction to engineering optimization, General principles, Classification, Problem formulation & their classifications, Classical optimization techniques, Single variable and multivariable optimization, Single and Multi-objectives, Pareto Optimal solutions.

Unconstrained Optimization Techniques: Techniques of unconstrained optimization, Golden section, Random, Pattern and Gradient search methods, Interpolation methods.

Constrained Optimization Techniques: Optimization with equality and inequality constraints, Direct methods, Indirect methods using penalty functions.

Unconventional Optimization Techniques: Genetic Algorithms, Particle Swarm Optimization, Simulated Annealing and Ant Colony algorithm.

Applications: Application of Fuzzy logic and Artificial Neural Networks in optimization.

Structural applications, Design of simple truss members, Design applications, production planning, controlling and scheduling, Facility layout applications, etc.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. S.S. Rao, “Engineering Optimization – Theory & Practice”, New Age International (P) Limited, New Delhi, 2009.
2. R.L.Fox, Addison, Optimization Methods for Engineering Design. Wesley Publishing
3. Kalyanamoy Deb, “Optimization for Engineering Design Algorithms and Examples”, Prentice Hall of India Pvt. Ltd., 2006.
4. Johnson Ray, “Optimum Design of Mechanical Elements”, Wiley, John & Sons,Digitized 2007.
5. C.S.Rao, “Optimization Techniques”, Dhanpat Rai& Sons, New Delhi
6. S. Rajasekaran, G. A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications” PHI Learning Pvt. Lmt. 2nd Edition, New Delhi, 2017</td></tr>
</table>

<table>
<tr><td>Subject Code
ME510</td><td>Industrial Safety</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Manufacturing Technology-I</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand and apply the principles of science, technology, engineering, and maths to solve industry-related problems.
• Contribute to the profitable growth of industrial economic sectors by using IE analytical tools, effective computational approaches, and systems thinking methodologies.</td></tr>
<tr><td colspan="3">Introduction: Evolution of modern safety concept, safety policy, Safety Organization, Safety Committee, budgeting for safety.

Safety training: Creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign

Accident: Concept of an accident, reportable and non-reportable accidents, reporting to statutory authorities, principles of accident prevention, accident investigation and analysis, records for accidents, departmental accident reports, documentation of accidents, unsafe act and condition, domino sequence, supervisory role, cost of accident.

Machine Guarding: Machine Guarding, guarding of hazards, Machine Guarding types and its application, Safety in welding and Gas cutting, Safety in Manual and Mechanical material handling, Safety in use of electricity

Chemical Safety: Toxicity, TLV, Types of Chemical Hazards, Occupational diseases caused by dust, fumes, gases, smoke and solvent hazards, control measures

Fire Safety: Fire triangle, Types of fire, first aid firefighting equipment, flammability limit, LPG safety

Acts: Overview of factories act 1948 – OHSAS-18000</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. “Accident Prevention Manual for Industrial Operations”, N. S. C. Chicago, 1982
2. Blake R.B., “Industrial Safety” Prentice Hall, Inc., New Jersey, 1973
3. Heinrich H.W. “Industrial Accident Prevention” McGraw-Hill Company, New York, 1980.
4. Krishnan N.V. “Safety Management in Industry” Jaico Publishing House, Bombay, 1997.
5. John Ridley, “Safety at Work”, Butterworth & Co., London, 1983.</td></tr>
</table>

<table>
<tr><td>Subject Code
ME511</td><td>Maintenance Engineering and Management</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Manufacturing Technology-I</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To enable the student to understand the principles, functions and practices of maintenance activities.
• To develop ability in formulating suitable maintenance strategies to achieve reliable manufacturing system.
• To introduce the different maintenance categories and failure analysis tools.
• To equip with essential system diagnosis techniques so as to identify and take appropriate actions on error symptoms and causes of failures.
• To illustrate the techniques used for maintenance management.
• To empower with the skills to manage a manufacturing system to achieve continuous system availability for production.</td></tr>
<tr><td colspan="3">Maintenance: Key to reliability & productivity, Basic elements of maintenance system, inspection, planning & scheduling, job execution, record keeping, data analysis, learning & improvement. Preventive, operating and shutdown maintenance; Condition based maintenance and Application of preventive maintenance for system of equipment.

Vibration and signature analysis: Causes; remedy in rotating machinery. Fluid analysis for condition monitoring, various methods of fluid analysis. Vibration monitoring, Data acquisition, Transducers, Time domain and frequency domain analysis, Phase signal analysis, Fault diagnosis of rotating equipment, antifriction bearings and gears.

Non-destructive testing: Visual examination, optical aids, liquid penetrate testing, magnetic particle testing, eddy current testing, radiography, ultrasonic testing, acoustic emission testing, thermography, leak testing, corrosion monitoring, standards for NDT.

Lubrication: Introduction to lubrication engineering, types, classification of lubricants with their properties and characteristics. Bearing lubrication technique for minimization of friction and wear.

Science of friction and wear: Different types of wear, such as abrasive, corrosive, seizure, scoring, scuffing, pitting, spalling, adhesive, etc. and techniques for minimization of wear. Data collection and analysis, Introduction to computer-aided maintenance management system</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. H.P.Garg, “Industrial Maintenance”, Kindle edition, S Chand, 2014
2. Srivastava S. K., “Maintenance Engineering and Management”, S. Chand & Company Ltd., New Delhi, 1998.
3. Venkataraman, “Maintenance Engineering and Management”, Prentic-Hall of India Pvt. Ltd., New Delhi, 2007.
4. Gupta A. K., “Reliability, Maintenance and Safety Engineering”, University Science Press, New Delhi, 2009.
5. Rao S. S., “Reliability-Based Design”, McGraw-Hill, Inc, New York, 1992.</td></tr>
</table>

Subject Code ME512	# Lean Manufacturing	Credits: 3 (3-0-0) Total hours: 42
Course Prerequisites	• Manufacturing Technology I	
Course Objectives	• To introduce the fundamentals of Lean Manufacturing • Components for Lean including: Waste identification and elimination (value stream analysis), 5S, JIT, Kaizen and Poke Yoke.	

Role of Inventory in Production: Principles of Production systems, Production System Models

Objectives of lean manufacturing: Key principles and implications of lean manufacturing- traditional Vs lean manufacturing. Value creation and waste elimination, main kinds of waste, pull production, different models of pull production continuous flow, continuous improvement/Kaizen- worker involvement, cellular layout, administrative lean.

Standard work: communication of standard work to employees, standard work and flexibility, visual controls, quality at the source, 5S principles, preventative maintenance, total quality management, total productive maintenance, changeover/setup time, batch size reduction, production levelling.

Value Stream Mapping: The as-is diagram-the future state map, application to the factory simulation scenario, line balancing, Poke Yoke, overall equipment effectiveness. One Piece Flow, Process razing techniques, cells for assembly line, case studies

Introduction: Elements of JIT, uniform production rate, pull versus push method Kanban system, small lot size, quick, inexpensive set-up, continuous improvement. Optimized production technology.

Team establishment: Transformation process, Project Management, Lean implementation, Reconciling lean with other systems, lean six sigma, lean and ERP lean with ISO 9001:2000.

Text/Reference Books	1. Askin R G and Goldberg J B, "Design and Analysis of Lean Production Systems", John Wiley and Sons Inc., 2003 2. Hobbs, D.P. "Lean Manufacturing implementation", Narosa Publisher, 2004. 3. Micheal Wader, "Lean Tools: A Pocket Guide to Implementing Lean Practices", Productivity and Quality Publishing Pvt. Ltd, 2002. 4. Michael L George, David T Rowlands, Bill Kastle, "What is Lean Six Sigma", McGraw Hill, New York, 2004.

<table>
<tr><td>Subject Code
ME513</td><td>Fluid Power Control</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Fluid mechanics</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand fundamental principles, design and operation of hydraulic and pneumatic machines, components and systems
• To impart knowledge on hydraulics and Pneumatics application in recent automation revolution</td></tr>
<tr><td colspan="3">Fluid Power fundamentals: Fluid properties and qualities; Hydraulic and Pneumatic symbols and Circuits, Flow through conduits, orifices, minor losses, temperature rise and Pressure transients. Theory, construction, operation and characteristics of Positive displacement Pumps and Motors; Flow and Torque losses and machine efficiencies, Construction, operation and characteristics of pressure, flow and direction control valves. Construction, operation and selection of accumulators, intensifiers, Hydraulic Cylinders. Construction and design of hydraulic circuits for specific applications.

Fluid Power Circuits: Single and Multi-Actuators system, Electro-hydraulic Servo-Valve and its dynamics, Theory, Construction and operation of Pneumatic actuators, valves and other accessories.

System Dynamics and Control: Basics of System Dynamics and Control; Application to a servo-valve motor open loop and closed loop drive systems; Servo-valve with linear actuators.

Introduction to PLC: Introduction to the use of PLC (Programmable Logic Control) for sequence control of hydraulic and pneumatic systems.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. S. R. Majumder, Oil Hydraulic System, Tata-McGraw Hill Publication, 2001
2. Esposito AP, Fluid Power with Applications, Pearson Education Asia, 2005
3. S. R. Majumder, Pneumatic Systems, Tata-McGraw Hill Publication, 2006
4. Shanmugasundaram. K, “Hydraulic and Pneumatic controls”, Chand and Co, 2006.
5. Srinivasan. R, "Hydraulic and Pneumatic Control", Tata McGraw - Hill, 2012.
6. Herbert E. Merritt, Hydraulic Control Systems, John Wiley and Sons, 1967
7. Noah D. Manring and Roger C. Fales, Hydraulic Control Systems, John Wiley and Sons, 2019
8. John S. Cundiff, Fluid power Circuits and Controls, CRC Press, 2001
9. John Watton, Fundamentals of Fluid Power Controls, Cambridge University Press, 2014</td></tr>
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<table>
<tr><td>Subject Code
ME514</td><td>Mechatronics Engineering</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation
• To understand the application of Mechatronic Systems in various fields</td></tr>
<tr><td colspan="3">Introduction: Introduction to Mechatronics, need and applications, elements of mechatronic systems, role of mechatronics in automation, manufacturing and product development

Sensors and Feedback Devices: Importance of sensors in Mechatronics, Static and Dynamic characteristics of sensors, errors and output impedance of sensors, transducers for measurement of displacement, strain, position, velocity, noise, flow, pressure, temperature, humidity, vibration, liquid level, vision sensors

Control Elements and Actuators: On/off push buttons, control relays, thermal over load relays, contactors, selector switches, solid state switches. Mechanical actuators – types of motion, gear trains, belt and chain drives, screw rods. Electrical actuators, solenoids, DC drives and AC variable frequency drives, AC and DC motors, servomotors, stepper motors, linear motors. Hydraulic and Pneumatic controls, functional diagram - control valves, cylinders and hydro motors

PLC: Introduction to PLC, simple programs for process control application based on
relay ladder logic-Supervisory Control and Data Acquisition Systems (SCADA) and Human Machine Interface (HMI)

Interfacing Systems: Introduction to interfacing of different hard wares in industry, need for networks in industrial plants, hierarchy and structure of networking, RS 232 based network, Ethernet, TCP/IP, MAP/TOP

Application of Mechatronic Systems: Introduction to factory automation and integration, design of simple Mechatronics systems, Case studies based on the application of mechatronics in manufacturing, autotronics, bionics and avionics</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Bolton W, Mechatronics, Pearson Education Asia, New Delhi, 2004.
2. S Cetinkunt, Mechatronics, John wiley, 2007.
3. D. G. Alciatore and M. B. Histand, Introduction to Mechatronics and Measurement systems, McGraw Hill, NY, 2007.
4. J Stenersons, Fundamentals of Programmable Logic Controllers Sensors and Communications, Prentice Hall, 2004.
5. Kuttan K K, Introduction to Mechatronics, Oxford University Press, 2007.
6. HMT, Mechatronics, Tata McGraw Hill Publishers, New Delhi, 1998.
7. S. Soloman, Computer Control of Manufacturing Systems, McGraw Hill, New York, 1983.</td></tr>
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<table>
<tr><td>Subject Code
ME515</td><td>Integrated Product Design and Prototyping</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand the fundamentals of product design, strategies and analysis
• To understand human considerations and modern approaches in product design
• To know the basic knowledge on reverse engineering</td></tr>
<tr><td colspan="3">Introduction: Definition of Product Design, Design by Evolution and Design by Innovation, Essential Factors, Morphology of Design, Primary Design Phases and Flow Charting,

Product Strategies and Analysis: Standardization, Generic Process of Product development- Concept generation, concept selection, TRIZ, concept testing.

Industrial Design Organisation: Role of Aesthetics in Product Design, Functional Design Practice, Strength, Stiffeners and Rigidity Considerations in Product Design, Review of Production Processes Economic Factor Effecting Design, Product Value, Design for Safety, Reliability and Environmental Considerations, Economic Analysis,

Human Considerations in Product Design: Introduction to Human Considerations in Product Design, Anthropometry, Design of Control and displays, Introduction to Reverse Engineering.

Modern Approaches to Product Design: Concurrent Design. Prototyping, Virtual and Physical. Rapid Prototyping Technologies</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Ulrich and Eppinger, Product Design and Development; Tata McGraw Hill, 2005
2. K Otto and K Wood, Product Design, Pearson Education, Inc. 2001
3. Chitale & Gupta, Product Design and Manufacturing, PHI, 3rd edition, ISBN-10: 8120326369, 2005.
4. K G Cooper, Rapid Prototyping Technology, Marcel Dekker, Inc. 2001
5. D T Pham and S S Dimov, Rapid Manufacturing, Springer-Verlag, 2001</td></tr>
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<table>
<tr><td>Subject Code
ME516</td><td>Micro Electro Mechanical Systems</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
• To educate on the essentials of Micro fabrication techniques.
• To introduce various sensors and actuators
• To introduce different materials used for MEMS
• To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.</td></tr>
<tr><td colspan="3">MEMS and Micro integrated Systems: Introduction, history of MEMS development, intrinsic characteristics of MEMS. Devices: Sensors and Actuators. Overview of microfabrication, microelectronics fabrication process, silicon-based MEMS processes, new materials and fabrication processes. Points of consideration for processing.

Scaling Laws and Miniaturization: Introduction. Scaling in geometry. Scaling in rigid body dynamics. The trimmer force scaling vector – scaling in electrostatic forces, electromagnetic forces, scaling in electricity and fluid dynamics, scaling in heat conducting and heat convection.

MEMS Processing: Photolithography. Photoresist and applications. Light sources. X-ray and electron beam lithography. Ion implantation. Diffusion process. Oxidation, thermal oxidation. Silicon di oxide. Thermal oxidation rates. Oxide thickness by colour

Micromachining Methods: Bulk micromachining, Isotropic and anisotropic etching, Wet etchants, etch stops, dry etching comparison of wet and dry etching. Dry etching, physical etching, reactive ion etching, comparison of wet and dry etching, Surface micromachining, process in general, problems in surface micromachining. The LIGA process, description, materials for substrates and photoresists, electroplating, the SLIGA process.

Micro System Packaging: The three levels of microsystem packaging – die level, device level and system level. Essential packaging technologies – die preparation – surface bonding, wire bonding and sealing. Three-dimensional packaging. Assembly of Microsystems – selection of packaging materials</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Tai-Ran Hsu, ―MEMS and Microsystems Design and Manufacture‖, Tata Mc Graw Hill Publishing Co Ltd, New Delhi, 2002.
2. JJ Allen, MEMS Design CRC Press Publisher, 2010
3. Chang Liu, Foundations of MEMS, Pearson International Edition, 2006.
4. Mark Madou, Fundamentals of Microfabrication, CRC Press, New York, 1997.
5. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD, 2002</td></tr>
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<table>
<tr><td>Subject Code
ME517</td><td>Automation Technologies</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Electrical and Electronics Technology</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To impart knowledge on basics of automation, sensors, robots and its application</td></tr>
<tr><td colspan="3">Introduction to automation: basic notions and definitions, technical and economic requisites. Automation as a means of control and inspection, basic control system concepts, control system analysis, systems of automatic control.

Sensors: sensory equipment, range sensing, proximity sensing, touch sensing, force and torque sensing, signal conditioning equipment.

Introduction to machine vision: sensing and digitizing, image processing and analysis, applications.

Introduction to robots: definition of robot, basic concepts, robot configurations, types of robot drives, basic robot motions - point to point control, continuous path control, Components and operations, basic actuation mechanisms, robot actuation and feedback, manipulators –director and inverse kinematics, coordinate transformation, brief robot dynamics. Types of robot and effectors, grippers, tools as end effectors, robot end - effort interface.

Robot programming: Methods, languages, capabilities and limitation, artificial intelligence, Knowledge representation, search techniques, AI and robotics. Some Industrial applications of robots</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. K. S. Fu., R. C. Gonalez, c. S. G. Lee, Robotics control sensing, Vision and Intelligence, McGraw Hill international edition, 1987.
2. Michelle P. Groover, Mitchell Weiss, Industrial Robotics, Technology, Programming, and Applications, Mc Graw Hill international editions, 1986.
3. Klafter Richard D., Chmielewski Thomas A., Negin Michael, Robotic Engineering – An Integrated approach, Prentice hall inc, 1989.</td></tr>
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<table>
<tr><td>Subject Code
ME518</td><td>Synthesis of Mechanisms</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components
• Detailed study of mechanical components such as fasteners, shafts, couplings etc. and emphasize the need to continue learning
• To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems
• To teach students how to apply computer-based techniques in the analysis, design and/or selection of machine components</td></tr>
<tr><td colspan="3">Introduction to kinematics: types of mechanism, kinematics synthesis, science of relative motion, tasks of kinematic synthesis with practical applications,

Degree of freedom: class-I, class-II chain, Harding's notation, Grash of criterion, Grubler's criterion.

Introduction to position generation problem: concept of pole, two & three position generation synthesis, pole triangle, Relationship between moving & fixed pivots, Four position generation, opposite pole quadrilateral, center point & circle point curve, Burmester's point. Matrix method for position generation problem, rotation matrix, displacement matrix.

Introduction to function generation problem: co-ordination of input-output link motion, relative pole technique, inversion technique, overlay technique, graphical synthesis of quick return mechanisms for optimum transmission angle. Types of errors, accuracy points cheby shev's spacing and frudenstein’s equation.

Introduction to path generation problem: synthesis for path generation with and without prescribed timing using graphical method. Coupler curves, cognate linkages, Robert's law of cognate linkages.

Complex number method for path generation problem, 3 precision points. Synthesis for infinitesimally separated position, concept of polode and centrod, Euler's savery equation, inflection circle, Bobbilier and Hartman's construction. Optimal synthesis of planer mechanisms, least square method.

Introduction to spatial mechanisms: D-H notations, Introduction to kinematic analysis of robot arms.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. D. C. Tad, “Applied linkage synthesis”, Addison Wesley publication, 1964
2. A. G. Erdman, “Mechanism Design -Analysis and Synthesis”, Vol. I, Prentice Hall, New Jersey, 1997
3. G. N. Sandor, A. G. Erdman, “Advanced mechanism design”, Prentice Hall Inc, 1984
4. C. H. Suh, C. W. Radcliff, “Kinematics and mechanisms design”, John Wiley &Sons., 1978
5. A. H. Soni, “Mechanism Synthesis and Analysis”, McGraw Hill, 1984
6. R. L. Norton, “Design of Machinery- An Introduction to the Synthesis and Analysis of Mechanisms”, McGraw-Hill Higher Education, Boston, 2004</td></tr>
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<table>
<tr><td>Subject Code
ME519</td><td>Industrial Robotics</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To develop the student’s knowledge in various robot structures and fundamental concepts in CAM, CIMS, Robots
• To develop student’s skills in performing spatial transformations associated with rigid body motions
• To develop student’s skills in perform kinematics analysis of robot systems through NC part programming, APT programming and Robot programming
• To provide the student with knowledge of the singularity issues associated with the operation of robotic systems such as sensors, actuators
• To provide the student with some knowledge and skills associated with robot control</td></tr>
<tr><td colspan="3">Types of industrial robots: Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell. Construction of manipulators, advantages and disadvantages of various kinematic structures. Pneumatic, hydraulic and electric. Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations. Characteristics and control. Nonservo robots, motion planning. Feedback systems, encoders, servo control PTP and CP. Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications. Gripper force analysis and gripper design, design of multiple degrees of freedom, active and passive grippers. Manipulator dynamics and force control. Vision, ranging, laser, acoustic, tactile. Developments in sensor technology, sensory control. SELECTION OF ROBOT: Factors influencing the choice of a robot, robot performance testing, economics of robotisation, Impact of robot on industry and society.

Programming Language: VAL, RAIL, AML. Mobile robots, walking devices.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, “Fundamental of Robotics”, McGraw Hill, 1987
2. Y. Koren, “Robotics for Engineers”, McGraw Hil, 1985
3. A. Ghosal, “Robotics-Fundamental Concepts and Analysis”, Oxford University Press. 2013
4. J. J. Craig, “Robotics”, Addison Wesley, 1986
5. R. D. Klafter, T. A. Chmielewski, M. Negin, “Robotic Engineering – An integrated Approach” Prentice Hall India, New Delhi, 2001
6. M. P. Groover, “Automation, Production Systems, and Computer Integrated Manufacturing” Pearson, 2013
7. J. A. Rehg, “Introduction to Robotics in CIM Systems”, Prentice Hall, India, 2002
8. S. R. Deb, “Robotics Technology and Flexible Automation”, TMH, New Delhi, 2010</td></tr>
</table>

<table>
<tr><td>Subject Code
ME520</td><td>Tribology</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To establish the fundamental understanding of tribological engineering by balancing both, theoretical and practical aspects of tribology
• To understand basic lubrication mechanism and various lubrication systems
• To understand different types of bearings in context of tribology and its design-based applications
• To understand the friction and wear phenomenon</td></tr>
<tr><td colspan="3">Engineering Surfaces: Properties and Measurement, Surface Contact Adhesion, models, indices, adhesive surface contact Friction, origin, theories, components, measurement, friction behavior of materials. Wear, origin, types – adhesive, abrasive, corrosive, fatigue, erosion etc., measurement, theories, delamination theory, wear debris analysis, ferrography, wear behavior of materials. Thermal Considerations in Sliding Contact, measurement of flash temperature, modeling.

Surface Engineering: treatments and coatings.

Liquid Lubricants: Properties and Measurement, Fluid Film Lubrication, Hydrodynamic and hydrostatic lubrication, Thrust and Journal Bearing, Squeeze Film Bearings, Gas-Lubrication, Elasto hydro dynamic Lubrication, Rolling Element Bearings,

Boundary Lubrication: metal working, Bio-tribology. Nanotribology – concept, measurement tools.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. A. Cameron, “Basic Lubrication Theory”, John Wiley & Sons, Incorporated, Second Edition, 1977
2. G. W. Stachowiak & A. W. Batchelor, “Engineering Tribology”, Elsevier, 3rd Edition, 2011
3. B. C. Majumdar, “Introduction to Tribology of Bearings”, S. Chand, 2008 (5)
4. S. K. Basu, S. N. Sengupta, B. B. Ahuja, “Fundamentals of Tribology”, PHI learning, 2005</td></tr>
</table>

<table>
<tr><td>Subject Code
ME521</td><td>Machine Dynamics</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To establish the fundamental understanding of tribological engineering by balancing both, theoretical and practical aspects of tribology
• To understand basic lubrication mechanism and various lubrication systems
• To understand different types of bearings in context of tribology and its design-based applications
• To understand the friction and wear phenomenon</td></tr>
<tr><td colspan="3">Introduction: Force analysis of slider crank mechanism, Flywheel. Revision of Balancing of rotating masses, Balancing of Reciprocating masses. Applications to balancing of inline, V and radial engines.

Introduction to Kinetics of Mechanisms Review of SDOF theory: free undamped, free damped, forced vibration, detailed engineering applications inclusive of Transmissibility, rotor vibration, principles of vibration measurement etc. Transient and Non harmonic vibration of SDOF systems. Introduction to random vibration of SDOF systems.

Preliminary treatment of MDOF systems: natural frequency and mode shape, harmonic excitation and applications inclusive of vibration absorption. Approximation methods- Dunkerlay & Rayleigh</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Ghosh & Malik. “Theory of Mechanism and Machine”, Affliated East-West Press, 1988
2. S. S. Rattan, “Theory of Machine”, Tata McGraw Hill, 12th Reprint Edition, 2009
3. J.S. Rao, “Introductory Course on Theory and Practice of Mechanical Vibrations”, New Age International, 2nd Edition, 1999
4. L. Meirovitch, “Elements of Vibration Analysis”, McGraw Hill Publications, 2nd Edition, 1975</td></tr>
</table>

<table>
<tr><td>Subject Code
ME522</td><td>Fracture Mechanics</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To study the characteristics of basic mechanics behind crack propagation and fracture phenomenon
• To examine the concept of failure in engineering materials with pre-existing flaws
• To design the parts from fracture mechanics point of view by selecting proper materials and geometric features
• To introduce the physical and mathematical principles of fracture mechanics and their applications in wide range of engineering design
• To determine the fracture toughness and stress intensity factor of pre-existed engineering materials</td></tr>
<tr><td colspan="3">History of failure by Fracture: failure of structures, bridges, pressure vessels and ships, brittle fracture, development of testing for failure, identification of reasons for failure, existence of crack, Griffith crack and experiment, energy release rate and stress for failure in presence of crack. Stress field around crack tip; revision of theory of elasticity conformal mapping,

Airy's stress function: for crack tip stress field with crack emanating from straight boundary, stress state in crack tip vicinity, modes of crack face deformation, stress intensity factor and Irwin's failure criterion, fracture toughness. Determination of Stress Intensity Factor, different specimen configuration, numerical techniques-boundary collocation and boundary integral, finite element method, experimental method-reflection and refraction polariscopy.

Determination of fracture toughness: Energy consideration; potential energy, surface energy, plastic deformation around crack tip, energy release rate, compliance and correlation with fracture toughness, crack opening displacement (COD), COD as fracture criterion, experimental determination of COD, use of fracture toughness and COD as design criteria.

Concepts: J-Integral, Stress corrosion cracking, hydrogen embrittlement, leak before burst, Crack Propagation; law of fatigue crack propagation, life calculation when a crack is present and loaded, microscopic aspects of crack propagation, elastic crack and plastic relaxation at crack tip.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. T. L. Anderson, "Fracture Mechanics-Fundamentals and Applications", 3rd Edition, CRC Press, 2005
2. Prashant Kumar, "Elements of Fracture Mechanics", McGraw Hill Education (India) Pvt., Ltd, New Delhi, 2014
3. S.A .Meguid, "Engineering Fracture Mechanics", Springer Publications, 1989
4. K. Hellan, "Introduction to Fracture Mechanics", McGraw Hill Publications, 1985
5. D. Broek, "Elementary Engineering Fracture Mechanics", Springer, 1982 (3)
6. K. R. Y. Simha & K. R. V. Simha, "Fracture Mechanics for Modern Engineering Design", Universities Press, 2001</td></tr>
</table>

<table>
<tr><td>Subject Code
ME523</td><td>Finite Element Method</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To study the characteristics of basic mechanics behind crack propagation and fracture phenomenon
• To examine the concept of failure in engineering materials with pre-existing flaws
• To design the parts from fracture mechanics point of view by selecting proper materials and geometric features
• To introduce the physical and mathematical principles of fracture mechanics and their applications in wide range of engineering design
• To determine the fracture toughness and stress intensity factor of pre-existed engineering materials</td></tr>
<tr><td colspan="3">Introduction: weak formulations, weighted residual methods, linear and bilinear Forms, variational formulations, weighted residual, collocation, subdomain, least square and Galerkin’s method, Second-order differential equations in one dimension,

Basis steps: discretization, element equations, linear and quadratic shape functions, assembly, local and global stiffness matrix and its properties, boundary conditions, penalty approach, multipoint constraints, applications to solid mechanics, heat and fluid mechanics problems, axisymmetric problems, Plane truss, local and global coordinate systems, stress calculations, temperature effect on truss members, Euler Bernoulli beam element, Hermite cubic spline functions, frame element,

Solution of practical problems: Formulation, FEM models, semi discrete FEM models, time approximation schemes, applications, problems, Single variables in 2-D, triangular and rectangular elements, constant strain triangle, isoparametric formulation, higher order elements, six node triangle, nine node quadrilateral, master elements, modelling considerations, numerical integration, approximations errors, convergence and accuracy computer implementation, Torsion, heat transfer, heat transfer in thin fins, potential flow problems, axisymmetric problems, impositions of essential BCs, Review of equations of elasticity, stress-strain and strain-displacement relations, plane stress and plane strain problems, velocity pressure formulation, LMM and PM model.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. J. N. Reddy, “An Introduction to Finite Element Methods”, 3rd Edition, Tata McGraw-Hill, 2005
2. O. C. Zienkiewicz, “The Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2002
3. K. D. Cook, D. S. Malkus and M. E. Plesha, “Concept and Applications of Finite Element Analysis”, 3rd Edition, John Wiley and Sons, 1989
4. S. S. Rao, “The Finite Element Method in Engineering”, 4th Edition, Elsevier Science, 2005
5. J. N. Reddy and D. K. Gartling, “The Finite Element Method in Heat Transfer and Fluid Dynamics”, 3rd Edition, CRC Press, 2001
6. J. Fish and T. Belytschko, A First Course in Finite Elements, 1st Edition, John Wiley and Sons, 2007
7. J. Chaskalovic, Finite Element Methods for Engineering Sciences, 1st Edition, Springer, 2008</td></tr>
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<table>
<tr><td>Subject Code
ME 524</td><td>Refrigeration and Air Conditioning</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To provide fundamentals of refrigeration and air conditioning, psychrometry.
• To accustom with various methods of production of cold.
• To impart knowledge about applications of refrigeration and air conditioning.
• To familiarize with industrial protocols, regulations in the field.</td></tr>
<tr><td colspan="3">Introduction about Refrigeration: Definitions of various terms. Methods of refrigeration. Air refrigeration system. Bell, Coleman cycle, Introduction about Air craft Air Conditioning, Analysis of Vapour compression cycle, Modifications to basic cycle. Multi pressure systems.

Multi-evaporator system and Cascade systems: Properties of refrigerants. Selection of refrigerants. Discussion of components of V.C system, Servicing. vacuumizing and charging of refrigerant. Introduction to cryogenics.

Psychrometry: Definitions for properties. Introduction to cooling load calculations. Comfort conditions. Effective temperature concept.

Air-conditioning systems: Discussion about the central plant with direct evaporator and chiller applications, Ice plant, refrigerators. Food preservation, IQF technique and freeze drying etc. Cold storage and thermal insulation.</td></tr>
<tr><td>Text/Reference
Books</td><td colspan="2">1. Arora, C.P., “Refrigeration and Air Conditioning”, Tata McGraw-Hill, 2nd edition., 2000
2. Manohar Prasad, “Refrigeration and Air Conditioning”, New Age International, 3rd edition, 2004.
3. Dossat R.D., “Principle of Refrigeration”, Prentice-Hall, 4th edition, 1997.</td></tr>
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<table>
<tr><td>Subject Code
ME 525</td><td>Cryogenic Engineering</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To provide the fundamentals of cryogenics
• To accustom with various methods of production of cryogenic fluids
• To impart knowledge about applications of cryogenics</td></tr>
<tr><td colspan="3">Introduction: Definition and Engineering Applications of Cryogenics, Properties of solids for cryogenic systems.

Refrigeration and Liquefaction: Simple Linde cycle, Pre-cooled Joule-Thomson cycle, dual pressure cycle, Simon helium liquefier, classical cascade cycle, mixed-refrigerant cascade cycle.

Ultra-low-temperature refrigerators: Definition and Fundamentals regarding ultra-low temperature refrigerators, Equipment associated with low-temperature systems, Various Advantages and Disadvantages.

Storage and Handling of Cryogenic Refrigerants: Storage and Transfer systems, Insulation, Various Types of Insulation typically employed, Poly Urethane Foams (PUFs) and Polystyrene Foams (PSFs), Vacuum Insulation

Applications: Broad Applications of Cryogenic Refrigerants in various engineering systems.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Mamata Mukhopadhyay, “Fundamentals of Cryogenic Engineering”, PHI, 4th edition, 2010.
2. Thomas Flynn, “Cryogenic Engineering, Revised and expanded”, CRC, 2nd edition, 2004.
3. A. R. Jha, “Cryogenic Technology and Applications”, Butterworth-Heinemann, 2005.</td></tr>
</table>

Subject Code ME 526	# Computational Fluid Dynamics	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To provide the fundamentals of cryogenics • To accustom with various methods of production of cryogenic fluids • To impart knowledge about applications of cryogenics	

Introduction: Introduction to analytical, numerical and computational methods, Mathematical description of physical phenomena, Physical significance for mathematical classifications of partial differential equations as elliptic, parabolic and hyperbolic, Physical meaning of general partial differential equations, Simplification methods, proper choice of coordinate, transformed coordinates, normalization, Physical domain and computational domain, Discretization methods for converting derivatives to their finite difference forms. Taylor series method, polynomial fitting method, integral method and physical formulation, Discretization error, first order, second order and higher order accuracy discretization methods.

Model equations: Laplace's equation, heat equation, first order wave equation, Burger's equation (INVISCID), Computational methods for one, two, three-dimensional steady state conduction problem in Cartesian and cylindrical co-ordinates, Methods to deal Dirichlet, Neumann and Robins type boundary conditions for regular and irregular shapes, Fine, coarse, uniform and non-uniform grids, Solution of the linear algebraic equations, Gaussian elimination method, Tri-diagonal Matrix Algorithm (TDMA), Iterative methods, Gauss-Seidel point by point method, Gauss Seidel line by line methods, under and over relaxations

Computational Methods: Computational Methods for one, two and three-dimensional heat equations, explicit, implicit, Crank- Nicholson, ADI schemes, ADE schemes, Fractional step methods, Hopscotch scheme, Douglass scheme, Conservative form of partial differential and finite difference equations, Methods to deal interface property and no linearity, Consistency, stability and convergence of computational methods, Discrete perturbation stability analysis, Von- Neumann stability analysis, Validation of computational solution.

Computational methods of first order wave equations and Burger's Equation (INVISCID), explicit schemes, implicit schemes, upstream difference schemes, Lax–Wendroff scheme, Mac Cormack, hybrid and power law schemes, Dissipation and dispersion errors, Four basic rules to obtain consistency and stability, Computation of the flow field using stream function-vorticity formulation, Analysis of two dimensional incompressible viscous flow inside a Lid Driven Cavity, Algorithms to obtain flow field by solving coupled system of equations. semi implicit methods for pressure linked equations and its revised schemes

Text/Reference Books	1. John D Anderson, "Computational Fluid Dynamiocs" McGraw-Hill Education 1995. 2. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", CRC Press, 2017. 3. Muraleedhar, K., and Sundararajan, T. "Computational Fluid Flow & Heat Transfer", Alpha Science International Ltd; 2nd edition,2003 4. Versteeg, H.K. & Malalasekera, W. "An introduction to computational fluid Dynamics: The Finite Volume Method" 2nd edition, Adison Wesley-Longman, 1995. 5. Roache, P.J. "Computational Fluid Dynamics", 2nd edition, Hermosa, 1982

<table>
<tr><td>Subject Code
ME 527</td><td>Renewable Energy Systems</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand basic characteristics of renewable sources of energy and technologies
• To give review on utilisation trends of renewable sources of energy</td></tr>
<tr><td colspan="3">Introduction: Energy problem, finite conventional energy sources, energy and environment, need for renewables and energy efficiency, Solar energy, measurement of solar radiation ,estimation of terrestrial solar radiation, methods of solar collection and thermal conversion, thermal analysis of flat plate collectors, testing procedures, solar pond, parabolic collectors, paraboloid dish, central receiver, Energy storage systems, Applications of solar thermal systems, residential water heating, industrial heating, power generation.

Biomass energy systems: Biomass conversion routes, combustion, gasification, anaerobic digestion, pyrolysis, cogeneration, Performance analysis and testing, Thermal applications, power generation.

Wind energy conversion: Wind distribution, types and operation of wind turbines and their characteristics, generators and control strategies, Small hydro power, classification of hydro turbines, performance analysis, selection and sizing, Ocean thermal energy conversion, power generation options, Wave and tidal energy, systems for power generation.

Economic analysis: Calculation of energy cost from renewables, comparison with conventional energy systems, calculation of carbon dioxide reduction, incremental costs for renewable energy options, Introduction to integrated energy systems.</td></tr>
<tr><td>Text/Reference
Books</td><td colspan="2">1. Sukhatme, S.P., and Nayak, J.K., “Solar Energy-Principles of Thermal Collection and Storage”, Tata McGraw Hill, 3rd edition, 2008.
2. Duffie, J.A., and Beckman, W.A., “Solar Engineering of Thermal Processes”, Wiley, 3 rd edition, 2006
3. Goswami, D.Y., Kreith, F., and Kreider, J.F., “Principles of Solar Engineering”, Taylor and Francis, 2nd edition. 2003.
4. Twidell, J. and Weir T., “Renewable Energy Resources”, Taylor and Francis, 2nd edition, 2006.
5. Boyle, G. (Ed.), “Renewable Energy”, Oxford University Press, 2nd edition, 2004.
6. Deublein, D., and Steinhauser A., “Biogas from Waste and Renewable Resources: An Introduction”, Wiley, 2nd edition, 2010</td></tr>
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<table>
<tr><td>Subject Code
ME 528</td><td colspan="2">Internal Combustion Engines</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To describe the performance and operating characteristics of Internal Combustion Engines.
• To explain the parts and complete knowledge of type of fuels used in IC engines and the fuel supply systems
• To describe combustion process phenomena in IC engines
• To explain the different methods of performance analysis of IC engines</td></tr>
<tr><td colspan="4">Fuel-air cycles, Actual cycles, Combustion in SI engines, Stages of combustion, Flame propagation, SI combustion chambers, Combustion in CI engines, Delay period, CI engine combustion chambers, Testing and Performance, Adiabatic flame temperature, Enthalpy of product, CRDI, MPFI, CDI, Supercharger, Turbocharger. Alternative fuels for IC engines.</td></tr>
<tr><td>Text/Reference
Books</td><td colspan="3">1. M.L Mathur & R.P Sharma, “A Course in Internal Combustion Engine”, Dhanpat Rai & Sons, New Delhi,2001
2. John. B. Heywood, “Internal combustion engine fundamentals”, McGraw Hill, 1st Edition, 1988.
3. E.F Obert, “Internal combustion engines”, Addision Wesley, 3rd edition, 1968,
4. V.Ganesan, “Internal Combustion Engines”, McGraw-Hill, 4th edition,1995.</td></tr>
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<table>
<tr><td>Subject Code
ME 529</td><td>Energy Audit and Management</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To learn the benefits and drivers of an energy audit.
• To have knowledge of the energy audit of electrical utilities.
• To understand to plan and carry out an energy audit.
• To be confident with the process of reviewing energy data and analysis in the energy audit process</td></tr>
<tr><td colspan="3">Energy Scenario: Introduction, energy problems, energy use trends in developing countries, prospects of changes in energy supply, strategies for sustainable development, finite fossil reserve, Energy and environment, Need for renewable and energy efficiency, Energy conservation principles.

Energy management: Definitions and significance, Two sides of energy management, Sectors of supply side energy management, Objectives of energy management, Hierarchical levels of supply side energy management, Trade-off between energy and environment, Energy and economy, energy management and control system (EMC's or EMS) for demand side, Energy management in end user plant, Seven principles of energy management, Energy policy of supply organization and demand side organization for energy management, Organization of energy management, Training and human resource development, motivation.

Energy Planning : Energy strategy, Energy policy and energy planning, Essential imperatives and steps in supply side energy planning, energy planning flow for supply side, Essential data for supply side energy planning, infrastructure planning, Transportation of energy, Per capita energy consumption, Essential imperatives and steps in user side energy planning, Energy policy of demand side organization (energy consumer).

Energy Audit: Introduction, Types of energy audits, energy audit, Intermediate energy audit, Comprehensive energy audit, End use energy consumption profile, Procedure of energy auditing, Composition of comprehensive auditing, Data for comprehensive audit, Site testing and management.

Energy Conservation and Recycling : Introduction, Listing of energy conservation opportunities, Electrical ECOs, Thermodynamic ECOs, ECOs in chemical processing industries, ECOs in medium and small industries, ECOs in residential buildings, shopping complexes and in university campus, Human and animal bio-muscle energy, Waste management, Recycling of discarded materials and energy recycling, Waste recycling management.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. S. Rao, Dr. B.B. Parulekar, "Energy Technology (Non-Conventional, Renewable and Conventional)" Khanna publications, 3rd edition, 1994
2. A.B. Gill, "Power Plant Performance", Standards media, 2003 I.G.C. Dryden, "The Efficient use of Energy", Butterworth-Heinemann Ltd; 2nd edition, 1982
3. Wood, A.J., Wollenberg, B.F., "Power generation, Operations and control", Wiley-Blackwell, 3rd edition, 1984.</td></tr>
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<table>
<tr><td>Subject Code
ME 530</td><td>Aerodynamics</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To define basic aerodynamic forces acting on an aircraft
• To list the factors affecting aerodynamic forces
• To define geometric characteristics of airfoil and wing</td></tr>
<tr><td colspan="3">Equations for incompressible inviscid flows, Fluid circulation and rotation, vorticity, Kelvin’s theorem, velocity potential, stream function, equation of a stream line, complex potential, Blasius theorem for force and moment on bodies, Elementary flow patterns and their superposition. Flow past a cylinder, Magnus effect, Kutta condition, Vortex theory of lift. Conformal transformation, The Joukowski transformation, lift on arbitrary cylinder, Aerodynamic center, Pitching moment. Aerofoils, low speed flows over aerofoils, the vortex sheet, Thin aero foil theory, symmetric aerofoil, Tear drop theory, Camber line at zero angle of attack, Characteristics of thin aero foils, Motion in three dimensions, Flow past slender bodies. Finite wings, downwash and induced drag, Prandtl-Lachester theory, Biot- Savart law, General series solution, Glauret method, Multhop’s method, Horseshoe effects, Ground effects, Lineraised compressible flows in two dimensions, flow past a wavy wall, Similarity rules, Aerofoil in compressible flows.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Anderson, J.D., “Fundamentals of Aerodynamics”, 5th edition., McGraw Hill, New York, 1998
2. Kuethe, A.M., and Chow,C., “Foundations of Aerodynamics” 4th Edition, Wiley Eastern, New Delhi, 1986.
3. Katz,J., and Plotkin,A., “Low Speed Aerodynamics” , McGraw Hill, New York, 1991.
4. Houghton,E.L., and Brock,A.E. “,Aerodynamics for Engineering Students”, Edward Arnold, London,1960.</td></tr>
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<table>
<tr><td>Subject Code
ME 531</td><td>Heating Ventilation and Air Conditioning</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand the fundamentals of Psychrometry
• To apply human comfort indices and comfort chart to design indoor conditions of HVAC systems.
• To estimate heating and cooling loads for buildings according to ASHRAE procedures/standards.
• To design and evaluate complete air distribution system including fan, duct, and installation requirements for a typical HVAC system.</td></tr>
<tr><td colspan="3">Principles of refrigeration, Carnot refrigeration cycle, unit of refrigeration, capacity, coefficient of performance. Refrigeration systems, vapour compression system, theoretical and practical cycles, system components, compressors, condensers, expansion devices, evaporators, refrigerants. Air refrigeration cycle, Vapour absorption refrigeration system. Psychrometry, psychrometric processes, determination of condition of air entering conditioned space. Air conditioning systems, summer, winter and year-round-year air conditioning systems, central and unitary systems. Requirement of air conditioning, human comfort, comfort chart and limitations, effective temperature, factors governing effective temperature, design considerations. Cooling load calculations, various heat sources contributing heat load, solar load, equipment load, infiltration air load, duct heat gain, fan load, moisture gain through permeable walls and fresh air load, Design of air conditioning systems. Duct design, equal friction method, static regain method, velocity reduction method, Air distribution systems, Analysis for heating and cooling systems, Insulation. Heating systems, warm air systems, hot water system, steam heating systems, panel and central heating systems, Heat pump circuit, Heat sources for heat pump. Air conditioning equipments and control systems, air filters, humidifiers, fan, blowers, control systems for temperature and humidity – noise control. Installation and charging of refrigeration unit, Testing for leakage, Cause for faults and rectification.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Noman C. Harris, “Modern Air conditioning Practice”, McGraw-Hill, 2nd edition, 1974.
2. Stoecker, W.F., “Refrigeration & Air conditioning”, McGraw Hill, 2nd edition New York, 1987.
3. Dossat, R.J., “Refrigeration & Air conditioning”, prentice hall, 4th edition. 1997.
4. Arora, C.P., “Refrigeration & Air conditioning”, McGraw Hill, 2nd edition, 2000.
5. Stoecker, W.F., “Principles of Air conditioning”, industrial press, 2nd edition, 1977.
6. Laub, J.M.,”Heating & air conditioning of buildings”, Holt, Rinehart and Winston, 1963.
7. Kell, J.R., and Martin, P.L., “Air conditioning & Heating of buildings”, Architectural Press, 6th edition, 2007.
8. Carrier’s Handbook for Design of Unit Air Conditioners, Kenrick Place Media Ltd, 14th edition,1996</td></tr>
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<table>
<tr><td>Subject Code
ME 532</td><td colspan="2">Advanced Thermodynamics</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To understand Maxwell’s and thermodynamic relations of gas mixtures.
• To estimate thermodynamic properties of gas mixtures.
• To identify the models to estimate the properties of real gases.
• To analyze reactive and non-reactive gas mixtures using the concepts of statistical thermodynamics and kinetic theory of gases.
• To analyze chemical reaction and combustion of gas-mixtures.</td></tr>
<tr><td colspan="4">General principles of classical thermodynamics, postulational approach, basic postulates conditions of equilibrium, fundamental equations, equations of state, Euler equation, Gibbs-Duhem equation, Multi component simple ideal gases. Reversible processes, maximum work theorem, alternate formulation, energy minimum principle, Legendre transformations, Extremum principles in the Legendre transformed representation, Thermodynamic potentials and Massieu functions, Maxwell relations and Jacobian methods, Procedure to reduction of derivatives, applications, Stability criteria of thermodynamic systems, First-order phase transition, single component and multi-component systems, Gibbs phase rule, phase diagram for binary systems. Critical phenomena, Liquid and solid Helium, Nernst postulate, Introduction to irreversible thermodynamics, linearised relation, Onsager’s reciprocity theorems, Special topics on advanced thermodynamics.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. Callen, H.B., “Thermodynamics and an Introduction to Thermostatics”, 2nd Edition, John Wiley &Sons, 1985.
2. Rao, Y.V.C., “Postulational and Statistical Thermodynamics”, Allied Publishers, 1994.
3. Zemansky, M.W., Abbot, M.M. and Van Ness, H.C., “Basic Engineering Thermodynamics”, McGraw-Hill, 1987
4. Saad, M.A., “Thermodynamics for Engineers”, Prentice Hall of India, 1987.
5. Lee, J.F., Sears, F.W., “Thermodynamics: An Introductory Text for Engineering Students”, Addison Wesley, 1964.
6. Wark Jr., K., “Advanced Thermodynamics for Engineers”, McGraw-Hill, 1995.
7. O’ Cornell, J. P. and Maile, J. M., “Thermodynamics – Fundamentals for Applications”, Cambridge University Press, 2004.
8. Sonntag, R.E., Borgnakke, C and Van Wylen, G. J., “Fundamentals of Thermodynamics”, John Wiley & Sons, 6th Edition, 2004.</td></tr>
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<table>
<tr><td>Subject Code
ME 533</td><td>Experimental Methods of Fluid Flow and Heat Transfer</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand the concepts of errors in measurements, statistical analysis of data, regression analysis, correlation and estimation of uncertainty.
• To understand conceptual development of zero, first and second order systems
• To describe the working principles in the measurement of field and derived quantities.
• To analyse sensing requirements for measurement of thermo-physical properties, radiation properties of surfaces, and vibration.</td></tr>
<tr><td colspan="3">Introduction to experimental methods: Basic concepts, accuracy, precision, resolution, uncertainty, Pressure measurements: dynamic response considerations, dead-weight tester, bourdon-tube pressure gage, diaphragm and bellows gages, bridgman gage, pirani thermal-conductivity gage, knudsen gage, ionization gage, alphatron.

Flow measurement: Passive-displacement methods, flow-obstruction methods, sonic nozzle, flow measurement by drag effects, pressure probes, hot-wire and hot-film anemometers, magnetic flowmeters,

Flow visualization methods: Smoke methods, shadowgraph, schlieren photography, laser Doppler anemometer, laser-induced fluorescence, particle image velocimetry.

Temperature measurements: Temperature scales, ideal-gas thermometer, temperature measurement by mechanical effects, temperature measurement by electrical effects, temperature measurement by radiation, transient response of thermal systems, thermocouple compensation, temperature measurements in high-speed flow, interferometric method.

Transport-property measurements, thermal conductivity measurements, measurement of viscosity, gas diffusion, calorimetry, convective heat transfer measurement, humidity measurement, heat flux meters, pH measurement, Thermal-radiation measurements, emissivity measurement, reflectivity and transmissivity measurement, solar radiation measurement.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. J.P. Holman, “Experimental Methods for Engineers”, McGraw-Hill Company, 7th edition, 2004.
2. Figliola, Richard S, & Beasley, Donald E, “Theory and Design for Mechanical Measurements”, John Wiley & Sons Inc, 3rd edition, 2008
3. Doebelin, Ernest O., “Measurement Systems”, McGraw-Hill International, 7th edition, 2019</td></tr>
</table>

Academic Handbook

for

Bachelor of Technology Programme

in

Civil Engineering

National Institute of Technology Goa

Farmagudi, Ponda, Goa - 403 401

Programme Structure Summary

Categories of the Courses

The Bachelor of Technology (B.Tech.) program in the Dept. of Civil Engineering at National Institute of Technology Goa (NIT Goa) will have 171 credits as the lower limit for the award of degree. These courses are grouped in a number of categories as shown below:

Sl. No.	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)	6*	✓ Environmental Studies -1 Credit ✓ Professional Communication -II and Language Lab -3 Credits ✓ Physical Education -1 Credit ✓ Value Education -1 Credit
Total Credits		**171**	**165 credits are counted for CGPA**

Semester-Wise Credit Distribution

Semester	Total Credits
I	22
II	21+1*
III	21+1*
IV	24
V	19+4*
VI	24
VII	19
VIII	15
Total Credits	**165+6**

Semester-wise Distribution of the Courses

I Semester

Sl. No.	Sub. Code	Subjects	L-T-P	Credits
1	MA100	Mathematics-I	3-1-0	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

Sl. No.	Sub. Code	Subjects	L-T-P	Credits
1	MA150	Mathematics-II	3-1-0	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		**21+1***

III Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	MA200	Mathematics-III	3-0-0	3
2	CV200	Mechanics of Solids	3-0-0	3
3	CV201	Mechanics of Fluids	3-0-0	3
4	CV202	Engineering Earth Sciences	3-0-0	3
5	CV203	Planning and Functional Design of Buildings	3-0-0	3
6	CV204	Fluid Mechanics Lab	0-0-3	2
7	CV205	Material Testing Lab-I	0-0-3	2
8	CV206	Geology Lab	0-0-3	2
9	VE200	Value Education	1-0-0	1*
			Total Credits	**21+1***

IV Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	MA250	Mathematics-IV (Computational Methods for Civil Engineering)	3-0-0	3
2	CV250	Structural Analysis-I	3-0-0	3
3	CV251	Surveying	3-0-0	3
4	CV252	Building Material and Construction Technology	3-0-0	3
5	CV253	Environmental Engineering-I	3-0-0	3
6	CV254	Geotechnical Engineering-I	3-0-0	3
7	CV255	Surveying Lab	0-0-3	2
8	CV256	Material Testing Lab-II	0-0-3	2
9	CV257	Geotechnical Engineering Lab	0-0-3	2
			Total Credits	**24**

V Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	CV300	Structural Design-I (RCC)	3-0-0	3
2	CV301	Structural Analysis-II	3-0-0	3
3	CV302	Transportation Engineering-I	3-0-0	3
4	CV303	Geotechnical Engineering-II	3-0-0	3
5	ES301	Environmental Studies	1-0-0	1*
6	HU300	Professional Communication-II and Language Lab	2-0-3	3*
7	HS300	Economics	3-0-0	3
8	CV304	Transportation Engineering Lab	0-0-3	2
9	CV305	Building Design and Drawing Lab	0-0-3	2
			Total Credits	**19+4***

VI Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	CV350	Structural Design-II (Steel)	3-0-0	3
2	CV351	Water Resource Engineering	3-0-0	3
3	CV352	Transportation Engineering-II	3-0-0	3
4	CV353	Environmental Engineering-II	3-0-0	3
5	CV5**	Elective-I	3-0-0	3
6	HS350	Management	3-0-0	3
7	CV354	Minor Project	0-0-3	2
8	CV355	Structural Design and Drawing Lab	0-0-3	2
9	CV356	Environmental Engineering Lab	0-0-3	2
			Total Credits	**24**

VII Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	CV400	Profession Practice (Construction Planning and Management)	3-0-0	3
2	CV401	Estimation, Costing & Specifications	3-0-0	3
3	CV5**	Elective-II	3-0-0	3
4	CV5**	Elective-III	3-0-0	3
5	CV402	Mini Project/Industrial Training	0-0-3	1
6	CV449	Major Project-I	0-0-4	4
7	CV450	Seminar	0-0-3	2
			Total Credits	**19**

VIII Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	CV5**	Elective-IV	3-0-0	3
2	CV5**	Elective-V	3-0-0	3
3	CV5**	Elective-VI	3-0-0	3
4	CV499	Major Project–II	0-0-6	6
			Total Credits	**15**

List of Electives

ELECTIVE I (VI SEM)				
Sl. No.	**Course Code**	**Course Name**	**L-T-P**	**Credits**
1	CV501	Concrete Technology	3-0-0	3
2	CV502	Composite Materials	3-0-0	3
3	CV503	Advanced Fluid Mechanics	3-0-0	3
4	CV504	Structural Design of Foundations	3-0-0	3
5	CV505	Disaster Management and Mitigation	3-0-0	3
6	CV506	Advanced Surveying	3-0-0	3
7	CV507	Computer Aided Design	3-0-0	3
8	CV508	Smart Materials and Structures	3-0-0	3

ELECTIVE II (VII SEM)				
Sl. No.	**Course Code**	**Course Name**	**L-T-P**	**Credits**
1	CV509	Advanced RCC Structures	3-0-0	3
2	CV510	Earth Retaining Structures	3-0-0	3
3	CV511	Advanced Solid Mechanics	3-0-0	3
4	CV512	Advanced Irrigation Engineering	3-0-0	3
5	CV513	Industrial Waste Treatment	3-0-0	3
6	CV514	Advanced Highway Engineering	3-0-0	3
7	CV515	Ground Improvement Techniques	3-0-0	3
8	CV516	Pavement Design	3-0-0	3

ELECTIVE III (VII SEM)				
Sl. No.	**Course Code**	**Course Name**	**L-T-P**	**Credits**
1	CV517	Finite Element Method	3-0-0	3
2	CV518	Advanced Steel Structures	3-0-0	3
3	CV519	Non-Destructive Testing and Evaluation	3-0-0	3
4	CV520	Experimental Stress Analysis	3-0-0	3
5	CV521	City and Urban Planning	3-0-0	3
6	CV522	Remote Sensing and GIS	3-0-0	3
7	CV523	Environmental Pollution and Control	3-0-0	3
8	CV524	Geo-environmental Engineering	3-0-0	3

ELECTIVE IV (VIII SEM)				
Sl. No.	**Course Code**	**Course Name**	**L-T-P**	**Credits**
1	CV525	Advanced Pre-Stressed Composite Materials	3-0-0	3
2	CV526	Earthquake Resistant Structures	3-0-0	3
3	CV527	Structural Reliability	3-0-0	3
4	CV528	Occupational Safety and Health Act	3-0-0	3
5	CV529	Advanced Geo-Environmental Engineering	3-0-0	3
6	CV530	Multi-Hazard Resistant Designs	3-0-0	3
7	CV531	Non-conventional and Renewable Energy	3-0-0	3

ELECTIVE V (VIII SEM)				
Sl. No.	**Course Code**	**Course name**	**L-T-P**	**Credits**
1	CV532	Structural Dynamics	3-0-0	3
2	CV533	Design of Bridges	3-0-0	3
3	CV534	Rapid Transport System and Smart Cities	3-0-0	3
4	CV535	Structural Stability	3-0-0	3
5	CV536	Rock Mechanics and Engineering	3-0-0	3
6	CV537	Ocean Engineering	3-0-0	3
7	CV538	Computational Fluid Dynamics	3-0-0	3
8	CV539	Green Building Design	3-0-0	3

ELECTIVE VI (VIII SEM)				
Sl. No.	**Course Code**	**Course name**	**L-T-P**	**Credits**
1	CV540	Wind Resistant Designs	3-0-0	3
2	CV541	Repair and Rehabilitation of Structures	3-0-0	3
3	CV542	Engineering Optimization	3-0-0	3
4	CV543	Structural Optimization	3-0-0	3
5	CV544	Failure Forensics	3-0-0	3
6	CV545	Structural Health Monitoring	3-0-0	3
7	CV546	Tunnel and Underground Structures	3-0-0	3
8	CV547	Offshore Structures	3-0-0	3
9	CV548	Hazardous Waste Management	3-0-0	3

Detailed Syllabus of Courses

III Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	MA200	Mathematics-III	3-0-0	3
2	CV200	Mechanics of Solids	3-0-0	3
3	CV201	Mechanics of Fluids	3-0-0	3
4	CV202	Engineering Earth Sciences	3-0-0	3
5	CV203	Planning and Functional Design of Buildings	3-0-0	3
6	CV204	Fluid Mechanics Lab	0-0-3	2
7	CV205	Material Testing Lab-I	0-0-3	2
8	CV206	Geology Lab	0-0-3	2
9	VE200	Value Education	1-0-0	1
			Total Credits	**21+1**

<table>
<tr><td>Subject Code
MA200</td><td colspan="2">Mathematics-III</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="3">• Mathematics-I &II</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• 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</td></tr>
<tr><td colspan="4">Complex Analysis: 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.

Power Series Solutions: Differential Equations Power Series Method - application to Legendre equation, Legendre Polynomials, Frobenious Method, Bessel equation, Properties of Bessel functions, Sturm- Liouville BVPs, Orthogonal functions.

Partial Differential Equations: 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.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999).
2. W. E. Boyce and R. Di Prima, Elementary Differential Equations (8thEdition), John Wiley (2005).
3. R. V. Churchill and J. W. Brown, Complex variables and applications (7th Edition), McGraw-Hill (2003).</td></tr>
</table>

<table>
<tr><td>Subject Code
CV200</td><td><h1>Mechanics of Solids</h1></td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To understand behavior of solids subjected to different kinds of forces and stresses.
To idealize real life structure problems into simple structures for analysis.
To understand various important relationships between material properties.</td></tr>
<tr><td colspan="3">
Stress: Types of forces, Definition of stress, Stress tensor, plane stress, differential equations of stress equilibrium, Principal stresses, maximum shear stress, Mohr’s Circle, stress invariants, Stresses due to impact.
Strain: Definition of strain, strain tensor, Plane strain, Saint Venant’s equation of compatibility, Principal strains, strain invariants, Poisson’s ratio, volumetric strain, thermal strain and deformation, strain rosettes.
Stress-Strain Relationships: Hooke’s Law, constitutive relations, deformation of axially loaded bars, elastic constants, generalized Hook’s law for isotropic materials, Navier’s Equations, Elastic strain energy, introduction to Tresca and Von-Mises theory of failure, Octahedral shear stress.
Torsion: Torsion of circular elastic bars, torsion equation, introduction to warping of non-circular bars, power transmitted by shaft and hollow circular sections.
Bending Moment and Shear force: Beams and support conditions, Types of supports and loads, shear force and bending moment, their diagrams for simply supported beams, cantilevers and overhanging beams.
Bending Stress and Shear Stress: Theory of simple bending–Stress distribution at a cross section due to Bending Moment and Shear Force, Curved bars, Unsymmetrical bending, Product moment of inertia, shear centre, thin and introduction to thick walled cylinder.
Deflection of beams: Moment curvature relation of beam, differential equation of beam. Slope and deflection for determinate structures using integration, moment area and conjugate beam method.
Elastic Stability of Columns: Short and Long Column, stability of a long column, Euler’s Theory of Columns, differential equations of beam- columns, Derivation of Buckling Load for different end conditions, Rankine’s Formula.
</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">Timoshenko, S.P., and Young, D.H., " Elements of Strength of Materials", Affiliated East-West Press Pvt. Ltd.
Srinath, L.S, Desai. P., "Strength of Materials", Tata McGraw-Hill.
Popov, E.P., "Engineering Mechanics of Solids",P HI.
Kazimi, S. M.A, "Solid Mechanics", Tata McGraw-Hill.
Shames, H, "Introduction to Solid Mechanics", PHI.
Shaneloy, F.R,"Strength of Materials", McGraw Hill.
Timoshenko, S, "Strength of Materials Vol. I", McGraw Hill.
Srinath, L.S., "Advanced Mechanics of Solids", TataMcGraw-Hill.
R C Hibbeler,"Mechanics of Materials”, Pearson.
Singer, F.L. Strength of Materials, 3rd Edition, Harper and Row Publishers, New York,1980.</td></tr>
</table>

Subject Code CV201	**Mechanics of Fluids**	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To understand the properties of fluids and fluid statics. • To solve kinematic problems such as finding particle paths and streamlines. • To use important concepts of continuity equation, Bernoulli's equation and turbulence, and apply the same to problems.	

Properties of Fluid: Surface tension, viscosity–Ideal and real fluids, Newtonian and non- Newtonian fluids, Incompressible and compressible fluids.

Fluid pressure and Hydrostatics: Pressure at a point, Pascal's law etc., Introduction to Pressure measuring devices (Manometers & Mechanical Gauge), Total pressure and centre of pressure on plane and curved submerged bodies.

Buoyancy: Centre of buoyancy, Metacentric height, Equilibrium analysis.

Kinematics of fluid flow: Lagrangian and Eulerian approaches, Types of fluid flow, Continuity equation, Velocity potential function and Stream Function.

Dynamics of fluid flow: Euler's Equation of motion, momentum equation, Bernoulli's equation, Applications of Bernoulli's equation, Flow through Orifice, Mouth piece, Notches and weirs.

Introduction of open channel flow: Critical depth, Concepts of specific energy and specific force, application of specific energy.

Uniform Flow: Chezy's and Manning's equations for uniform flow in open channel, Velocity distribution, most efficient channel section.

Hydraulic Jump: Classical hydraulic jump, Evaluation of the jump elements in rectangular and non-rectangular channels on horizontal and sloping beds.

Dimensional Analysis and Hydraulic Similitude: Dimensional Analysis, Buckingham's theorem, important dimensionless numbers and their significance. Flow through pipes, friction and losses.

Text/Reference Books

1. Modi, P.N and Seth, S.M., Hydraulics and Fluid Mechanics, Standard Book House, Delhi,2010.
2. Streete. V.L and Wylie. E.B., Fluid Mechanics, McGraw Hill Book Company, New York,1997.
3. Ven Te Chow, Open Channel Hydraulics, McGraw Hill, New York1959.
4. Nagaratnam, S., Fluid Mechanics, Khanna Publishers,1995.
5. Natarajan, M.K. Principles of Fluid Mechanics, Oxford & IBH Publishing Co, 1994.
6. R.K.Bansal, " Fluid Mechanics and Hydraulic Machines", Laxmi Publication Pvt. Ltd., 2005
7. Jagdish Lal, Hydraulics and Fluid Mechanics, Tata McGraw Hill,2001.
8. Streeter V.L., Fluid mechanics, Tata McGraw Hill,1998.
9. Garde, R. J. and A G Mirajgoaker, "Engineering Fluid Mechanics", Nem Chand & Bros Roorkee,1983.
10. Garde, R.J , "Fluid Mechanics through Problems", Wiley Eastern Limited New Delhi,1989.

Subject Code CV202	Engineering Earth Sciences	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To identify and classify minerals based on physical, optical and chemical properties • To identify and classify rocks based on igneous, sedimentary and metamorphic. • To study the geology of earth, causes and effects of earthquake. • To study different types of maps and their cross sections	

Introduction to Geology: Relevance of geology in Civil Engineering, Introduction to formation of Rocks, Exploration and testing of Rock, Rock Quality Designation (RQD), Borehole problems. Elementary concepts of mineralogy, petrology, structural geology with special emphasis on structures in igneous, metamorphic and sedimentary rocks.

Engineering Geological/ geotechnical problems and particular relevance of geology to civil engineering projects, Geotechnical properties of rock. Geotechnical considerations of ground water, environment, natural resources and Energy.

Hydrogeology: Aquifers, geophysical exploration, selection of dam sites, tunnels, land slide control measures, environmental geology. Geology of Dam and reservoir sites, tunnels, hill slope. Weathering and erosion of rocks including rapid mass wasting movements.

Fundamentals of Geophysical Prospecting, Importance of Seismic method and electrical resistivity method to civil engineering projects, Brief description of Seismic and Electrical resistivity prospecting for civil engineering purposes.

Engineering seismology: Causes of earthquakes; seismic waves; magnitude, intensity and energy release; characteristics of strong earthquake ground motions, Earthquake occurrence in the world, Plate tectonics, Faults, Related Hazards, Volcanoes, Landslides.

Structural geology: Discontinuities and Defects in rock mass, Strike and Dip, Study of folds, faults, Joints, unconformities.

Text/Reference Books

1. Parbin Singh, Engineering and General Geology, Katson Pub., Delhi, Sixth edition 2001.
2. Blyth. F.G.H & De Freitas M. H., Engineering Geology, ELBS, 7th edition,1984
3. D.V.Reddy, Engineering Geology for Civil Engineers, Oxford IBH Publishers, 1995, 1997.
4. N. Chennakesavulu, A text book of Engineering Geology.
5. A.E. Kehew., General Geology For Engineers.
6. Perry H. Rahu. "Engineering Geology An Environmental Approach",
7. P.K. Mukherjee, "A text Book of Geology",
8. Blyth. F.G.H & De Freitas M. H, "Engineering Geology", ELBS D.V. Reddy, "Engineering Geology for Civil Engineering", Oxford IBH Publishers
9. William D. Thornbury, "Principles of Goomorphology", Wiley Eastern

<table>
<tr><td>Subject Code
CV203</td><td>Planning and Functional Design of Buildings</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand principles of building planning, importance of by-laws in construction and concept of energy efficient buildings.
• To understand the acoustical design concepts and noise control techniques.
• To impart the fundamental concepts of natural and artificial lighting designs.
• To provide principles of climatic conscious design of buildings with special emphasis on tropical climates.
• To understand the thermo physical properties of building materials and design of shading devices.</td></tr>
<tr><td colspan="3">Introduction: Building planning and by-laws, conceptual and functional planning, Introduction to Energy efficient buildings

Acoustics: Physics of sound- Behavior of sound- Sound insulation and reverberation control

Lighting: Principles, Day lighting and artificial lighting, design methods

Thermal design of buildings: Climatic elements, classification- thermal comfort and indices-solar radiation calculations and design of shading devices.

Thermo physical properties of building materials and thermal control: passive and active building design, Steady and periodic heat flow through building envelope. Concept of green building.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. National Building Code 2016, Bureau of Indian Standards
2. Ajitha Simha.D, Building Environment, Tata McGraw Hill Publishing Co., New Delhi,1985
3. Bureau of Indian standards, Handbook on Functional Requirement of Buildings, SP:41(S and T),1987
4. Givoni. B Man, Climate and Architecture, Applied Science Publication,1976
5. Knudsen V.O. and Harris C.M., Acoustical Design in Architecture, John Wiley,1980
6. Koenigseberger, Manual of tropical Housing and Building Part I, Climatic design, Orient Longman, 2011
7. Krishnan, Climate responsive architecture, Tata McGraw Hill,1999
8. M.G. Shah, C.M. Kale and S.Y. Patki; Building Drawing; Tata McGraw Hill Publication.
9. Olgay Victor, Design with climate-A bioclimatic approach to architectural regionalism- Princeton Universitypress-1963
10. Human Factors Design Handbook, Wesley Woodson, Barry Tillman, Peggy Tillman, McGraw-Hill</td></tr>
</table>

<table>
<tr><td>Subject Code
VE200</td><td>Value Education</td><td>Credits: 1 (1-0-0)
Total hours: 14</td></tr>
<tr><td>Course Prerequisite</td><td colspan="2">• General Awareness of the Society/ Environment we live in</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• It aims at Holistic Development, such that towards the end of the course, the students should be a complete human being in every respect</td></tr>
<tr><td colspan="3">Ethics in Engineering: Concepts of Values and Ethics, History and Purposes, Utilitarianism, Duties, Rights, Responsibility, Virtue, Honesty, Moral Autonomy, Obligations of Engineering Profession and moral Propriety

Engineer’s Moral responsibility: Engineer’s Moral responsibility for Safety and Human Rights, Risk Assessment and Communication, Product Liability, Engineers-Employers Liaison, Whistle-Blowing and Its Moral Justification.

Computer Ethics: Social Impact of Computer, Gender-Issues and Privacy, Cyber Crime, Ethical use of Software

Intellectual property: 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</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">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”, Case Studies from Newspapers</td></tr>
</table>

Subject Code CV204	Fluid Mechanics Lab	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	• To understand flow measurement in a pipe flow. • To determine the energy loss in pipe flow • To study the characteristics of pumps	

- Calibration of V notch: To determine the coefficient of discharge of a V notch.
- Venturi meter: To determine the coefficient of discharge of a Venturi meter.
- Orifice meter: To determine the coefficient of discharge of an Orifice meter.
- Water meter: To determine total flow of water in a pipeline using water meter.
- Friction factor of pipes: To determine coefficient of friction for pipes.
- Impact of jet on vanes: To investigate the reaction forces produced by the change in momentum of a fluid flow when a jet of water strikes a flat plate or a curved surface, and to compare the results from this experiment with the computed forces by applying the momentum equation.
- Bernoulli's theorem: To verify Bernoulli's theorem experimentally.
- Losses in pipes: To determine different types of losses (connections and friction)
- Metacentric height: To determine experimentally the metacenter height using metacentric buoyancy apparatus.

Reference books	Modi, P.N and Seth, S.M., Hydraulics and Fluid Mechanics, Standard Book House

Subject Code CV205	Material Testing Lab-I	Credits: 2 (0-0-3) Total hours: 42
Course Objectives	• Determine different type of stresses in materials • Understand behavior of materials under different types of loading • Conduct investigations and apply proper tools to make measurements • Collect and record data in an appropriate way • Know about the safety measurements while conducting the experiments • Conduct the experiments with a team work	

- Stress-strain characteristics of (a) Mild Steel and (b) Tor steel (c) Copper (d) Aluminium (e) G.I. wire and sheet
- Compressive strength tests on building materials like (a) wood (b) brick (c) rocks (d)concrete
- Hardness tests of metals (a) Steel (b) Brass (c) Aluminium (d)Copper
- Modulus of rigidity and Torsion test on (a) Solid shafts (b) Hollow shaft.
- Determination of Young's modulus on material by conducting deflection tests on

(a) Simply supported beam. (b) Propped Cantilever beam. (c) Continuous beam

- Ductility test for steel.
- Shear test on steel.

Reference Books	Timoshenko and Gere, Mechanics of Materials, CBS Publishers, New Delhi, 1996

<table>
<tr><td>Subject Code
CV206</td><td>Geology Lab</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To identify different types of minerals and rocks
• To draw cross section of geological maps
• To understand dip and strike
• To identify different types of rocks</td></tr>
<tr><td colspan="3">• RQD, study of bore-log data.
• Petrology: Identification and description of Igneous, Sedimentary, Metamorphic rocks.
• Structural Geology: Interpretation of geological and Structural geological maps, Solving Dip and strike problems.</td></tr>
<tr><td>Reference Books</td><td colspan="2">1. K.M. Gurappa, Structural geology Manual
2. B.S. Sathya Narayanaswamy, Engineering Geology Laboratory Manual, Eurasia pub.</td></tr>
</table>

IV Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	MA250	Mathematics-IV (Computational Methods for Civil Engineering)	3-0-0	3
2	CV250	Structural Analysis-I	3-0-0	3
3	CV251	Surveying	3-0-0	3
4	CV252	Building Material and Construction Technology	3-0-0	3
5	CV253	Environmental Engineering-I	3-0-0	3
6	CV254	Geotechnical Engineering-I	3-0-0	3
7	CV255	Surveying Lab	0-0-3	2
8	CV256	Material Testing Lab-II	0-0-3	2
9	CV257	Geotechnical Engineering Lab	0-0-3	2
			Total Credits	**24**

<table>
<tr><td>Subject Code
MA250</td><td>Mathematics-IV (Computational Methods in Civil Engineering)</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">To get familiarized with the numerical solution of linear and non-linear systems, Numerical solution of ordinary differential equations and partial differential equations; probability and statistics.</td></tr>
<tr><td colspan="3">
Numerical solution of linear and nonlinear: Gauss elimination method and Gauss-Seidel iterative method, sufficient conditions for convergence, power method to find the dominant Eigen value and eigenvector. Bisection method, Fixed point method, Newton- Raphson method-order of convergence, interpolation and curve fitting, method of least squares.

Numerical solution of ordinary differential: Numerical differentiation and integration. Euler's method, Euler's modified method, Taylor's method and Runge-Kutta method for simultaneous equations and second order equations, multistep methods, Milne's and Adams’ methods.

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.

Probability and Statistics: Introduction to Probability, Conditional Probabilities; Independence; Bayes’ Theorem and application. Concept of Random Variables; Distribution and Density Function; Joint Distributed Random of Variables; Conditional and Joint Density Distribution function; Function of Random Variables; Expected Value: Mean and Variance; conditional expectation; covariance and correlation; Some special distributions: Uniform, Gaussian, Binomial and Poisson distributions.
Statistics: Elements of estimation theory: linear minimum mean-square error and Orthogonality principle in estimation; Parameter Estimation
</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">
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. E.Kreyszig, “Advanced Engineering Mathematics”, 8th Edition, Wiley India Pvt. Ltd., 2010.
3. R. L. Burden and J. D. Faires, “Numerical Analysis", 9thEdition, Brooks/Cole, 2012.
4. S. C. Gupta, and V.K. Kapoor, “Fundamentals of Mathematical Statistics”, 7th Edition, Sultan Chand and Sons, 1980.
5. Papoulis, and P. Unnikrishnan, “Probability, Random Variable and Stochastic Process”, 4th Edition, Tata McGraw-Hill,2002
6. G.D Smith, “Numerical solution of Partial Differential Equations,” Oxford University Press.
7. Peter V.O Neil, “Advanced Engineering Mathematics,” 5th Edition, Thomson, Book/Cole.(2003).
8. B.S.Grewal, “Higher Engineering Mathematics,” 42nd Edition, Khanna Publications, 2013
</td></tr>
</table>

<table>
<tr><td>Subject Code
CV250</td><td>Structural Analysis-I</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To analyze 2D pin jointed and rigid frames to find deflections and rotations.
• To find the influence line diagrams of various beams.
• To analyze arches and curved beams using energy and displacement methods.</td></tr>
<tr><td colspan="3">
Introduction: General introduction on concept of analysis of determinate structures. Concept of Force, Method of Analysis Classification of Structures, Stress resultants, Degrees of freedom per node, Static and Kinematic Indeterminacy.

Analysis of Plane Trusses: Classification of Pin jointed Determinate Trusses, Analysis of determinate plane Trusses by Method of Joints and Sections and tension coefficient method.

Strain Energy: Strain energy due to axial load, bending and shear, theorem of minimum potential energy, principle of virtual work, law of conservation of energy, Castiglino’s Theorems, Betti’s & Maxwell’s reciprocal theorem, Deflection of Beams, pin jointed truss and frames using Strain Energy Method and Unit load method

Rolling Loads and Influence Lines: Rolling loads, influence lines for beams and trusses, Absolute maximum bending moment.

Analysis of Arches: Analysis of Arches, Linear Arch, Eddy’s theorem, three hinged parabolic arch, moving loads & influence lines.

Analysis of Cables and Suspension bridges: Analysis of Cables under point loads and UDL, Analysis of Suspension bridges.

Analysis of Beams: Analysis of Fixed beam, Continuous beam and simple frames with and without translation of joints by Method of Consistent Deformation and Three moments Theorem. Analysis of Propped Cantilever beam, Two-hinged Arches, ILD for Continuous beam.

Curved Beams: Introduction, Bending of Curved bars in plane of bending, stresses in bars of small and large initial curvatures, combined bending and torsion.
</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Bhavikatti S.S., "Basic Structural Analysis (Vol. I & II", Vikas Publishing
2. B.C. Punmia, "Theory of Structures", Laxmi Publication
3. Jain, O.P. and Jain B.K., "Theory & Analysis of Structures (Vol., I & II)", Nem Chand
4. R.C. Hibber, "Structural Analysis", Pearson Publication
5. Willbur and Norris, "Elementary Structural Analysis", Tata McGraw Hill
6. Negi L.S. & Jangid R.S., "Structural Analysis", Tata McGraw Hill
7. Ramamurtham S. & Narayan R, "Theory of Structures", Dhanpat Rai Publications
8. Norris and Wilbur, "Elementary Structural Analysis", Tata McGraw Hill
9. Wang, C. K Indeterminate Structural Analysis, McGraw Hill
10. Kinney, J.S. Indeterminate Structural Analysis McGraw Hill</td></tr>
</table>

<table>
<tr><td>Subject Code
CV251</td><td>Surveying</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand principals of surveying.
• To get acquainted with the use of various surveying instruments.
• To understand various types of surveying for different terrain types.</td></tr>
<tr><td colspan="3">Introduction and Principles of surveying: Introduction, classification of surveying, Principles.

Compass Surveying: Principles, Prismatic compass, Bearings, Magnetic declination, Local attraction, Error in compass surveying.

Levelling: Introduction, definition basic terms, instruments, Method of Levelling, Reciprocal Levelling, Correction for Curvature and refraction, Contouring.

Plane Table Surveying: Principle, instruments, Methods, Two- and Three-point problems.

Areas and Volumes: Area from field measurements, Area from plans, Planimeter. Area of cross-section, Measurement of volumes, Mass diagram.

Theodolite Surveying: Introduction, Types of Theodolite, Definitions of Terms, Temporary adjustments, Measurement of various angels, Fundamental lines and desire relations, Sources of Error in theodolite work. Tachometric surveying, Traversing, Balancing of traverse, Calculation of traverse area.

Introduction to Advanced Surveying equipment: Total station - Remote Sensing- GPS.

Application of surveying: Setting out of buildings, culverts, tunnels, road and bridges, Curve setting Types.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill,2004.
2. Punmia, B.C. Surveying Vol.I and II, Standard Publishers,1994.
3. Arora, K. R. Surveying Vol. I and II, Standard Book House,1996.
4. Satheesh Gopi. Advanced Surveying, Pearson Education,2007.
5. Satheesh Gopi. The Global Positioning System and Surveying using GPS, Tata McGraw,2005
6. Agor, R. Surveying Vol. I & II Khanna publications
7. Bannister, Solving Problems in Surveying Longman Scientific Technical
8. Kanetkar, T.P., " Surveying I, II, Pune Vidyarthi Griha Prakashan</td></tr>
</table>

<table>
<tr><td>Subject Code
CV252</td><td colspan="2">Building Materials and Construction Technology</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To introduce various types of building materials used in construction
• Study of different types of foundations, foundation failures and remedial measures
• Identify the construction materials required for the assigned work.
• Provide procedural knowledge of the simple testing methods of cement, lime and concrete etc.
• Study of materials and methods of sound proof construction.</td></tr>
<tr><td colspan="4">Building Materials: Bricks, Stone, Timber, Plywood, Steel: Classification, Properties and selection criteria. Cement, Aggregate, Admixture: Types, Properties and selection criteria and tests. Concrete: Preparation and properties. Mortar: Types, classification and strength, I.S. specifications.

Foundations: Brief study of different types of foundations, nature of soil (expansive or non-expansive, alluvial or residual, sandy or clayey for settlement etc.), approximate values of bearing capacities, breadth and depth of foundation, typical cross sections for foundations under walls and R.C.C. Columns. Foundations in black cotton soils, under reamed pile foundations, foundation failures and remedial measures.

Masonry: Technical terms in masonry, classification and brief specifications of stone masonry, bonds in brick masonry, general principles to be observed in stone and Brick Masonry Construction.

Walls: Different types (load bearing, cavity-walls and partition walls), thickness considerations. Doors, Windows and Lintels: Different types based on materials and methods of construction, technical terms, size and locations.

Floors: Ground and upper floors, various types, their suitability, construction details of concrete and terrazzo floors, Floor tiles. Roofs: Technical terms and different types of pitched and flat roofs. Various roof coverings for pitched and flat roofs.

Formwork: Different types of formwork, stripping times.

Damp Proofing: Causes and effect of Dampness, parts of a building likely to be affected most, methods of damp proofing in different locations including roofs. Plastering And

Plastering and Pointing: Types and considerations during plastering and pointing.

Stairs: Types based on geometry and material, suitability, proportioning of stairs, lifts and escalators.

Sound Proofing: Materials and Methods of sound proof construction.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. Building Construction, B.C. Punmia (Laxmi Publication Pvt. Ltd.)
2. Building Construction, Sushil Kumar (Standard Publication Distributors)
3. Building Construction, S. C. Rangwala (Charotar Publishing House, Anand, Gujarat)
4. Building Construction, Gurucharan Singh (Standard Publication Distributors)
5. Arora, S.P. A text book of Building Construction, Dhanpat Rai and Sons
6. Jha, J and Sinha, S.K. Building Construction. Khanna Publishers, Delhi
7. Kulkarni, C.J. A text Book of Engineering Materials. Ahmedabad Book Depot
8. Kulkarni, C.J. A text Book of Engineering Construction. Ahmedabad Book Depot
9. Kumar Sushil, "Building Construction", Distributors Delhi Standard Publishers
10. McKay W.B. Building Construction Distributors, Delhi Vol. 1 to 4, Orient Longman Ltd., Hyderabad</td></tr>
</table>

<table>
<tr><td>Subject Code
CV253</td><td>Environmental Engineering-I</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand importance and necessity of water supply scheme.
• Outlining the process of water supply from source to the end user.</td></tr>
</table>

Introduction: Necessity and importance of water supply schemes.

Water demand: Classification of water demands, Estimation of quantity of water required by a town, per capita demand, factors affecting per capita demand, design period and population forecasting, variation in water demand.

Sources of water supply: Surface sources and underground sources, Intake works, site selection, type of intake works.

Quality of Water: Common impurities, physical, chemical and biological characteristics of water, water quality standards for municipal and domestic supplies.

Water Processing: Object of water processing, flow diagrams of typical ground water system and surface water systems.

Sedimentation: Theory of sedimentation, sedimentation tanks and its types, design parameters related with sedimentation tanks, sedimentation with coagulations, coagulants and coagulant aids, Jar test for determining coagulant dosage.

Filtration: Theory of filtration, slow sand and rapid sand filters, Construction and operation.

Disinfection: Methods of disinfection, Chlorination, Types of chlorination, Break Point chlorination.

Softening: Methods of Softening, Iron Removal, Fluoridation.

Distribution System: Methods of distribution, layout of distribution system, methods of analysis, pressure in the distribution system, distribution reservoirs, functions and its types, storage capacity of distribution reservoir.

Plumbing: Plumbing designs for a typical building.

<table>
<tr><td>Text/Reference Books</td><td>1. S.K. Garg, Water Supply Engineering, Khanna Publication
2. B.C. Punmia, Water Supply Engineering, Laxmi Publication, New Delhi
3. Peavy & Rowe, Environmental Engineering, Tata McGraw Hill, New Delhi
4. Henry and Heinke, C P H E E O Manual on Water Supply and Treatment Environmental Science and Engineering, Pearson Education</td></tr>
</table>

<table>
<tr><td>Subject Code
CV254</td><td>Geotechnical Engineering-I</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand the fundamentals of Soil Mechanics
• To acquire proper knowledge about the basic, index and engineering properties of soils.</td></tr>
</table>

Introduction: Introduction to Geotechnical Engineering; Unique nature of soil; Soil formation and Soil types.

Soil Properties: Basic Definitions; Phase relations; Index properties of soil-soil grain and soil aggregate properties of coarse grained and fine-grained soils.

Soil Classification: Indian Standard Soil Classification System, AASHTO, Unified Soil Classification.

Permeability: One dimensional flow; Permeability of soils-Darcy's law; Permeability as a function of soil type, void ratio, soil fabric, and effective stress; Two dimensional flow problems- steady flow, confined flow and unconfined flow; Flow nets and their characteristics; Uplift pressure; Exit gradient; Failure due to piping; Criteria for design of filters; Quick Sand; Liquefaction.

Compaction Behavior: Clay minerals (basic concepts) and soil structure; Theory of compaction and compaction control.

Compressibility and Consolidation Behavior: Compressibility-Effects of soil type, stress history and effective stress on compressibility; Consolidation-Factors affecting consolidation and compressibility parameters; Different forms of primary consolidation equation; Transient flow condition; Terzaghi's theory of one-dimensional consolidation and time-rate of consolidation; Evaluation of compressibility and consolidation parameters from consolidation.

Principle of Effective Stress and related Phenomena: Principle of effective stress; Capillarity; seepage force and quick sand condition; Total pressure and elevation heads.

Stress Due to Applied Load: Introduction; Stress-Strain parameters; Geo-static Stresses; Vertical stress due to concentrated loads; Isobar diagram; Vertical Stress distribution on a horizontal plane; Influence Diagram; Vertical stress distribution due to line load, strip load, circular area, rectangular area; Newmark's Influence charts.

Shear Strength Behavior: Introduction; Stress at a point and Mohr's stress circle; Mohr-Coulomb failure criterion; Laboratory tests for shear strength determination; Effective stress and total stress shear strength parameters; UU, CU and CD tests and their relevance to field problems; Shear strength characteristics of normally consolidated and pre-consolidated clays; Shear strength characteristics of sands.

<table>
<tr><td>Text/Reference Books</td><td>1. Gopal Ranjan and Rao, Basic and Applied Soil Mechanics, A.S.R New Age International, New Delhi
2. Terzaghi, K, and Peck, Soil Mechanics in Engineering Practice, R.B John Wiley, New York, 1968.
3. Arora, K.R., Soil Mechanics and Foundation Engineering, Standard Publishers & Distributors, New Delhi.</td></tr>
</table>

<table>
<tr><td>Subject Code
CV255</td><td>Surveying Lab</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To understand and study different types of instruments for surveying.
• Traversing and ranging different terrains.
• Plotting the cross section of a terrain.</td></tr>
<tr><td colspan="3">• Compass surveying
• Plane table surveying; Radiation, intersection-Traverse-Resection, Two point and Three-point problems.
• Levelling: Fly levelling and contouring
• Subtense Bar
• Theodolite surveying:
    o Single and two plane observation of trigonometric levelling
    o Determination of Tacheometric Constants
    o Tangential Tacheometry
• Total station- Demonstration and simple exercises-calculation of area, heights and distances.</td></tr>
<tr><td>Reference books</td><td colspan="2">1. Punmia, B.C., Surveying (Vol. I & II), Laxmi Publications, New Delhi,1996
2. Kanetkar T.P., Surveying (Vol. I & II), Pune Vidyarthi Griha Prakashan, Pune</td></tr>
</table>

<table>
<tr><td>Subject Code
CV256</td><td>Material Testing Lab-II</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To study the different tests on cement, its physical and chemical properties.
• The students will be able to conduct the tests on tiles.
• The students will be able to conduct tests on concrete and its constituents
• To study mix design.</td></tr>
<tr><td colspan="3">• Studies on Cement- physical and chemical properties
• Tests on Concrete and Concrete making materials: Green and hardened concrete
• Mix Design
• Tests on Tiles</td></tr>
<tr><td>Reference Books</td><td colspan="2">1. Timoshenko and Gere, Mechanics of Materials, CBS Publishers, New Delhi, 1996.</td></tr>
</table>

<table>
<tr><td>Subject Code
CV257</td><td colspan="2">Geotechnical Engineering Lab</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• Explain the procedures of laboratory tests used for determination of physical, index and engineering properties of soils.
• Classify soil based on test results and interpret Engineering behavior based on test result.
• Evaluate the permeability and shear strength of soil.
• Evaluate settlement characteristics of soils.
• Evaluate compaction characteristics required for field application.
• Evaluate the subgrade strength by conducting CBR test.</td></tr>
<tr><td colspan="4">Following 9 topics can be suitably combined into 6 experiments
1. Grain Size analysis of Soil by Sieve.
2. Specific Gravity of Soil.
3. Grain size analysis of Soil by Hydrometer.
4. Field Density of Soil (Two Methods)
5. Atterberg Limits of Soil (Two methods)
6. Permeability test of Soil.
7. Consolidation Test of Soil.
8. Determination of moisture content by rapid moisture meter.
9. Standard Proctor test of Soil.

Following 6 topics can be suitably combined into 4 experiments
1. Direct Shear Test.
2. Triaxial Test for Different Drainage Condition.
3. Standard Penetration test of Soil and Static Cone Penetration Test.
4. Dynamic Cone Penetration test.
5. Plate load test.
6. Block vibration test.</td></tr>
<tr><td>Reference Books</td><td colspan="3">1. Alam Singh, Soil Testing and Instrumentation, New Age International, New Delhi, 1998. (Revised Edition),</td></tr>
</table>

V Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	CV300	Structural Design-I (RCC)	3-0-0	3
2	CV301	Structural Analysis-II	3-0-0	3
3	CV302	Transportation Engineering-I	3-0-0	3
4	CV303	Geotechnical Engineering-II	3-0-0	3
5	ES301	Environmental Studies	1-0-0	1
6	HU300	Professional Communication-II and Language Lab	2-0-3	3
7	HS300	Economics	3-0-0	3
8	CV304	Transportation Engineering Lab	0-0-3	2
9	CV305	Building Design and Drawing Lab	0-0-3	2
			Total Credits	**19+4**

Subject Code CV300	# Structural Design-I (RCC)	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To introduce to students the theory and application of analysis and design of reinforced concrete structures using Limit state method. • To understand the designing concepts of various components of a building.	

Introduction: Structures and structural systems–Internal forces in different types of structural systems such as Trusses, Cables, Arches, Beams and Slabs, Frames, stability criteria, design considerations, Different loadings, loading standards Design philosophy: Working Stress Method, Ultimate load method, probabilistic analysis and Limit State method - Limit state of collapse, Limit state of serviceability.

Limit state of collapse: Flexure Assumptions, moment capacity of rectangular and flanged sections - singly and doubly reinforced sections - design tables and charts, critical sections for bending in important structural elements such as slabs, beams, retaining wall, footings, staircase etc.

Limit state of Serviceability: Deflection, short term and long term deflection- cracking.

Limit State of Collapse: Shear Nominal shear stress- design shear strength of concrete, design of shear reinforcement, critical sections for shear in important structural elements such as beams, retaining walls, footings etc. Design of slabs, beams, retaining walls, footings and stair case. Limit State of Collapse: Torsion General, critical section, equivalent shear and bending moment– reinforcement for torsion.

Design of columns: Compression Analysis and design of columns of rectangular and circular cross sections - axially loaded columns - columns with uniaxial and biaxial eccentricity using SP 16 design charts - short and slender columns.

Introduction to EQ design and detailing: Concept of Seismic design - Approach to earthquake resistant design, General principles of a seismic design, Review of IS 1893:2002, Guide lines for earthquake resistant design, Ductile detailing for seismic design.

Text/Reference Books	1. Dayaratnam,P, Sarah P, Design of Reinforced Concrete Structures:, Medtech Publishers,2018 2. Sinha & Roy, Fundamentals of Reinforced Concrete:, S. Chand and Co. Ltd., 2007 3. V. L. Shah and S. R. Karve, Illustrated Reinforced Concrete Design: Structure Publications,Pune. 4. Ferguson, P. M., Breen, J. E., and Jirsa, J. O., Reinforced Concrete Fundamentals:, John Wiley & Sons (1988) 5thEdition. 5. Pillai, S.U. and Devdas Menon, Reinforced Concrete Design: Tata Mc-Graw Hill Publishing House,2017 6. S.N. Sinha, Reinforced Concrete Design, Tata Mc-Graw Hill Publishing House, New Delhi. 7. N. Subramanian, Theory of Reinforced concrete structures, Oxford University Press. 8. Punmia, B. C., Jain, A. K., and Jain, Arun, K., RCC Design (WSM and LSM): Laxmi Publications. 9. Relevant IS codes

<table>
<tr><td>Subject Code
CV301</td><td>Structural Analysis-II</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To impart the principles of elastic structural analysis and behaviour of indeterminate structures
• Formulate Equilibrium and compatibility equations for structural members
• To understand the structural behavior before and after application of loads.</td></tr>
<tr><td colspan="3">Slope Deflection Method: Development of slope-deflection equations and analysis of fixed beam, continuous beam and simple frame without and with translation of joints.

Moment Distribution Method: Definition of terms-Distribution factor, Carry over factor, Development of method of analysis of fixed beam, continuous beam and simple frame without and with translation of joints.

Kani's method - Application to continuous beams and portal frames (Single bay two storey; column analogy method

Flexibility method of structural Analysis: Flexibility Coefficient, Analysis of truss, beams and portal frames by using flexibility method.

Stiffness methods of structural Analysis: Stiffness Coefficient, Analysis of truss, beams and portal frames by using stiffness method.

Plastic Analysis: Basics of Plastic Analysis, Application of Static and Kinematic theorem for plastic analysis of beams and plane frames.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. S.S Bhavikatti, Structural Analysis II, Vikas Publishing House; Fourth edition, 2013
2. S Ramamrutham, Theory of Structures, Dhanpat Rai Publishers, Ninth edition, 2014
3. Nirris and Wilbur, Elementary Structural Analysis, Tata McGrawHill
4. Ghali A and Neville M ,Structural Analysis, , Chapman and Hall
5. RC Hibber, Structural Analysis, , Pearsons Publication
6. Reddy CS ,Basic Structural Analysis, , Tata McGraw Hill
7. Wang CK , Indeterminate Structural Analysis, Mcgraw Hill
8. Kinney J S , Indeterminate Structural Analysis, McGraw Hill
9. Weaver W and Gere JM Weaver, Matrix Analysis of Framed Structures,. CBS Publishers Delhi
10. Neal BG, Plastic Method of Structural Analysis, Chapman and Hall</td></tr>
</table>

Subject Code CV302	Transportation Engineering-I	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• Plan and design highway geometrics • Analyze and design flexible and pavements • To understand the concepts of design, construction and maintenance of roads	

Highway Development and Planning: Importance of Transportation, Classification of roads, Road patterns, Highway Planning; Necessity of highway planning, Need for Highway alignment; Factors controlling alignment, Planning surveys, Preparation of plans, Interpretation of planning surveys, Preparation of master plan, Highway planning and Development in India, Preparation of detailed project reports, Environment impact assessment.

Highway Cross Section Elements: Carriageway, Shoulders, Formation, Road Margins, Width of roadway, Right of way; Kerbs, Foot paths, Medians service ducts - Design specifications; Pavement Surface characteristics; Skid resistance, Factors affecting skid resistance, Measurement of skid resistance; Road roughness, Measurement of road roughness; Camber, Objectives of camber, Design standards. Typical cross section of road –cuttings, Embankment, Hilly areas, 6 lane expressway, Divided highway.

Geometric Design of Road: Factors influencing geometric design elements, Types of sight distances and Significance, Analysis of sight distances, Horizontal Alignment: Requirements, Super elevation, Methods of attainment of super elevation, Extra widening of curves, Transition curves, Types, Length of transition curve. Vertical Alignment: Types of gradients, Grade compensation on curves, Vertical curves Intersections: Types, At-grade Intersections, Channelization, Objectives; Traffic islands.

Design, Construction and Maintenance: Types of pavements and its components, Factors influencing the design of pavements, Wheel load applications, pavement design traffic, Subgrade strength and Characteristics. Construction of Roads: Bituminous concrete, Cement concrete, Cement stabilized roads, Brief study of types and Uses of failures in flexible and Rigid pavements and Maintenance, Strengthening of existing pavements, Modern methods of road construction. And recent innovations

Design of Flexible Pavements: Methods, IRC guidelines, CBR method of design, Group index method.

Design of Rigid Pavements: Factors affecting design, Stresses in rigid pavements, IRC method of design, Joints in Rigid pavements, Design of joints,

Failures in pavements: Brief study of failures in flexible and Rigid pavements and Maintenance, strengthening of existing pavements, Overlays, Worked out problems.

Text/Reference Books	
	1. C. E. G. Justo and S. K. Khanna, Veeraraghvan; Highway Engineering; Nem Chand and Brothers.10thedition,2018 2. L. R. Kadiyali; Highway Engineering; Khanna Publishers, New Delhi,2019 3. Ministry of Road Transport and Highway; Specifications for Roads and Bridges, IRC, New Delhi. 4. IRC 104: Guidelines for Environmental Impact Assessment of Highway. 5. IRC SP: 63-2004 "Guidelines for Use of Interlocking Concrete Block Pavement", Indian Roads Congress. 6. Subhash C. Saxena; Highway and Traffic Engineering; CBS publishers and distributors New Delhi. 7. James H. Banks; Transportation Engineering; Mc. Graw. Hill Pub. New Delhi. 8. James H. Banks; Transportation Engineering; Mc. Graw. Hill Pub. New Delhi.

<table>
<tr><td>Subject Code
CV303</td><td>Geotechnical Engineering-II</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Analyze the stability of finite and infinite slopes
• Understand the concept of bearing capacity of shallow foundations
• Analyze the causes and remedial measures of total and differential settlements
• Analyze shallow and deep foundations
• Understand the basic concepts of caissons and machine foundations</td></tr>
<tr><td colspan="3">Stability of Slopes: Concept of limit, Equilibrium method, Stability of slopes; Introduction, Different factors of safety, Types of slope failures, Analysis of finite and Infinite slopes, Wedge failure, Swedish circle method, Friction circle method, Method of slices for c-Φ soil, Stability numbers and Charts, Taylor's Stability number and Stability curves, Bishops method of slices.

Bearing Capacity: Definition, General shear and Local shear failure, Terzaghi bearing capacity equation for shallow foundation, Effect of water table on bearing capacity, Bearing capacity for layered soils, IS Code method of determination of bearing capacity, Factors influencing bearing capacity, Introduction to Meyerhof's bearing capacity theory, Use of plate load test, Pressure-meter test and SPT and CPT in assessing safe bearing capacity. Calculation of bearing capacity using bore log data - a case study.

Settlement Analysis: Definition, Types of settlements, Computations based on theory and Test results, Effect of width and Depth of foundation, Construction time settlement, Components of settlements and their estimation, Allowable settlement values, Effects, Causes and Remedial measures of total and Differential settlements, Permissible settlements as per I.S.

Shallow Foundation: Types of foundations and Choice, Basic requirements, Minimum depth of foundation, Contact pressure distribution, Isolated square and Rectangular footing, Combined rectangular, Trapezoidal and Strap footing and Raft foundation. Pressure distribution below mat foundation

Pile Foundation: Classification and uses, Load carrying capacity calculations of single pile by different methods, Static and Dynamic approach, In-situ penetration tests, Pile load tests, Initial and Routine, Negative skin friction, Under-reamed pile foundations; Pile groups, Necessity, E-Efficiency, Group capacity and Settlements.

Caisson and machine foundations: Introduction, Shapes of wells and Component parts, types of machine foundation, vibration isolation</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. K. R. Arora Soil mechanics and foundation engineering, Standard Publishers, 2014.
2. B. C. Punmia; Soil Mechanics Foundations; Laxmi publications, Pvt.Ltd.
3. Alam Singh; Modern Geotechnical Engineering; CBS Publishers and distributors, 3rd edition,2006
4. S. P. Brahma; Foundation Engineering; Tata McGraw Hill.
5. Swami Saran; Design of Sub-Structures; CRC press.
6. Bowles J. E.; Foundation Analysis and Design; McGraw Hill Pub. Co., New York.
7. Craig R. F.; Soil Mechanics; Chapman and Hall.
8. Purshottam and Raj; Soil Mechanics and Foundation; Pearson Education.
9. Braja M. Das; Principles of Foundation Engineering, Cengage Learning, 7th edition, 2013.
10. Relevant IS Codes</td></tr>
</table>

Subject Code ES301	Environmental Studies	Credits: 1 (1-0-0) Total hours: 14
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.	

Introduction: Multi-disciplinary nature of environmental studies: Definition, scope and importance, Need for public awareness.

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.

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).

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.

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.

Text/Reference Books	1. Erach Bharucha, Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education (online book -UGC Website), , University Grants Commission ,India. 2. Anil Agarwal, Dying Wisdom, Publisher: Centre for Science and Environment, Edi:1st,1997, ISBN-139788186906200; ISBN-108186906207 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

<table>
<tr><td>Subject Code
HU300</td><td>Professional Communication-II and Languages Lab</td><td>Credits: 3 (2-0-3)
Total hours: 42</td></tr>
<tr><td>Course Prerequisite</td><td colspan="2">• Knowledge of English</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• This course aims at Personality Development. Towards the end of the course, the students should possess a Saleable Image with employability skills.</td></tr>
<tr><td colspan="3">Principles of Soft Skills and Practice: Definition of Soft Skills and Personality, Attitude, Dress Code, Body Language, Individual and Group Behavior, Personality Test, C.V Writing and the difference between CV & Resume

Group Discussion, Extempore, JAM and Survey: 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

Interview: Types of Interview, Interview Ethics, Questions and Mock-Interview Sessions

Business Presentation and Seminars: Business Presentation and Students' Seminar</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">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)
4. 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</td></tr>
</table>

Subject Code HS300	# Economics	Credits: 3 (3-0-0) Total hours: 42
Course Prerequisites	• Basic concept of macroeconomic & Indian Economy.	
Course Objectives	• To develop the ability to understand and analyze the broad macroeconomic scenario and its dynamism	

Introduction to Economics: Constructing a Model, Optimization and Equilibrium in market demand and supply, Comparative statistics and asset allocation.

Budget Constraint and Consumer Preference: 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.

Choice and Demand: Optimal Choice, Consumer demand, Implication of MRS conditions, Normal and Inferior Goods, Income Offer Curves and Engel Curves, The Price Offer Curve

Technology: From 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

Profit Maximization: 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.

Cost Function: Cost Minimization, Revealed Cost Minimization, Returns to Scale and the Cost Function, Average Costs, Marginal Costs, Marginal Costs and Variable Costs.

Markets: Monopoly, Maximizing Profits, Linear Demand Curve and Monopoly, Markup Pricing, Oligopoly and Choosing a Strategy, Price Leadership, Comparing Price Leadership and Quantity Leadership.

National Income Accounting: National Income and Related concepts, Nominal or real GDP, Methods of measuring NI.

Determinants of Equilibrium Output: Aggregate demand and Equilibrium output, Consumption function and aggregate demand, Multiplier, Govt. sector, Budget and Full employment

Money, Interest and Income: The goods market and is curve, The Asset market and LM Curve, Equilibrium in Goods band asset market and Adjustment towards equilibrium.

Monetary and Fiscal Policy: Monetary policy, Fiscal Policy, crowding out, Composition of output and policy mix and implementation

Text/Reference Books	1. Varian, Hal R.: Intermediate Microeconomics, W.W. Norton & Co., New work (ISBN:0393978303) 2. Koutsoyiannis, A.: Modern Microeconomics, 2nd ELBS/Palgrave Macmillan, London (ISBN:0333778219) 3. Dornbusch and Stanley Fisher: Macroeconomics, Mc Graw Hill 4. Barro Robert J. “Macroeconomics, New York, John Wiley.

Subject Code CV304	**Transportation Engineering Lab**	Credits: 2 (0-0-3) Total hours: 42

Course Objectives

- Characterize the pavement materials
- Perform quality control tests on flexible pavements and flexible pavement materials

List of Experiments: At least 8 experiments should be conducted from the below list of experiments.

1. To determine Grain size analysis of fine and coarse aggregates.
2. To determine flakiness and elongation Index of aggregates.
3. To determine Los Angeles Abrasion value.
4. To determine Impact value for aggregates.
5. To determine Crushing value for aggregates.
6. To determine the softening point of bitumen.
7. To determine ductility value of bitumen.
8. To determine Penetration test for bitumen.
9. To determine Bitumen content in the given mix.
10. To determine the Marshall stability value of the given mix.

Reference Books

1. L.R. Kadiyali, Principles and Practices of Highway Engineering, Khanna Publishers, 2009
2. MoRTH (2013) Specification for Road and bridge works (5^{th} revision)
3. MS-2 manual (2015) Seventh edition, Asphalt Institute.
4. S. K. Khanna, C. E. G. Justo, A Veeraragavan, Highway Engineering, Khanna Publishers, 10^{th} edition

<table>
<tr><td>Subject Code
CV305</td><td>Building Design and Drawing Lab</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To Visualize, sketch and accurately draw the components in order to communicate information to specific audiences.
• To know various rules and regulations of planning pertaining to Public Buildings.
• To learn usage of softwares like Auto-CAD in drafting.</td></tr>
<tr><td colspan="3">• Bubble diagrams, Line diagrams for planning and drawing of different public buildings, commercial buildings, residential etc.
• Planning and drawing of residential buildings-site plans using bye laws (National building codes)
• Planning and drawing of public buildings.
• Computer aided drawing, use of AutoCAD for building planning, preparation of site plan, Plumbing and Electrical drawings</td></tr>
<tr><td>Reference Books</td><td colspan="2">1. M.G. Shah, C.M. Kale and Patki, Building Drawing, Tata McGraw Hill Publishers, Delhi
2. Chakraborty M, Monojit Chakraborty, Civil Engineering Drawing: Publication, Kolkata
3. B.T.S. Prabhu, K.V. Paul and C. Vijayan, Building Drawing Detailing, SPADES Publications, Calicut, Kerala
4. Y.S. Sane, Planning Designing Buildings, Modern Publication House, Pune</td></tr>
</table>

VI Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	CV350	Structural Design-II (Steel)	3-0-0	3
2	CV351	Water Resource Engineering	3-0-0	3
3	CV352	Transportation Engineering-II	3-0-0	3
4	CV353	Environmental Engineering-II	3-0-0	3
5	CV5**	Elective-I	3-0-0	3
6	HS350	Management	3-0-0	3
7	CV354	Minor Project	0-0-3	2
8	CV355	Structural Design and Drawing Lab	0-0-3	2
9	CV356	Environmental Engineering Lab	0-0-3	2
			Total Credits	**24**

Subject Code CV350	# Structural Design-II (Steel)	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• Learn the basic elements of a steel structure and the fundamentals of structural steel fasteners • Able to design basic elements of steel structure like tension members, compression members, beams and beam-columns • Able to design column splices and bases.	

Introduction to Steel Structure: Introduction to type of steel, mechanical properties of Structural steel, advantages of steel as structural material, design philosophies of Working Stress Method (WSM), Limit state Method, limit state of strength serviceability (deflection, vibration, durability, fatigue, fire) characteristics, partial safety factor design loads, partial safety factor for material. Structural steel section. Classification of cross section-plastic, compact, semi-compact slender, limiting width to thickness ratio.

Simple Connection Bolted & Welded: Introduction to bolted welded connection by working stress method and limit state method, Type of bolts, advantage of bolts & welds, simple connection for bolted and welded connection.

Tension Members: Design of tension members with welded and bolted end connection using single angle section & double angle section by Limit State Method, design strength due to yielding of gross section, rupture of critical sections and block shear.

Compression Members - Struts: Design of compression members as struts with welded /bolted end connection using single angle sections & double angle section by Limit State Method. Effective length of compression members, buckling class of various cross sections, limiting values of effective slenderness ratio.

Compression Members -Column: Design of column with single built-up section, design of lacing batten plates with bolted & welded connection using Limit State Method, column buckling curves, effective length of compression members, buckling class of various cross sections, limiting values of effective slenderness ratio.

Bracket Connection Beam to Column Connection: Bolted welded connection by Limit State Method, beam to beam, beam to column connection (simple frame connection, unstiffened and stiffened seat connections.

Column Bases: Design of slab bases & gusseted base using bolted /welded connection

Text/Reference Books

1. William T. Segui, LRFD Steel Design: PWS Publishing
2. Edwin H. Gaylord, Charles N. Gaylord James, Stallmeyer, Design of Steel Structures:, Mc-Graw-Hill
3. Dayaratnam P, Design of Steel Structures, S Chand, 1stedition,2012.
4. Punmia, A. K. Jain and Arun Kumar Jain, Comprehensive Design of Steel Structures:, Laxmi Publication, 2ndedition,2015
5. Kazimi S. M. and Jindal R. S , Design of Steel Structures, Prentice Hall India.
6. Breslar, Lin Scalzi, Design of Steel Structures, John Willey, NewYork.
7. Arya and Ajmani, Design of Steel Structures: Nem Chand and Bros., Roorkee
8. Sarwar Alam Raz, Structural Design in Steel:; New Age International Publisher
9. Relevant Indian Specifications, Bureau of Indian Specifications, New Delhi

Subject Code CV351	# Water Resources Engineering	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To gain basic knowledge of Hydrology. • To understand the design parameters of reservoir and dams, operation and sedimentation, failure and control. • To understand various irrigation techniques and requirements of the crops. • To get an insight of Distribution systems for canal irrigation, design of unlined and lined irrigation canals design sediment problems associated with canal.	

Introduction: Necessity, Planning, C-B ratio, Inter and Intra basin transfer, Different methods of irrigation, Irrigation from ground water deep and Shallow wells, Tube wells. Water Requirement of Crops; Duty and Delta, Base period of crops, Factors affecting duty, Methods of improving duty, Crop seasons in India

Basic Hydrology: Hydrological cycle, Precipitation, Analysis of data, Supplementing missing data, Consistency of record, Hyetograph, Mass curve analysis, Measurements of rainfall, evaporation and Evapo-transpiration, Infiltration and Soil moisture, Stream flow measurement; Runoff, Factors affecting runoff, Catchment classification, Flood estimation, Hydrograph, Unit hydrograph Synthetic unit hydrograph, S-curve, Unit hydrograph of varied durations, Instantaneous unit hydrograph, Conceptual models. Computation of peak flow, Flood Routing

Storage Reservoirs: Physical characteristics of reservoirs, Reservoir capacity for a given yield, Mass curve, Reservoir reliability, Sedimentation control, Reservoir leakage, Ideal site for reservoir.

Dams: Types of Dams, Suitability of a type of dam. Forces acting on dams, Failure of dams and criteria for structural stability, Principal and Shear stress, Stability analysis, Elementary profiles, Design criteria, Causes of failures, Control of Seepage, Stability of slopes, Design considerations, for Gravity, Earth dams. High and Low gravity dams, Openings in dams, Functions and Effects of opening, Joints, Keys and Water stops in gravity dams, Foundation treatment for various dams.

Spillways and Energy Dissipaters: Introduction, Essential requirements of a spillway, Spillway capacity, Components, Types of spillways, Design of Ogee spillway, Energy dissipation below spillways.

Text/Reference Books

1. P. N. Modi; Irrigation Water Resources and Water Power Engineering; Standard Book House, 11^{th} edition (2020)
2. Punmia, Pande, Lal, A. K. Jain; Irrigation and water power Engineering; Laxmi Publications (P) Ltd, 16^{th}edition,2019
3. K Subramania, Engineering hydrology, Tata Mcgraw Hill,2017
4. V T Chow, D R Maidment and LW Mays, Applied hydrology 2017, McGraw hill
5. R. K. Sharma and T. K. Sharma; Irrigation Engineering; S Chand Publications Pvt. Ltd.
6. R. S. Varshney, Hydropower Structures; Nem Chand and Bros.
7. Basak, Irrigation Engineering; Tata McGraw Hill Publishing Ltd.(1999)
8. S. K. Garg; Irrigation Engineering and Hydraulic Structures; Khanna Publishers, Vol. 2, 1976
9. Larry W. Mayas; Water Resources Engineering; John Wiley and sons.
10. K. R. Arora; Irrigation, Water Power and Water Resources Engineering; Standard Publishers, New Delhi.

Subject Code CV352	**Transportation Engineering-II**	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To impart in-depth knowledge about the aircraft characteristics, planning and airport components. • To know the basics and design of various components of railway engineering. • To impart knowledge about methods of tunneling • To study the types and components of docks and harbours	

Airport Engineering: Airport Planning and design, Layout of an airport with component parts and Functions, Site selection for airport, Aircraft characteristics affecting the design and Planning of airport, Airport classification, Runway orientation using wind rose with examples, Basic runway length, Corrections and Examples, Runway geometrics and Design, Runway safety. Taxiway Design, Factors affecting the layout, Geometrics of taxiway, Visual aids, Airport marking, Lighting, Air traffic control, Instrumental landing system.

Railway Engineering: Importance of railways in national development, Factors controlling alignment, Engineering surveys for track alignment, Typical cross sections for single- and Double-line tracks, Gauges, Coning of wheels and Tilting of rails, Rails, Functions and requirements of component parts of railway track, Creep of rails. Sleepers; Functions and Types, Ballast; Properties, Subgrade and Formation, Geometrical design of railway track, Horizontal curves, Super elevation, Points and Crossings, Track junctions and Simple track layouts, Transition curves, Safe speed on curves, Different types gradients, Grade compensation. Modern welded railway track, Signalling and Interlocking, Railway stations and Yards, Modernization of railways, High speed trains, Ballast-less tracks.

Railway Construction and Maintenance: Construction of railway track, Earthwork, Plate laying and Packing, Maintenance of track alignment, Gauge, Renewal of component parts and Drainage, Modern methods of track maintenance.

Docks and Harbours: Classification of harbours, Components, Site selection, Construction and Maintenance of wet and dry docks, Breakwaters, Lock gates, Quays, Jetties, Landing piers, Fenders, Dolphins, Slipways, Aprons, Transit sheds, Ware houses, Navigational aids such as light house, Buoys, Beacons, Study of important harbours, Objectives of dredging, Dredging equipment, Types of dredging in different soil conditions.

Introduction to Traffic Engineering: Traffic Characteristics, Speed, Journey time and Delays, Vehicle volume counts, Origin and Destination, Analysis and Interpretation of survey data, Traffic operations, Traffic signals, Parking space, Highway lighting, Planning and Administration, Road accidents and Safety measures, Road signage, Road safety audit.

Text/Reference Books	1. Khanna, Arora and Jain, Airport Planning and Design, Nem Chand Bros, Roorkee, 6^{th} Edition (2017) 2. R. Srinivasan; Harbour, Dock and Tunnel Engineering, Charotar Publishing House (2015) 3. Horenjeff and McKelvey, Planning and Design of Airports; McGraw Hill Company, New York.,5^{th} Edition (2010) 4. Satish Chandra, M. M. Agarwal, Railway Engineering; Oxford University Press, New Delhi. (2007) 5. M. M. Agarwal, Indian Railway Track, Jaico Publications, Bombay. 6. J. S. Mundrey, Railway Track Engineering, Tata McGraw Hill, New Delhi. 7. M. M. Agrawal, Railway Engineering, Prabha and Co., Delhi. 8. Saxena and Arora, Railway Engineering, Dhanpat Rai and Sons, New Delhi. 9. H. P. Oza and G. H. Oza, Docks and Harbour Engineering, Charaotar Publishing House.

Subject Code CV353	# Environmental Engineering-II	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To impart knowledge on basic concepts about sewerage system. • To make the student understand conveyance system of sewage. • To impart knowledge on primary, secondary and tertiary treatment of sewage.	

Introduction: Definitions, Aim and Objective of sewage disposal. Methods of collection–conservancy system and Water carriage system. Sewerage Systems; Separate, Combined and Partially separate systems.

Quantity of Sanitary Sewage: Source, Factors affecting sanitary sewage, Variation in quantity of sanitary sewage, Peak flow and Minimum flow, Determination of flow velocity using empirical formulae.

Quantity of Storm Sewage: Factors affecting storm sewage, Quantity of storm water-rational method, Empirical formulae, Rainfall intensity curves.

Characteristics of Sewage: Physical, Chemical and Biological characteristics of sewage, sampling methods, Decomposition of sewage, Dissolved oxygen, Bio chemical oxygen demand, Expression for B.O.D and C.O.D.

Treatment of Sewage: Classification of treatment processes, Layout of treatment plants, Factors to be considered while designing a sewage treatment plant.

Physical Unit Operation: Design and Description of Screens, Grit chambers, Skimming tanks, Grease traps, Sedimentation tanks.

Biological Unit Process: Activated sludge process, its concepts, Design and Operation of aeration tanks, Types of aerators. Trickling filters, their classification, Geometry, Design and Operation, their operational difficulties and Remedies, Oxidation ponds, their classification, and Geometry \ Aerobic ponds. Lagoons, Oxidation ditches, SBR.

On- Site Sanitation: Septic tank, Imhoff tanks.

Sewage Disposal: Reuse of treated effluent, Disposal by dilution, Disposal on land, Water.

Sewer Appurtenances: Manholes, Drop manholes, Street inlets, Flushing tanks, Catch basin, Sand traps.

Solid and hazardous waste management Sources: Types , composition, Physical biological properties of solid wastes, sources types of hazardous infectious wastes in municipal solid wastes Solid waste generation collection, storage, handling , transportation, processing Treatment disposal methods Material separation recycle, physical-chemical biological stabilization solidification thermal methods, of disposal, site remediation, leachate & its control. Effects of hazardous waste on environment & its disposal.

Text/Reference Books	1. Peavy and Rowe, Environmental engineering McGraw Hill, 2017 2. Kiely, Environmental engineering, Prentice hall, 2015 3. CPHEEO manual on sewage and sewage treatment 4. Metcalf and Eddy, Waste water Engineering; McGraw-Hill Education. 5. Wentz, Solid and hazardous waste management, McGraw-Hill Education (ISE Editions); International 2 Revised edition1995) 6. S. K. Garg, Sewage and Waste Disposal Engineering, Khanna Publishers. 7. Ernest W. Steel, Water supply and Sewage, McGraw-Hill Education. 8. B. S. Raju, Water supply and Waste Water Engineering, Tata McGraw-Hill

<table>
<tr><td>Subject Code
HS350</td><td>Management</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Prerequisites</td><td colspan="2">• Basic concept of monetary economic, financial concepts and Basic statistics.</td></tr>
<tr><td>Course Outcome</td><td colspan="2">• Develops the ability to understand and analyze the broad aspect of management and its financial dynamism</td></tr>
<tr><td colspan="3">Principles of Accounting: Accounting Cycle, Assumptions, Classifications of Accounts-Journal, Cash Book, Ledger, Final Accounts-Manufacturing Account, Trading Account, P & L Account, Balance Sheet.
Financial Statement Analysis: Balance sheet, Profit and Loss Account, Economic vs Accounting Profit, Changes in Financial Position, Funds flow and cash flow statement.
Ratio Analysis: Nature of Ratio Analysis, Liquidity Ratio, Leverage Ratio, Activity Ratio, Profitability Ratio, DuPont Analysis, Comparative statement and Trend Analysis, Inter-firm Analysis.
Working Capital: Concept of working Capital, Operating and Cash conversion Cycle, Permanent and Variable working Capital, Balance working capital position and Issues.
Time Value of Money: Time preference for money, Future value, Annuity, Perpetuity, Sinking fund factor, Present value, Annuity, Perpetuity, capital recovery factor, Multiple period Compounding.
Capital Budgeting: 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, and decision points.
Financial System: Introduction to Indian Financial System, Financial Institutions and Financial Markets.
Industrial Engineering & Project Management: Work Study, Time Study, Industrial Psychology, Project Management (PERT, CPM)</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. I.M Pandey, Financial Management, 10th edition, Vikish Publication
2. Brealey Y Myers, Principles of Corporate Finance, McGraw-Hill
3. Rajiv and Anil, Financial Management, 2nd Edition, Oxford UniversityPress
4. L.M Bhole, Financial Institutions and Markets, Tata McGraw-hill</td></tr>
</table>

<table>
<tr><td>Subject Code
CV355</td><td>Structural Design and Drawing Lab</td><td>Credits: 2 (0-0-3)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To study about bolted and welded connection.
• To learn about the detailing of slab base structure, plate girder, beams, columns, footings and slabs
• To make students understand about the beam column connections.</td></tr>
<tr><td colspan="3">• Detailing of different types of bolts and welds.
• Bolted and welded connection detailing.
• Detailing of a truss structure.
• Detailing of slab base connected with primary and secondary beams, resting on columns.
• Detailing of plate girder.
• Detailing of beams, columns, footings and slab, stairs for RCC Beam column connections</td></tr>
<tr><td>Reference Books</td><td colspan="2">1. N. Subramanian, Design of steel structures, Oxford higher education, (2008)
2. Relevant IS Codes</td></tr>
</table>

Subject Code CV356	**Environment Engineering Lab**	Credits: 2 (0-0-3) Total Hours: 42
Course Objectives	• To conduct experiments and determine the physical, chemical and biological characteristics of water and wastewater. • Compare the experimental results with standards and deliberate based on the purpose of analysis. • Determine type & degree of treatment, for water and wastewater. • Relate the significance of experimental results in environmental engineering practices.	
List of Experiments (At least 8 experiments to be performed)	1. Determination of solids (total, dissolved, suspended, organic, inorganic, settleable) in water. 2. Determination of pH 3. Determination of fluoride, 4. Determination of iron, 5. Determination of turbidity 6. Determination of Acidity and Alkalinity 7. Determination of Chlorides 8. Determination of Dissolved oxygen content in water 9. Determination of Biochemical Oxygen demand 10. Determination of Chemical Oxygen demand 11. Determination of sludge volume index of sewage sample. 12. Microbiological studies	
Reference Books	1. Lab Manual, ISO 14001 Environmental Management, Regulatory Standards for Drinking Water and Sewage disposal. 2. Clair Sawyer and Perry McCarty and Gene Parkin, "Chemistry for Environmental Engineering and Science", McGraw-Hill Series in Civil and Environmental Engineering. 3. Guide manual: Water & wastewater analysis, Central Pollution Control Board, Govt. of India. 4. APHA standard methods for the examination of water and wastewater, 20th edition. 5. Water supply engineering, S.K. Garg- 30th Edition.	

VII Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	CV400	Profession Practice (Construction Planning and Management)	3-0-0	3
2	CV401	Estimation, Costing & Specifications	3-0-0	3
3	CV5**	Elective-II	3-0-0	3
4	CV5**	Elective-III	3-0-0	3
5	CV402	Mini Project/Industrial training	0-0-3	1
6	CV449	Major Project-I	0-0-4	4
7	CV450	Seminar	0-0-3	2
			Total Credits	**19**

<table>
<tr><td>Subject Code
CV400</td><td>Professional Practice
(Construction Planning and Management)</td><td>Credits: 3 (3-0-0)
Total Hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Analyze methods, materials, and equipment used to construct projects.
• Understand construction risk management.
• Understand construction accounting and cost control.
• Understand construction quality assurance and control.
• Understand construction project control processes.
• Understand the basic principles of sustainable construction.</td></tr>
</table>

Fundamentals of Construction Management: Fundamental components, Construction industry, Construction projects, Principles of management (Henri Fayol), Modern scientific management, Agencies associated with the construction industries in national development Main causes of project failure, project life cycle. Importance of planning, Scheduling and Controlling projects.

Project Planning Scope: Project clearance procedures and Necessary documentation for major works like dams, Multistoried structures, Ports and Tunnels, Functions and Role of Chief planner and Project management consultants.

Project Scheduling Scope: Guidelines for drawing project network, Work breakdown structure, Scheduling of bar chart and Preparing construction schedule by bar chart for small projects, Advantages and Limitations of bar chart. Time estimation in CPM, PERT, RPM (Repetitive Project Modeling) techniques and Analysis, Critical path method calculation. Factors affecting work scheduling, LOB techniques, Precedence network analysis.

Project Management Software: Hands on software in construction scheduling (MSP or Primavera).

Planning Construction Resources: Manpower: Necessity, Establishing workers productivity standards, Scheduling construction site workers, Project manpower grouping and Designing workers financial incentive scheme, Important Acts and Labour laws related to construction activity.

Materials: ABC Classification of construction materials, Materials Usage/wastage standards, Materials provisioning process, Planning materials inventory.

Project Construction Equipment: Selecting construction equipment, Classification of major equipment, Earth factor in earthwork, Earth excavating equipment, Earth cutting and Hauling equipment, Earth compacting and Grading equipment, Concreting plant and Equipment, Cranes for materials hoisting, Equipment for dredging, Trenching, Tunneling and Pile driving.

Planning Construction Costs and Construction Budgets: Classification of construction costs, Elements and Classification of cost accounting, Breakeven point, Standard ‘S’ curve forecasting tool, Fund flow v/s cash flow. Structuring responsibility centres, Costs inflation, Escalation and Contingencies, Types of budget, Techniques for budgeting, Budgetary forecasts, Project master budget.

Project Control: Control system framework, Monitoring performance, Resource productivity control, Project time and Cost control basics, Disputes and claims management, Concepts of quality control and its importance for construction work.

<table>
<tr><td>Text/Reference Books</td><td>1. K. K. Chitkara, Construction Project Management; Tata Mc GrawHill.
2. B. C. Punmia, Project Planning and Control with PERT and CPM; Laxmi Publications, NewDelhi.
3. Gautam V. Desai, Erik W. Larson, Clifford F. Grey, Project Management the Managerial Process; Tata Mc GrawHill.
4. Vazirani and Chavdale, Construction management and accounts;</td></tr>
</table>

	Khanna publications – New Delhi. 5. Patrick Charles, Construction Project planning and scheduling; Pearson. 6. V. K. Raiva; Construction Management Practice; Tata Mac-hill publication, New Delhi. 7. Robert L. Peurifoy, Construction Planning, Equipment and Method; Tata McGraw Hill Publishing Ltd. 8. G. D. Oberlender, Project Management for Engineering and Construction; Tata Mc Graw Hill Publishing Ltd.

Subject Code CV401	Estimation, Costing and Specifications	Credits: 3 (3-0-0) Total Hours: 42
Course Objectives	• To read, understand and interpret plans, sections, detailed drawings and specifications for a construction project. • To study the various methods of detailed and approximate estimates. • To emphasize the importance of relevant IS: 1200- 1964 codes and relevant Indian Standard specifications, taking out quantities from the given requirements of the work and drafting specifications. • To conduct a material and labour survey to understand the current market rates for the various materials required for construction and the different categories of labour required. • To perform the rate analysis for various items: standard and non-standard and the use of DSR in this process. • To study the process of tendering and its various stages, various types of contracts, its suitability and validity as per the Indian Contract Act of 1872 and draft various clauses and conditions of a contract	

Introduction: Definition of estimating and Costing, Purpose, Data required for preparing an estimate, Qualities of an ideal quantity surveyor.

Types of Estimates: Approximate or preliminary estimate, Detailed, Supplementary and Revised estimate with brief description of each. Purpose of approximate estimate and Methods of approximate estimation of a building and highway, Administrative approval, Expenditure sanction and Technical sanction.

Mode of Measurement: Standard unit of measurements, Modes of measurements for different items of work for buildings and Road work, Provision for lump sum, Spot item, and Provisional sums. Degree of accuracy in estimating; General rules for measurement of work as per IS 1200. Significance of provision for contingencies, Work charged establishment, Percentage provision for Water supply, Sanitation.

Specification: Definition, purpose of specification, Types and principles of writing specification. Writing detailed specification for some common items of civil engineering works.

Detailed Estimate and Abstracting: Types of forms used for detailed measurement and Abstracting. Methods of taking out quantities; Centre line methods and Long wall and Short wall method. Case studies with different items for a single storied residential building including working out the percentage cost for different stages of construction.

Road Earth Work: Computation of earth work with no transverse slope using mean area and Mean depth formula including soling area for pitching/turfing. Estimate of a road with WBM and Bituminous road surface involving all basic items including computation of earth work, Quantities of carious items with abstract.

Bar Bending Schedule: Detail bar bending schedule with quantity of steel for slabs, Beams, Footings, Columns, Retaining wall.

Rate Analysis: Factors considered for rate analysis, Schedule of rates and Market rates for common materials and Capacity, Preparation of material estimate for common items of work. Rate analysis for common items of work (as specified in the term-work only).

Valuation: Definition, Importance and Necessity of valuation, Factors affecting valuation, Methods of valuation, Book value, Market value, Single and Dual rates year's purchase, Depreciation, Sinking fund, Rent fixation, Valuation for various purposes.

Tenders and Contracts: Definition and Purpose of tender; Salient features of processing tender. Definition of contract. Type of contracts; Salient features, Obligation of the parties to a contract.

Earnest money deposit, Security deposit, Running account bill and Final bill.	
Text/Reference Books	1. B. N. Datta, Estimation and Costing, S. Dutta and co, Lucknow. 2. M. Chakraborti, Estimation and Costing; M. Chakraborty Publications 3. S. C. Rangawala, Elements of Estimation and Costing; Charotar Publishing House. 4. J. R. Mule, Valuation, Estimation and Costing; Charotar Publishing House. 5. G. S. Birdi, Text Book of Estimating; Dhanpatrai and Sons, Delhi. 6. B. S. Patil, Civil Engineering Contracts and Costing; Orient Blackswan Pvt. Ltd. C.P.W.D. Manual, Goa Schedule of rates

VIII Semester

Sl. No.	Course Code	Course Name	L-T-P	Credits
1	CV5**	Elective-IV	3-0-0	3
2	CV5**	Elective-V	3-0-0	3
3	CV5**	Elective-VI	3-0-0	3
4	CV499	Major Project–II	0-0-6	6
			Total Credits	**15**

Detailed Syllabus of Electives

<table>
<tr><td>Subject Code
CV501</td><td colspan="2"><h1>Concrete Technology</h1></td><td>Credits: 3 (3-0-0)
Total Hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To identify quality control tests on constituents of concrete
• To understand the behavior of fresh and hardened concrete.
• Design concrete mixes.
• Understand the durability requirement of concrete.
• Understand the need for special concrete.</td></tr>
<tr><td colspan="4">
Cement: Types of Portland cement, hydration, setting and hardening process, special hydraulic cements

Admixtures: Admixtures, accelerators, and retarders, air-entraining agents, plasticizer and super-plasticizers.

Aggregates: Shape and texture, bond, strength, specific gravity, bulk-density and moisture content of aggregates, bulking of sand, deleterious substances in aggregates, alkali-aggregate reaction, sieve-analysis and grading curves, fineness modulus, practical grading, gap grades aggregates.

Fresh Concrete: Rheological aspects such as workability-flow ability, compatibility and mobility of concrete, factors affecting workability and lab determination, segregation, bleeding & laitance, mass concreting

Hardened Concrete: Compressive strength and factors affecting the strength of concrete, behavior of concrete under various stress states, testing of hardened concrete, cube and cylinder test, Platen effect, flexure test, non-destructive testing such as rebound hammer test, USPV test, core-cutting, stress-strain relation and modulus of elasticity, shrinkage, creep of concrete and its effect.

Durability of Concrete: Corrosion of reinforcing bars, sulphate attack, frost action, deterioration by fire, concrete in seawater, acid attack and carbonation.

Concrete Mix Design: Basic consideration–cost, workability, strength and durability, grading, method of mix design, acceptance criteria for concrete.

Advances in concrete: High strength concrete, fibre-reinforced concrete, concrete containing polymers, heavy weight and light weight concrete, blended concrete, Ferro-cements and its applications.
</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. A M Nevelli , Properties of Concrete, 5th Ed, Prentice Hall Publishers, 2012.
2. M. S. Shetty, Concrete Technology, S Chand Co., Publishers,2006.
3. M. L. Gambhir, Concrete Technology,Tata McGraw Hill Publishers, 2012.</td></tr>
</table>

<table>
<tr><td>Subject Code
CV502</td><td>Composite Materials</td><td>Credits: 3 (3-0-0)
Total Hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Understanding the modelling of composite material by finite element analysis.
• Fabrication techniques of various composites.
• Understand different types of composites and their testing techniques.</td></tr>
<tr><td colspan="3">Introduction: Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres. Material properties that can be improved by forming a composite material and its engineering potential

Various types of composites: Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

Fabrication methods: Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resin-transplant method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films

Testing of Composites: Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Materials characterization, Vol. 10, ASM hand book,2014
2. G. Dieter, Mechanical Metallurgy, Mc-Graw Hill,3rdedition
3. R.F. Speyer, Thermal Analysis of Materials, Marcel Decker
4. A.K Bhargava, Engineering Materials: Polymers, Ceramics and Composites Prentice Hall India.</td></tr>
</table>

<table>
<tr><td>Subject Code
CV503</td><td>Advanced Fluid Mechanics</td><td>Credits: 3 (3-0-0)
Total Hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Derive the governing equations of transients in pipes and channels
• Apply method of characteristics and finite difference methods to solve unsteady flow problems in pipes and channels
• Analyze transients in pumping and hydropower systems
• Analyze dam break problem</td></tr>
<tr><td colspan="3">Basic concept and Governing Equations of Fluid Motion: Definition and Properties of Fluids, Langragian and Eulerian description, Velocity and stress field, Fluid statics, Fluid Kinematics, Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler’s equation, Bernoulli’s Equation.

Exact solutions of Navier-Stokes Equations: Couette flows, Poiseuille flows, Fully developed flows in non-circular cross-sections, Unsteady flows, Creeping flows.

Potential Flows: Stream and Velocity potential function, Circulation, Irrotational vortex, Source and Sink, Vortex flow, Doublet, Flow past a circular cylinder, Magnus effect; Kutta-Joukowski lift theorem; Concept of lift and drag.

Laminar Boundary Layers and Elements of Stability Theory: Boundary layer equations, Boundary layer parameters, Boundary layer on a flat plate, Integral form of boundary layer equations, Approximate Methods, Flow separation and control Concept of small-disturbance stability, Orr-Sommerfeld equation, Inviscid stability theory, Boundary layer stability, Thermal instability, Transition to turbulence.

Compressible Flows: Speed of sound and Mach number, Basic equations for one dimensional flows, Isentropic relations, Normal shock wave, Rankine-Hugoniot relations, Fanno and Rayleigh curve, Mach waves, Oblique shock wave, Prandtl Meyer expansion waves, Quasi-one dimensional flows, Compressible viscous flows, Compressible boundary layers.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Abbot, M.A. and Vervey, Computational Hydraulics, Elsevier Publications,1996.
2. Hoffman, J.D., Numerical Methods for Engineers and Scientists, CRC Press, Special Indian Edition,2011.
3. M.H. Choudhary, Applied Hydraulic Transients, Van Nostrand Reinhold, New York,2013.</td></tr>
</table>

<table>
<tr><td>Subject Code
CV504</td><td>Structural Design of Foundations</td><td>Credits: 3 (3-0-0)
Total Hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To impart knowledge about the design principles of various foundation types.
• To perform soil and structural design of various types of foundation types.
• Evaluate design parameters for dynamic loading.</td></tr>
</table>

Introduction: Soil exploration, Analysis and Interpretation of soil exploration data, Estimation of soil parameters for foundation design. Methods for bearing capacity estimation, Total and Differential settlements of footing and raft, Codal provisions.

Shallow Foundations: Design of individual footings, Strip footing, Combined footing, rigid and Flexible mat, Buoyancy raft, Basement raft.

Machine Foundations: Basic definitions in vibration, Free and Forced vibrations, Determination of natural frequency, Types of machine foundations, General criteria for design of machine foundation, Vibration analysis of a machine foundation, Degrees of freedom of a block foundation, Vibration isolation and Control.

Pile Foundations: Estimation load carrying capacity of single and Pile group under various loading conditions. Pile load testing (static, dynamic methods and data interpretation), Settlement of pile foundation, Code provisions, Design of single pile and Pile groups, and Pile caps.

Well Foundations: Types, Components, Construction methods, Design methods (Terzaghi, IS and IRC approaches), Check for stability, Base pressure, Side pressure and Deflection.

Retaining Walls: Types (Types of flexible and Rigid earth retention systems; Counterfort, Gravity, Diaphragm walls, Sheet pile walls, Soldier piles and Lagging). Support systems for flexible retaining walls (struts, anchoring), Construction methods, Stability calculations, Design of flexible and Rigid retaining walls, Design of cantilever and Anchored sheet pile walls.

Soil-Foundation Interaction: Idealized soil, Foundation and Interface behaviour. Elastic models of soil behavior; Elastic, Plastic and Time dependent behaviour of soil. Beams and Plates on elastic foundation; Numerical analysis of beams and Plates resting on elastic foundation.

Text/Reference Books

1. Murthy V.N.S Soil Mechanics and Foundation Engineering – CBS publications, Delhi, 2007.
2. Das, BM: Geotechnical engineering – Cengage learning, New Delhi,2009.
3. Gopal Ranjan, Rao ASR, Basic and applied soil mechanics – New age publication, Delhi,2000.
4. Srinivasulu, P. And Vaidyanathan, C. V., “Handbook of Machine Foundations” Tata McGraw-Hill, New Delhi,2001
5. Prakash Shamsher and Puri Vijay K, “Foundations for Machines, Analysis and Design” John Wiley and Sons, USA,1988.

Subject Code CV505	Disaster Management and Mitigation	Credits: 3 (3-0-0) Total Hours: 42
Course Objectives	• To describe the basic types of hazards and their potential consequences • To understand the strengths and weaknesses of disaster management approaches • Understand how to react effectively to natural, man-made, and technological threats.	

Introduction to Disasters, Classification, Causes, Impacts: Concept and Definitions of different terms of disaster. Approaches to understand disaster phenomena (natural science, applied, science, progressive and holistic approaches). Parameters of disaster risk levels of disaster as per national guideline.

Classification of Hazards (Natural and Manmade): General characteristics and Problem areas of different natural and Man-made hazards (e.g. Flood, Erosion, Earthquake, Landslide, Lightning, Tropical Cyclone, Drought, Civil Unrest etc.).

Disaster Trends (Global, National and Regional): Response time, Frequency Forewarning, Exposure time of different hazards. Common approaches to study natural and manmade hazards; Vulnerability and Disasters. Differential impacts- in terms of Caste, Class, Gender, Age, Location, Disability.

Disaster Risk Mitigation: Disaster risk assessment (Hazard-Vulnerability-Capacity analysis), Hazard mapping and Forecasting. Principles and Aspects of Disaster prevention, Disaster mitigation. Preparedness for damage mitigation and coping with disasters. Capacity building for disaster/damage mitigation (structural and non-structural measures). Contingency planning for damage mitigation of different hazards. Relevance of indigenous knowledge, appropriate technology and local resources in disaster risk mitigation. Community based disaster risk reduction mechanism. Counter disaster resources and their roles. Selected models for understanding the causes of disaster and disaster risk mitigation.

Environment and Disasters: Environment, Ecosystem and Disasters. Climate change-issues and Concerns. Industrial hazards and Safety measures. Post disaster impact on environment. Impact of developmental projects on disaster risk. Aspects of environmental management for disaster risk reduction. Environmental Impact Assessment (EIA).

Planning for Disaster Management: Community; Hazard profile in India. Different phases of Disaster Management (DM cycle). Relief mechanism (needs assessment, relief administration and distribution, management of relief centres, external support etc.). Compensation and Insurance. Planning strategies (state and district DM planning); planning needs. Disaster Management Act (2005); Disaster Management Policy (2009); organizational framework for disaster management in India.

Text/Reference Books	1. Introduction to Environmental Engineering and Science Gilbert, M. Masters, 3rd edition,2015 2. Environmental Science, G. Tyler Miller,13th edition,2010. 3. R. B. Singh (Ed) Disaster Management, Rawat Publication, New Delhi, 2000

Subject Code CV506	# Advanced Surveying	Credits: 3 (3-0-0) Total Hours: 42
Course Objectives	• To know about significance of advanced surveying in field measurements in terms of utility and precision of data collection • To learn on the principles of Electronic distance measurements, Total station and their accuracy • To get introduced to the concept of photogrammetry in preliminary identification and mapmaking • To know in detail the concept of remote sensing in identification of land features from space and to get introduced to different data acquisition techniques like LIDAR, RADAR • To get introduced to the field of geodesy, coordinate systems, Map projections, GPS, its working principles, data collection, data processing and analysis.	

Electromagnetic distance measurement (EDM): Principle of EDM Carrier waves, Types of EDM instruments, Distomat, Total Station, Principle, procedure & surveying using Total Station, precise leveling, micro-optic theodolite.

Photogrammetry: Terrestrial and Aerial Photogrammetry, Horizontal position of a point from photographic measurement, elevation of a point, Determination of focal length of camera, Geometry and scale of vertical photographs, Ground co-ordinates from vertical photographs, Relief displacement, Planimetric mapping from vertical photos, Stereoscopy, Photo interpretation.
Remote sensing: concepts, Idealized remote sensing system, characteristics, Types of remote sensing system, Remote sensing from space, Data interpretation, application of remote sensing, LIDAR, RADAR, SONAR.

Geodesy: Figure of earth, Classification, Earth surface, Geodetic reference surfaces, Coordinate systems, Geodetic datum and elements, Map, Scale of map, projection, UTM, Map projection of India, Space Geodesy, VLBI, SLR, LLR.

GPS Basics, system overview, working principle of GPS, Satellite ranging, calculating position, Ranging errors and its correction, GPS surveying Methods, static, Rapid static, DGPS and Kinematic methods, Real time and post processing DGPS, visibility diagram, GAGAN

Text/Reference Books	1. Borden D. Dent, Jeffrey Troguson, Thomas W. Hodler, Cartography: Thematic Map Design, McGraw-Hill Higher Education,2008. 2. Gopi, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education India,2007. 3. Hoffman.B, H.Lichtenegga and J.Collins, Global Positioning System - Theory and Practice, Springer -Verlag Publishers,2001. 4. Punmia B. C, Ashok K. Jain, Arun K. Jain, Higher Surveying, Laxmi Publications,2005

Subject Code CV507	Computer Aided Design	Credits: 3 (3-0-0) Total Hours: 42
Course Objectives	• To acquire knowledge for generating high quality images of massive geometric models in a short time. • To learn about the concepts of surface modeling, physically based modeling and surface visualization.	

Introduction: A typical product cycle, CAD tools for the design process of product cycle, CAD / CAM system evaluation criteria, Input / Output devices; Graphics Displays: Refresh display, DVST, Raster display, pixel value and lookup table, estimation of graphical memory, LCD, LED fundamentals. Concept of Coordinate Systems: Working Coordinate System, Model Coordinate System, Screen Coordinate System. Line and Curve generation algorithm: DDA, Bresenham's algorithms. Graphics exchange standards and Database management systems.

Curves and Surfaces: Parametric representation of lines: Locating a point on a line, parallel lines, perpendicular lines, distance of a point, Intersection of lines. Parametric representation of circle, Ellipse, parabola and hyperbola. Synthetic Curves: Concept of continuity, Cubic Spline: equation, properties and blending. Bezier Curve: equations, properties; Properties and advantages of B-Splines and NURBS. Various types of surfaces along with their typical applications.

Mathematical representation of solids: Geometry and Topology, Comparison of wireframe, surface and solid models, Properties of solid model, properties of representation schemes, Concept of Half-spaces, Boolean operations. Schemes: B-rep, CSG, Sweep representation, ASM, Primitive instancing, Cell Decomposition and Octree encoding.

Geometric Transformations: Homogeneous representation; Translation, Scaling, Reflection, Rotation, Shearing in 2D and 3D; Orthographic and perspective projections. Window to View-port transformation.

Text/Reference Books	1. Ibrahim Zied, CAD / CAM: Theory and Practice, McGraw-Hill, 2nd edition 2009 2. Hearn E J and Baker M P, Computer Graphics, Pearson, 2nd edition2002. 3. Chandrupatla T and Belegundu A D, Introduction to Finite Elements in Engineering, Pearson Education India, 4th Edition2015.

Subject Code CV508	**Smart Materials and Structures**	**Credits: 3 (3-0-0)** **Total Hours: 42**
Course Objectives	• Overview of smart materials, Piezoelectric Ceramics, Piezo-polymers, Magnetostrictive Materials • Electroactive Polymers, Shape Memory Alloys, Electro and Magneto Rheological Fluids. • Modelling of smart materials, introduction to composite smart materials, Mechanics of smart composite materials • Smart sensors based on high bandwidth low strain smart materials, Low-bandwidth high strain smart actuators • Micro-electro mechanical Smart Systems, Intelligent devices based on smart materials, • Applications of Smart Actuators: Active and Hybrid Vibration Control, Active Shape Control, Distributed Sensing and Control of Smart Beams. •	

Overview of Smart Materials: Introduction to Smart Materials, Principles of Piezoelectricty, Perovskite Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magneto strictive materials, Giant Magnetostriction and Magneto-resistance Effect, Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rheological Fluids

High-Band Width, Low Strain Smart Sensors: Piezoelectric Strain Sensors, In-plane and Out - of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors

Smart Actuators: Modelling Piezoelectric Actuators, Amplified Piezo Actuation, Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magneto-volume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control

Smart Composites: Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams

Advances in Smart Structures & Materials Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self-Healing Polymers.

Text/Reference Books	1. Brian Culshaw, Smart Structures and Materials, Artech House,2000 2. Gauenzi, P., Smart Structures, Wiley, 2009 3. Cady, W. G., Piezoelectricity, Dover Publication.

<table>
<tr><td>Subject Code
CV509</td><td colspan="2">Advanced RCC Structures</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• To impart knowledge on the behavior and design on various reinforced concrete structural elements.
• The students will be able to understand the design of portal frame using LSM.</td></tr>
<tr><td colspan="4">Yield line theory: Ultimate Load Analysis of RC slabs using Yield line theory (Virtual work and equilibrium method); Application for the analysis and design to orthotropically reinforced square/rectangular slabs with various boundary conditions under uniformly distributed loads.

Flat slab: Design of flat plates and flat slabs, Behavior of flat slab, Method of analysis (Direct design method, Equivalent frame method, Transfer of moments of column), Shear in flat plates and flat slabs, Design of flat plate and flat slab.

Design of Portal Frames: Introduction, Types of portal frames, design of portal frames using LSM.

Curved beams: Introduction, loaded perpendicular to their plane, Fixed and continuous curved beams, Design of beams curved in plan.

Silos and Bunkers: Lateral pressure as per Janssen's and Airy's theory, Design consideration for square, rectangular and circular shapes, Design of Hopper and Support structures.

Design of miscellaneous structures: Corbells, Deep beams, RC structural wall including introduction to shear walls; and design of nibs.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. B.C. Punimia, Ahok Kumar Jain and Arun Kumar Jain: Reinforced Cement Concrete Designs'; Laxmi Publishers, New Delhi -2015
2. Dr. H. J. Shah, "Reinforced Concrete", Vol-1 and Vol-2, Charotar, 8th Edition – 2009 and 6th Edition,2012
3. S.S. Bhavikatti: 'Advanced RCC Design (Vol. II)'; New Age Publishers, New Delhi-2010
4. N. Krishna Raju "Advanced Reinforced Concrete Design", 2nd edition, CBS Publishers and Distributors, 2009.
5. P.C Varghese "Advanced Reinforced Concrete Design" -. Prentice Hall of India – 2004.
6. IS456, SP16, SP34</td></tr>
</table>

<table>
<tr><td>Subject Code
CV510</td><td>Earth Retaining Structures</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• The overall objective of this course is to provide students the fundamentals and working tools needed for the design and analysis of earth retention systems.
• Selection, design, and performance of earth retaining structures used for support of fills and excavations.</td></tr>
</table>

Earthen Dam: Introduction to Earthen dams, types of dams, selection of type of dam based on material availability, foundation conditions and topography, Design details, crest, free board, upstream and downstream slopes, upstream and downstream slope protection, central and inclined cores, types and design of filters, Seepage analysis and control, seepage through dam and foundations, control of seepage in earth dam and foundation

Stability analysis: Critical stability conditions, evaluation of stability by Bishop's and sliding wedge methods under critical conditions, Construction techniques, methods of construction, quality control Instrumentation, measurement of pore pressures

Earth pressure: Earth pressure theories, Rankine's and Coulomb's earth pressure theories for cohesion less and cohesive backfills, computation of earth pressures for various cases, inclined, with surcharge, submerged and partly submerged, stratified backfills

Rigid Structures: Rigid retaining structures, active and passive earth pressures against gravity retaining walls, computation of earth pressures by Trial wedge method, a mathematical approach for completely submerged and partly submerged backfills, Perched water table, importance of capability tension in earth pressure.

Graphical methods of earth pressure computation: trial wedge method for Coulomb's and Rankine's conditions, for regular and irregular ground and wall conditions, Rebhan's construction for active pressure, friction circle method, logarithmic spiral method. Design of gravity retaining wall, cantilever retaining walls

Flexible retaining structure: type and methods of construction, design strength parameters, safety factor for sheet pile walls, computation of earth pressures against cantilever sheet piles in cohesion less and cohesive soils, anchored sheet piles, free earth method, fixed earth method, Rowe's moment reduction method, stability of sheet piling.

Text/Reference Books

1. B. M. Das, "Foundation engineering", Cengage Learning,2007
2. Gulhati, K. Shashi and M. Datta, "Geotechnical engineering", Mc.Graw Hill book company,2005
3. Huntington, Earth pressure on retaining walls, Literary Licensing, LLC -2013
4. Swami Saran, Analysis & Design of Foundation & Retaining Structures subjected to seismic loads, 2012
5. Bowles, Foundation Analysis and Design, McGraw Hill, 2001
6. Colin JFP Jones, Earth Reinforcements & Soil structures, Elsevier, 2013
7. Prakash, Ranjan & Sasan, Analysis & Design of Foundation & Retaining Structures, Meerut: Sarita Prakashan Publications

<table>
<tr><td>Subject Code
CV511</td><td>Advanced Solid Mechanics</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To analyze the transformation of stresses and strains in3D.
• To study engineering properties of materials, force-deformation, and stress-strain relationship.
• To understand the plastic behavior of deformable bodies</td></tr>
<tr><td colspan="3">Kinematics: Motion field, Displacement field, Deformation gradient, Transformation of curves, surfaces and volumes, strain measures, linearized strain measures, Principal strains and principal directions, Transformation of strain components with changes in coordinate basis, Compatibility conditions for linearized strain

Traction and stresses: Concept of traction, Cauchy's stress theorem, Postulate of Cauchy stress tensor, Traction on arbitrary planes, Extreme normal and shear traction, Octahedral shear stress, Other stress measure - Engineering stress

Equilibrium equations: Derive equilibrium equations in Cartesian and cylindrical polar coordinates, Constitutive relations: Restrictions on constitutive relations, General relationship between Cauchy stress and Cauchy Green strain for isotropic materials, General Hooke's law and its reduction for isotropic and orthotropic materials

Boundary value problems: Displacement method, Stress method, Airy's stress functions for plane stress and strain problems, Uniaxial Tension, Thick-walled annular cylinder subjected to uniform boundary pressure, Infinite medium with a stress-free hole under far field tension loading.

Bending of prismatic straight beams: Pure bending, bending due to uniform transverse loading and bending due to transverse sinusoidal loading of a beam, Asymmetrical bending of straight beams, Shear stresses in thin walled open sections

End torsion of prismatic beams: Formulation of the BVP for torsion of beams with solid cross section - warping function and Prandtl stress function approach, Torsion of circular, elliptic, rectangular and triangular cross sections, Membrane analogy, Torsion of thin walled tubes, thin rectangular sections, rolled sections and multiply connected sections

Beam on elastic foundation: Derivation of the basic governing equation, Solution to beam on an elastic foundation subjected to a point load at the center, moment at the center, uniformly distributed load over some length 'a' symmetrically about the center</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. S.P. Timoshenko and J. N. Goodier, 'Theory of Elasticity', 3rd ed., McGraw-Hill Education,2010.
2. M. Filonenko-Borodich, 'Theory of Elasticity‟, University Press of the Pacific, 2003
3. L.S.Srinath,"Advanced Mechanics of Solids" Tata McGraw Hill,2007.
4. M.H.Sadd,"Elasticity: Theory, Applications and Numerics", Academic Press, 2006.</td></tr>
</table>

Subject Code CV512	# Advanced Irrigation Engineering	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To understand the fundamental design concepts of hydraulic structures. • To get a quiet enough amount of knowledge about the types, functions and importance of hydraulic structures. • To read the contour and topo maps which are required for design purposes and analyzing the forces on structures required to be considered in design.	

Diversion Headworks: Introduction, Types of diversion works, Location and Components, Weir and Barrage, Effect of construction of weir on the river regime, Causes of failures of Weirs on permeable foundations, their remedies, Exit gradient, Principles of weir design on permeable formations, Bligh's creep theory and Khosla's theory.

Distribution Systems: Classification of canals, Design of irrigation canals by Kennedy's and Lacey's theories, Canal FSL, Losses of canal water, Silting and Scouring of canals, Method of design of unlined section of irrigation canal, Lined canals, IS standard for Design of canal lining, Satellite automated canals, Problem of water logging and Environmental concerns

Regulation Works: Introduction, Definition of falls, Necessity and Location of falls, Comparative study of the main types of falls, Cross regulator and Distributary regulator. Hydraulic Gates Control equipment's for out-lets, Spillway gates, Types, Design criteria for radial gates, Air vents, Canal escapes.

Cross Drainage Works: Introduction, Types, Suitability, Design of various types of C-D Works, Aqueduct, Syphon aqueduct, Super Passage, Syphon, Level crossing, Inlets and Outlets, Site selection.

Hydropower Engineering: Introduction, Components of hydropower, Classification of hydropower plants, Run-of-river plants, Valley dam plants, High head diversion plants, Diversion canal plants, Pumped storage plants, Tidal power plants, Environmental considerations, Estimation of hydropower potential, General load curve, Load factor, Capacity factor, Utilization factor, Diversity factor, Water conveyance system; Power canals, Alignment, Design of power canals, Flumes, Covered conduits and tunnels, Drainage and Ventilation in tunnels. Penstocks; Design considerations.

Text/Reference Books	1. Punmia, Pande, Lal, A. K. Jain; Irrigation Engineering; Laxmi Publications (P) Ltd. 2. P. N. Modi; Irrigation and Water Power Resources Engineering; Standard Book House. 3. R. K. Sharma and T. K. Sharma; Irrigation Engineering; S Chand Publications Pvt. Ltd. 4. R. S. Varshney, Hydropower Structures; Nem Chand and Bros. 5. S. K. Garg; Irrigation Engineering and Hydraulic Structures; Khanna Publishers, Delhi. 6. K. R. Arora; Irrigation, Water Power and Water Resources Engineering; Standard Publishers, New Delhi. 7. K Subramania, Engineering Hydrology, 2017, Tata Mcgraw hill 8. V T Chow, D R Maidment and LW Mays Applied hydrology, 2017, Mc Graw hill

<table>
<tr><td>Subject Code
CV513</td><td>Industrial Waste Treatment</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To study about the sampling and analysis of industrial wastes
• To understand the general treatment of industrial wastes
• Learn about the provision of various acts pertaining to industrial wastes.</td></tr>
<tr><td colspan="3"> General: Liquid wastes from industries, their volumes and characteristics, Effect of disposal into natural water courses, Municipal sewers and on land, stream standards and effluent standards.
Sampling and analysis of industrial wastes, Treatability study, good housekeeping, bioassay test, population equivalence.
Stream sanitation: Effects of industrial wastes on self-purification of streams and fish life, Statement and significance of the parameters of Streeter and Phelps's equation and BOD equations, Deoxygenating and reaeration, Oxygen sag and numerical based on this.
General treatment of industrial wastes: Neutralization, Equalization, segregation. Modification of conventional aerobic and anaerobic biological treatment methods. Dewatering and disposal of sludges, unit operation floatation, Vacuum filtration, Centrifugation, Filter press and membrane filters, Advanced treatment.
Detailed consideration of wastes produced from following industries: Manufacturing processes normally followed, Volume and effects of raw and treated effluent on streams, Sewers, Characteristics of effluents and land Treatment methods, reuse-recovery 1) Sugar-sugarcane 2) Distilleries 3) Pulp & paper: Sulphate process
4) Textiles: Cotton 5) Dairy 6) Tanneries 7) Electroplating.
Provision of various acts pertaining to industrial wastes / effluents, introduction to environmental impact assessment and environmental audit. Common Effluent Treatment Plants (CETPs): Location, Need, Design, Operation & Maintenance Problems and Economical aspects. </td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Waste Water Treatment: Rao & Datta, Oxford & IBH Publishing Co.3rd revised edition (2020)
2. Environmental Pollution and control in chemical process industries: S.C. Bhatia, Khanna Publication. (2001)
3. Industrial Water Pollution Control: W W Eckenfelder Jr, McGraw Hill. (1999)
4. Industrial Water Pollution Management: E F Gurnham, John Wiley.
5. Biological Waste Treatment: Eckenfelder & Connor Pergamon Press.
6. Theories and Practices of Industrial Waste Treatment: Addison Wesley.
7. Pollution Control in Process Industries: S P Mahajan, Tata McGraw Hill.</td></tr>
</table>

<table>
<tr><td>Subject Code
CV514</td><td>Advanced Highway Engineering</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• The students will be able to classify the different road making aggregates
• To learn about highway construction.
• To study the different highway construction equipment’s.</td></tr>
<tr><td colspan="3">Highway Planning: Highway development and planning in India, rural & urban road classification, planning surveys, highway alignment, computer aided planning.

Road making aggregates, classification, properties of aggregates, design of aggregate gradation; Bituminous road binders, penetration grade, emulsions, cut backs and modified binders; rheology of bituminous binders, modified binders; mix design, Marshall method and Superpave procedure; design of emulsified mixes, visco-elastic and fatigue properties of bituminous mixtures, resilient modulus of pavement materials; requirements of paving concrete, design of mixes for recycling of bituminous and concrete pavement surfaces; soil stabilization techniques.

Highway Construction: Earthwork & embankment construction; construction of stabilized sub-bases & base courses, drainage, surface / subsurface, sub-base & base construction techniques, WBM base, wet mix macadam, bituminous macadam, low cost road construction, construction of shoulder, footpath, paver block areas.

Highway Construction Equipment: Excavating, earth moving & compacting equipment, hot mix plant, pavers, and concrete mixers.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. L.R.Kadiyali, Highway Engineering, Khanna Publishing ,1st Edition(2019)
2. Daniel J..Findley, Batian S., Christopher C, Tom B, Highway Engineering, Planning, design and operation, Butterworth-Heinemann 1st edition(2015)
3. Highway Materials, Soils, and Concrete, Atkins Harold N, Principles and Applications, Marcel Dekker, Inc.,2000.
4. Relevant IRC codes</td></tr>
</table>

<table>
<tr><td>Subject Code
CV515</td><td>Ground Improvement Techniques</td><td>Credits: 3 (0-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To study engineering properties of soft, weak and compressible deposits.
• To learn about emerging trends in ground improvement.
• To understand principles and methods of ground improvement</td></tr>
<tr><td colspan="3">Introduction: Different types of problematic soils and their geological formation principles of treatment, Loading, Classification of ground modification techniques, Emerging trends in ground improvement.

Treatment of Loose Sands: Mechanical Stabilization- Shallow and Deep compaction requirements, Principles and methods of soil compaction, Shallow compaction and methods. Properties of compacted soil and Compaction control, Deep compaction and vibratory methods dynamic compaction. Compaction piles, deep compaction, Dynamic compaction, Vibroflot technique, Controlled blasting for compaction.

Hydraulic Modification - Ground improvement by drainage, Dewatering methods, Design of dewatering systems, Preloading, Vertical drains, Vacuum consolidation, Electro-kinetic dewatering, Heating and Freezing methods, Microbial geotechnology.

Treatment by Admixtures: Cement stabilization and Cement columns, Lime stabilization and Lime columns. Stabilization using bitumen and Emulsions, Stabilization using industrial wastes, Construction techniques and Applications.

Grouting Techniques: Permeation grouting, Compaction technique, Jet grouting, Different varieties of grout materials, Grouting in difficult conditions.

Treatment of Expansive Soils: Lime treatment for expansive soils, Injection method, Lime-columns, Chemical analysis.

Accelerated Consolidation Methods for Soft Clay Soils: Preloading and the techniques of preloading, Band drains, Consolidation by sand drains, Radial consolidation, Effect of smear zone on radial consolidation, Pre-fabricated drains. Vacuum consolidation, Vibro compaction, Stabilization of soil by vitrification, Ground freezing, Dewatering and Electro kinetics, Accelerated pre-consolidation of soft clay using geosynthetics.

Insitu Ground Treatment for Slopes: Different types of in situ soil stabilization like soil nails, Rock anchoring, Pre-stressed anchors, etc. Optimum design of nailed slopes, Design methods and Construction techniques. Evaluation of zone of liquefaction in field, Ground improvement techniques for improving liquefaction resistance of soils, Nano-technologies in ground improvement and Site remediation.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Manfred R. Haussmann, Engineering principles of ground modification, Pearson Education Inc. New Delhi, 2008.
2. Bell, F.G., Engineering Treatment of Soils, E& FN Spon, New York,2006.
3. Purushothama Raj, P, Ground Improvement Techniques, Laxmi Publications (P) Limited, 2006.
4. Patel, Geotechnical Investigations and Improvement of Ground Conditions Elsevier, 1st Ed.,2019
5. Gulati and Datta, Geotechnical Enginnering, Tata McGraw Hill. (2005)
6. M. P. Mooseley and K. Kirsch, Ground Improvement; 2nd Edition, Spon Press, Taylor and Francis Group, London, United Kingdom. (2004)</td></tr>
</table>

<table>
<tr><td>Subject Code
CV516</td><td>Pavement Design</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To study about the types, design aspects and components of pavements.
• To introduce highway pavements, design concepts and material properties
• To understand and enable students to carry out design of bituminous mixes, analyze and design flexible and rigid highway pavements
• To introduce the concepts of pavement evaluation and rehabilitation</td></tr>
<tr><td colspan="3">Fundamental Principles: Pavement types, Wheel loads and Design factors, Stresses inflexible and Rigid pavements, Determining ESWL for highways and Airports, ESWL factors, Effects on pavements due to climate and Environment, Pavement costs, Economic analysis, Properties of pavement components and Material characterization; Soil classification and Application, Types of tests; Plate load test, Triaxial Test, CBR Test, Stabilometer and Cohesiometer tests; Tests for bituminous mixtures and Concrete, Resilient modulus test.

Pavement Design: Design of flexible pavements for airports, CBR Method, FAA method; Design of flexible pavements for highways; CBR Method, IRC method, Limiting shear failure method, Limiting deflection method, Regression method based on pavement performance, Mechanistic method for bituminous pavement design, AASHO design method.

Design of Rigid Airport and Highway Pavements: Modulus of subgrade reaction, Design charts, Westergaard’s equations for load and Temperature stresses; Examples; Design of slab thickness only as per IRC: 58-2002, Factors affecting design and Performance, AASHTO method, PCA method; Joint and Reinforcement requirements.

Pavement Design and Construction: WBM Roads, WMM roads, Bituminous and Cement concrete roads, Design of bituminous and Cement concrete mixes.

Soil and Base Stabilization: Mechanics of stabilization, Types of stabilization, Construction and Field control, General properties of soil aggregate mixture.

Types of Bases and Sub-Bases: Macadam base courses, Cement treated bases, Asphalt treated bases, Base and Sub base drainage.

Pavement Evaluation and Rehabilitation: Pavement distress, Types and Causes, Condition and Evaluation surveys; Methods of measuring condition, Skid resistance.

Strengthening Existing Pavements: Principles of maintenance, Typical maintenance procedures, Deflection measurement as an evaluation tool, Benkelman beam, Static load deflection test procedure, Creep load deflection test procedure, Correction for temperature and Seasonal variations; Maintenance of shoulders.

Structural Evaluation of Rigid Pavements: Direct load test method, Indirect reverse design method, Determination of pavement structural strength. Overlays: Overlays for airport and Highway pavements, Types of overlays</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering: Principles and Practice, Second Edition, CRC Press, London, 2013
2. Papagiannakis, A.T. and E.A. Masad, Pavement Design and Materials, John Wiley and Sons, New Jersey, USA, 2008
3. IRC: 37-2012, Tentative Guidelines for the Design of Flexible Pavements
4. IRC: 58-2011, Guidelines for Design of Plain Jointed Rigid Pavements for Highways.
5. E. J. Yoder, M. W. Witczak, Principles of Pavement Design; Wiley Publication, 2008
6. Partha Chakroborty and Animesh Das, Principles of Transportation Engineering, Prentice Hall of India, NewDelhi.-2004</td></tr>
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<table>
<tr><td>Subject Code
CV517</td><td>Finite Element Method</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Understand the basic concepts of finite element method
• Analyze 1D stress deformation problems
• Develop shape functions and stiffness matrices for different finite elements
• Develop global stiffness matrices and global load vectors
• Analyze planar structural systems using finite element modeling
• Develop element mass matrix for bar and beam elements</td></tr>
<tr><td colspan="3">Introduction to Finite Element method (FEM): General description of the method, Steps involved, Advantages, Range of applications. Basic Equations from linear theory of elasticity; Equilibrium equations, Compatibility equations, Strain displacement equations. Generalized Hooke's law; Constitutive laws for plane stress and Plane strain problems, Potential energy approach, Rayleigh-Ritz method, Galerkin's method. Matrix algebra and Solution of simultaneous using equations Gauss elimination, Crouts reduction and Cholesky's decomposition methods.
Types of Elements, Discrete Systems: Analysis of one-dimensional stress deformation problems; Generation of matrix displacement equations for spring element, 1-D bar element using direct and energy approach. Assembly of global stiffness matrix and Load vector, Treatment of boundary conditions and Solutions.
Co-ordinate System: Global, Local and Natural co-ordinate. Convergence requirement on displacement field. Shape functions for linear, Quadratic and Cubic 1-D element.

Analysis of Plane Trusses: Plane trusses, Formulation of problem, Generation of element stiffness matrix, Assembly of global stiffness matrix and Load vector, Boundary conditions and Solution. Band width of a matrix.
Shape functions for Constant Strain Triangle (CST), Linear Strain Triangle (LST) and 4-noded rectangular element. 2-D stress deformation, Finite element formulation, Derivation of element equation, Problem solution for two-dimensional stress deformation problems using CST.
Introduction to Isoparametric element and its formulation; Jacobian matrix. Numerical integration; Gauss Legendre quadrature technique.
Stiffness matrix for a beam element. Hermite shape function. Applications to determinate and Indeterminate beams; Finite element formulation, Load vector, Boundary conditions, Shear force and Bending moment, Problem solution.

Dynamic Considerations in FEM: Introduction, Formulation of element mass matrix; for bar and beam element, Evaluation of Eigenvalues and Eigenvectors.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. S.S Bhavikatti, Finite Element Analysis, New Age International Publishers, Third Edition,2015
2. J. N. Reddy, An Introduction to the Finite Element Method, McGraw-Hill.
3. T. R. Chandraputla, A. D. Belegundu, Introduction to Finite Elements in Engineering; Pearson, 2015
4. K. J. Bathe, Finite Element Procedure, Prentice-Hall of India.
5. C. S. Krishnamoorthy, Finite Element Analysis-Theory and Programming; Tata McGraw-Hill.
6. Desai and Abel, Introduction to the Finite Element Method; CBS Publishers.
7. Singiresu and Rao, The Finite Element Method in Engineering; Butterworth-Heinemann.</td></tr>
</table>

Subject Code CV518	Advanced Steel Structures	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• Design members subject to tension and compression • Understand the different types of welded and bolted connections • Analyze and design different types of trusses and industrial buildings • Understand the behavior of compression and flexural members • Design light gauge steel structures	

Design of members subjected to combined forces: design of purlins, louver rails, gable column and gable wind girder, design of simple bases, gusseted bases and moment resisting base plates.

Design of connections: types of connections, welded and bolted, throat and root stresses in fillet welds, seated connections, unstiffened and stiffened seated connections, moment resistant connections, clip angle connections, split beam connections, framed connections, hsfg bolted connections.

Analysis and design of industrial buildings: analysis and design of different types of trusses, analysis and design of industrial buildings, sway and non-sway frames, aseismic design of steel buildings.

Plastic analysis of structures: introduction, shape factor, moment redistribution, combined mechanisms, analysis of portal frames, effect of axial force - effect of shear force on plastic moment, connections, requirements, moment resisting connections. Design of straight corner connections, haunched connections, design of continuous beams.

Design of light gauge steel structures: introduction to direct strength method, behaviour of compression elements, effective width for load and deflection determination, Behaviour of Unstiffened and Stiffened Elements, Design of webs of beams, Flexural members, Lateral buckling of beams, Shear Lag, Flange Curling, Design of Compression Members, Wall Studs.

Text/Reference Books

1. IS 800:2007 General constructions in steel
2. Lynn S. Beedle, Plastic Design of Steel Frames, John Wiley and Sons, 1990.
3. Narayanan.R.et.al., Teaching Resource on Structural steel Design, INSDAG, Ministry of Steel Publishing,2000.
4. Subramanian. N, Design of Steel Structures, Oxford University Press, 2014.
5. Wie Wen Yu, Design of Cold Formed Steel Structures, McGraw Hill Book Company, 199
6. Chen, W. F., & Kim, S. E. (1997). LRFD steel design using advanced analysis (Vol. 13). CRC press.

<table>
<tr><td>Subject Code
CV519</td><td>Non-Destructive Testing and Evaluation</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Understand the differences between NDT and mechanical testing
• Assess the concept of liquid penetrant testing and its application
• Understand the theory of magnetic particle testing
• Assess the principles and inspection methods involved in thermography</td></tr>
<tr><td colspan="3">NDT versus Mechanical testing: Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection, Unaided and aided, Fundamentals and introduction to destructive and non-destructive testing. Scope and limitations of NDT, Visual examination methods. Different visual examination aids

Liquid Penetrant Testing: Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results.

Magnetic Particle Testing: Theory of magnetism, inspection materials Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Thermography: Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation, infrared radiation and infrared detectors, Instrumentations and methods, applications, Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. ASM Metals Handbook, “Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey,2005
3. Charles, J. Hellier, “Handbook of Nondestructive evaluation”, McGraw Hill, New York2001.
4. ASNT, American Society for Non-Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing</td></tr>
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<tr><td>Subject Code
CV520</td><td>Experimental Stress Analysis</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Apply principles of elasticity theory to determine stresses and strains
• Apply theory of elasticity and formulate plane stress and plane strain problems
• Understand the types and working of static and dynamic recording systems
• Understand the concept of three-dimensional photo elasticity</td></tr>
<tr><td colspan="3">Introduction: Theory of Elasticity, Plane stress and plane strain conditions, compatibility conditions, problem using plane stress and plane strain conditions, three-dimensional stress strain relations. Strain measurement methods: various types of strain gauges, electrical resistance strain gauges, semiconductor strain gauge circuits.

Recording Instruments: Introduction, static recording and data logging, dynamic recording at very low frequencies, dynamic recording at intermediate frequencies, dynamic recording at high frequencies, dynamic recording at very high frequencies, telemetry systems.

Brittle Coatings: Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data.

Moire Methods: Introduction, mechanism of formation of Moire fringes, the geometrical approach to moiré-fringe analysis, the displacement field approach to Moire-fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of moiré-fringes, experimental procedure and techniques.

Photo Elasticity: Photo elasticity, polariscope, plane and circularly polarized light, bright and dark filed setup, photo elasticity materials, Isochromatic fringes – Isoclinics.

Three Dimensional Photo Elasticity: introduction, locking in model deformation, materials for three dimensional photo elasticity, machining cementing and slicing three dimensional models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the shear-difference method in three dimensions, applications of the Frozen-stress method, the scattered light method Bi refringent coating: Introduction, coating stress and stains, coating sensitivity, coating materials, application of coatings, effective of coating thickness, fringe-order determinations in coatings, stress separation methods.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Timoshenko and Goodier, Theory of Elasticity, 3rd Ed., McGraw Hill2010
2. J.W. Dally and W.F.Riley, Experimental Stress Analysis, 3rd Edition, McGraw Hill 1991
3. A treatise on Mathematical theory of elasticity / LOVE A.H./ Dover Publications
4. Frocht, M.M., Photoelasticity. J. Wiley and Sons, London, 3rd Edition
5. Sadhu Singh, Experimental Stress Analysis, Khanna Publications.</td></tr>
</table>

Subject Code CV521	City and Urban Planning	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• Identify the different stages involved in urban planning • Understand various types and principles of planning • Examine the urban planning agencies and their functions • Understand the town and country planning act and building byelaws	

Changing Cities & Neighborhoods: Broad Knowledge of the Concepts and Theories Relevant to the Study of Urban development; Spatial Planning and Urban Policy (together with an understanding of the main trends in urban development in developing countries today)

Policy Analysis for Urban development: Introduction of Different Ways of Thinking about what Policy is and how it is formulated: The Actors, Institutions, Ideologies, Information (Evidence), Popular Opinion, The Media and Other Factors that Influence Urban Policy Making and Policy Outcomes with Respect to Urban Renewal and Regeneration

Regenerating Cities-Strategies & Evaluation: An Overview of the Development, Delivery and Impact of Regeneration Strategies; The Challenges of Achieving Effective Regeneration in Indian Cities in the Context of Global Change and Competition and Experiences in South East Asian and East Asian Countries

The Role of Public Sector Agencies: Area Based development Initiatives; Property-Led Development Policies; Investment and Funding of Urban Development Schemes 25

Role of private sector in development: Nature of In-fill; Development Potential and Pricing; Land locking and stagnation; Plot reconstitution

Renewal through Housing and Mixed-Use Development: Community Participation in Renewal Schemes; Sustainable Development through Urban Renewal; Brownfield Development with Respect to Urban Renewal in Cities

Integrated Urban Conservation: Principles, Economic, Legal and Tourism Aspects; Planning Procedures, Inspection and Surveys; Investigation Techniques; Methods for Inventories and Documentation; Identification and Reporting on Heritage Zones; Grading and Enlisting

Programs and Techniques for Adaptive Reuse, Restoration, Rehabilitation: New Buildings in Historic Settings, Aspects and Design Methods

Implementation of Plans and Urban Management: Phasing, Resource Mobilization, Incentives; Acts, latest advancements.

Text/Reference Books	1. Hutchinson, B.G., Principles of Urban Transport Systems Planning, Scripta, McGraw-Hill, New York, 1974. 2. Claire, Hand Book of Urban Planning, Van Nostrand Book Company, 1974. 3. Gallian, B. Arthur and Simon Eisner, The Urban Pattern - City Planning and Design, Affiliated Press Pvt. Ltd., New Delhi, 1985. 4. Margaret Roberts, An Introduction to Town Planning Techniques, Hutchinson, London, 1980. 5. Hiraskar, G.K., Fundamentals of Town Planning, Dhanpat Rai Publications, 1992.

<table>
<tr><td>Subject Code
CV522</td><td>Remote Sensing and GIS</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Understand the basics of Geographic Information System and its components
• Introduce the process of map preparation and projections
• Identify the systems of data representation and analysis in GIS
• Understand the basic concepts of remote sensing and its integration with GIS</td></tr>
<tr><td colspan="3">Introduction to Geographic Information System: Definitions and related terminology, evolution of GIS, components of GIS, approaches to the study of GIS.

Maps and GIS: Introduction, Map scale and classes of maps, the mapping process, plane coordinate systems and transformations, geographic coordinate system of earth, map projection, geo-referencing and topographic mapping.

Digital Representation of Geographic Date: Introduction, database and database management systems, raster geographic date representation, vector data representation, data representation and data analysis in GIS.

Raster Basic GIS Data Processing: Introduction, acquiring and handling raster geographic data, raster-based GIS data analysis, cartographic modeling.

Vector Based GIS Data Processing: Introduction, Characteristics of vector-based GIS data processing, topological and non-topological functions.

Remote Sensing and GIS: Introduction, Principles of electromagnetic remote sensing, remote sensing system classifications, imaging characteristics, extraction of metric information from remotely sensed images, integration of remote sensing and GIS.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. M Anji Reddy, A Textbook of Remote Sensing and Geographical Information Systems, Fourth Edition, BS Publications,2012
2. Lo C P and Young K W, “Concepts and Techniques of Geographic Information Systems” PHI Pvt. Ltd, New Delhi, 2002.
3. Campbell J B, “Introduction to remote sensing” CBS Publishers & Distributors, New Delhi, 2003.
4. Burrough P A, “Principles of Geographic Information Systems for Land Resources Assessment” Oxford University Press, 2003.
5. Duggal S K, “Surveying Volume 2” Tata McGraw Hill, 4th Edition, 2013.
6. Donnay JP, “Remote Sensing and Urban Analysis” CBS Publishers & Distributors, New Delhi, 2003.</td></tr>
</table>

Subject Code CV523	Environmental Pollution and Control	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• Analyze the effects of pollutants on the environment • Distinguish air pollution control methods • Assess treatment technologies for wastewater • Identify treatment technologies for solid waste • Select treatment methodologies for hazardous and E-waste	

Introduction: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population growth, Pollution of air, Water and soil.

Air pollution sources & effects: Classification and properties of air pollutants, Emission sources, Behavior and fate of air pollutants, Effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, Wind velocity and turbulence, Plume behavior, Dispersion of air pollutants, Estimation of plume rise.

Air pollution sampling and measurement: Types of pollutant sampling and measurement, ambient air sampling, Stack sampling, Analysis of air pollutants.

Air pollution control methods & equipment: Control methods, Source correction methods, Cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous emissions, Design methods for control equipment. Control of specific gaseous pollutants: Control of NOx emissions, Control of hydrocarbons and mobile sources.

Water pollution: Water resources, Origin of wastewater, types of water pollutants and their effects.

Waste water sampling, analysis and treatment: Sampling, Methods of analysis, Determination of organic matter, Determination of inorganic substances, Physical characteristics, Bacteriological measurement, Basic processes of water treatment, Primary treatment, Secondary treatment, advanced wastewater treatment, Recovery of materials from process effluents.

Solid waste management: Sources and classification, Public health aspects, Methods of collection, Disposal Methods, Potential methods of disposal.

Hazardous waste management: Definition and sources, Hazardous waste classification, Treatment methods, Disposal methods.

E-waste: Sources, environmental and social issues, management practices

Text/Reference Books	1. Rao and Rao, Air Pollution; Tata McGraw-Hill Education, 1st edition,2013 2. Muralikrishna KVSG, Air Pollution and Control, Laxmi Publications,2015 3. H.C Perkins; Air Pollution; Mcgraw-Hill. 4. H S Peavy, D.R Rowe, G. Tchobanoglous, Environmental Engineering; McGraw-Hill, 1st edition,2017 5. Crawford and Martin, Air Pollution Control Theory; McGraw-Hill Inc.

<table>
<tr><td>Subject Code
CV524</td><td>Geo-Environmental Engineering</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Create awareness in the field of Geo-Environmental Engineering
• Impart knowledge on Geotechnical aspects in the disposal of waste materials and the remediation of contaminated site
• Familiarize the design of landfill and know the effect of change in environment on soil properties.</td></tr>
<tr><td colspan="3">Introduction and Soil-water-environment interaction: Introduction to geo-environmental Engineering, Soil-water-environment interaction relating to geotechnical problems, Sources of waste, classification and management of waste, Physical, chemical and geotechnical characterization of municipal solid waste, Impact of waste dump and its remediation

Geotechnical application of waste and disposal: Geotechnical use of different types such as Thermal power plant waste, MSW, mine waste, industrial waste, waste disposal facilities, Parameters controlling the selection of site for sanitary and industrial landfill. Site characterization. MoEF guidelines

Landfill Components: Landfill layout and capacity, components of landfill and its functions. Types and functions of liner and cover systems, Compacted clay liner, selection of soil for liner, methodology of construction

Leachate, Gas Management and Geosynthetics: Management of Leachate and gas. Various components of leachate collection and removal system and its design., gas disposal/utilization. Closure and post closure monitoring system, Geosynthetics- Geo membranes - geosynthetics clay liners -testing and design aspects.

Soil remediation: Investigation of contaminated soil, sampling, assessment, Transport of contaminants in saturated soil. Remediation of contaminated soil- in-situ / exit remediation, bio remediation, thermal remediation, pump and treat method, phyto-remediation and electro-kinetic remediation.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Daniel, D.E. (1993). Geotechnical Practice for Waste Disposal. Chapman, and Hall, London.
2. Koerner, R.M. (2012). Designing with Geosynthetics. Sixth Edition. Prentice Hall, New Jersey.
3. Reddi L.N and Inyang HI (2000) Geo-environmental Engineering: Principles and Applications, Marcel Dekker Inc Publication
4. R. N. Yong (2000) Geo-environmental Engineering: Contaminated Soils, Pollutant Fate, Mitigation Lewis Publication.
5. G V Rao and R S Sasidhar (2009) Solid waste Management and Engineered Landfills, Saimaster Geo-environmental Services Pvt. Ltd. Publication.
6. Ayyar TSR (2000) Soil engineering in relation to environment, LBS centre for Science and Technology, Trivandrum.
7. Hari D. Sharma, Krishna R. Reddy (2004) Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Publisher: John Wiley & Sons Inc.</td></tr>
</table>

Subject Code CV525	Advanced Pre-Stressed Composite Materials	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To perform analysis and design of prestressed concrete members and connections • To identify and interpret the appropriate relevant industry design codes. • To become familiar with professional and contemporary issues in the design and fabrication of prestressed concrete members • To understand the basic concepts of composite materials and their practical applications in structural engineering.	

Principles of Prestressing: Introduction, History of Prestressed Concrete, Classification and Types of Prestressed Concrete Structures, Prestressed Concrete Analysis, Prestressed Concrete Design, Prestressed Concrete versus Reinforced Concrete.

Constituent Materials and Code Provisions: reinforcing Steel, Prestressing Steel, Concrete

The Philosophy of Design: Strength Reduction Factors, Overload Factors.

Flexure-Working Stress Analysis and Design: Loading Stages, Useful Section Properties and Notations, Sign Conventions, Flexural Analysis - Mathematical Basis, Use of Stress-Inequality Conditions for the Design of Section Properties, Limiting the Eccentricity along the Span, Some Preliminary Design Hints, Cracking Moment.

Flexure-Ultimate Strength Analysis and Design: Load-Deflection Response, Flexural Types of Failure, Analysis of the Section at Ultimate, Concept of Reinforcement Index, Limiting Values of the Reinforcement Index, Satisfying Ultimate Strength Requirements, Design for Ultimate Strength, Indeterminate Structures and Composite Elements, Ultimate Strength

Deflections: Background Information, Short-Term Deflections, Long-Term Deflections (Simplified Method), Long-Term Deflections (Incremental Time-Step Method), Deflection Limitations, Deflection Control

Prestress Losses: Total Losses in Pretensioned Members, Total Losses in Post-Tensioned Members, Methods for Estimating Prestress Losses, Elastic Shortening, Relaxation, Shrinkage, Creep, Friction, Anchorage Set.

Analysis and design of composite beam: Methods of achieving continuity in continuous beams, Analysis for secondary moments, Concordant cable and linear transformation, Calculation of stresses, Principles of design.

Text/Reference Books	1. SS Bhavikatti, Design of Prestressed Concrete, Medtec,2019 2. Dayaratnam P, Prestressed Concrete Structures, Oxford & IBH Publishing Co Pvt Ltd, 2018 3. Louis A Pilato and Michael J. Michno, Advanced Composite Materials, Springer; Softcover reprint of hardcover 1st ed. 1994 edition (1 December 2010) 4. Krishna Raju, Prestressed Concrete Problems & Solutions, CBS Publishers & Distributors, 2017 5. Mehdi Setareh and Robert Darvas Concrete Structures, Springer Nature; 2nd ed. 2017 edition (25 August2016)

Subject Code CV526	**Earthquake Resistant Structures**	**Credits: 3 (3-0-0) Total hours: 42**
Course Objectives	• To provide a coherent development to the students for the courses in sector of earthquake engineering • To present the foundations of many basic engineering concepts related earthquake Engineering • To give an experience in the implementation of engineering concepts which are applied in field of earthquake engineering • To involve the application of scientific and technological principles of planning, analysis, design of buildings according to earthquake design philosophy.	

Engineering Geology of Earthquakes: Theory of tectonic plates, Faults, Seismic waves. Wave measuring instruments, Strong ground motions, Determination of epicentre, magnitude, epicentral distances and focal depth of earthquake, Micro zonation, Concept of seismic hazard analysis. Importance of architectural features in earthquake resistant design, Indian seismic codes, behaviour of masonry structures during earthquakes.

Methods of Analysis: Linear static analysis, Linear dynamic analysis, non-linear analysis, Modal analysis, Response spectrum method. Construction of response spectra. Equations of motion for SDOF and MDOF systems. Mode shapes and Frequencies of MDOF system, Response of multi storied building subjected to earthquake forces by Equivalent Static Load Method, Response of multi storied building subjected to earthquake forces by Response Spectrum Method.

Seismic Design and detailing: Design of flexural members and compression members for earthquake load cases. Design of shear wall, Seismic repair, rehabilitation and retrofitting, detailing of beams, columns, footings, beam-column junction as per IS 13920. Techniques used to reduce effect of earthquake on structures, Base isolation and Various types of dampers. P-Delta effects, Soil structure interaction.

Text/Reference Books	1. A.K. Chopra, Dynamics of Structures, 3rd Edition, Pearson, 2007. 2. I.S. 1893-2002, Code of Practice for Earthquake Resistant Construction of Buildings, BIS, New Delhi, 2002. 3. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall India, 2006. 4. R. L. Wiegel; Earthquake Engineering; Prentice Hall, Inc. 5. James L. Stratta; Manual of Seismic Design; Pearson education Publication. 6. S. K. Duggal; Earthquake Resistant Design of Structures; Oxford Publication. 7. Farzad Neaim; Handbook on Seismic analysis and Design of Structure; Springer.

<table>
<tr><td>Subject Code
CV527</td><td>Structural Reliability</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Provide a brief review of mathematical tools for quantifying uncertainties using theories of probability, random variables and random processes.
• To develop the theory of methods of structural reliability based on concept of reliability indices. This includes discussions on FORM and SORM.
• To introduce methods of reliability analysis using Monte Carlo simulations that includes discussion of variance reduction techniques and RSM.
• To explain the basics of code calibration.
• To provide the necessary background to carry out reliability-based design.</td></tr>
<tr><td colspan="3">Introduction to structural Reliability: basic statistics Theory of Probability Probability Distributions (Continuous & Discrete) Random Variables

Level-2 Reliability Methods: Failure Surface & Definition of Reliability in Std. Normal Space (Cornell's Reliability Index), First Order Reliability Method (FORM) Hasofer-Lind's Definition of Reliability Rackwitz-Fiessler Algorithm Asymptotic Integral, Second Order Reliability Method (SORM)

Monte-Carlo Methods: Latin Hypercube Sampling, Variance Reduction Technique, Importance Sampling and Adaptive Sampling Subset Simulation, Implicit Performance Function, Polynomial Response Surface Method (RSM) Stochastic Response Surface Method (SRSM)

Stochastic Models of Loads: Code Calibration, Partial Safety Factors, LRFD Format System Reliability, Time Varying Reliability Analysis

Reliability Based Optimization: Introduction to Stochastic FEM</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Haldar, A., and Mahadevan, S. (2000). Reliability assessment using stochastic finite element analysis. John Wiley and Sons, New York.
2. Choi S K, Grandhi R V and Canfield R A. Reliability Based Structural Design, Springer Verlag, London, UK, 2007.
3. Ranganathan, R. (1999). Structural reliability analysis and design. Jaico Publishing House, Mumbai.
4. H O Madsen, S Krenk and N C Lind, 1986, Methods of structural safety, Prentice Hall, Englewood Cliffs, NJ.
5. P Throft-Christensen & Y Murotsu, 1986, Application of structural systems reliability theory, Springer Verlag, Berlin.
6. Melchers R E., Structural Reliability: Analysis and Prediction, John Wiley, Chichester, 1999.
7. Rackwitz R, Augusti G and Borri A, Reliability and Optimization of Structural Systems, Chapman & Hall, London, UK,1995.
8. Waarts P H.Structural Reliability Using Finite Element Methods, Delft Univ. Press, Netherland, 2000.</td></tr>
</table>

Subject Code CV528	Occupational Safety and Health Act	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• Explain that occupational health and safety is more than accident prevention – that it encompasses all aspects of working conditions • Explain the role of health representatives in occupational health • Recognize a number of occupational hazards and some of the types of work generally associated with those hazards	

Occupational Health and hazards: Concept of occupational health, Occupational and Work-related diseases, History of occupational health, Characteristics of occupational diseases, Adverse health effects of noise, Vibration, Cold, Heat stress, Improper illumination, Thermal radiation, short term and Long-term effects of exposures; Preventive and Control measures.

Accident and Incident Investigation and analysis: Definition; Incident, Accident, Injury, Unsafe acts, Unsafe conditions, Hazards, Error, Oversight, Mistakes etc., standard classification of factors associated with accident. Accident reporting: Report forms, Writing reports, Essential elements, Factories Act, Workmen's Compensation Act and Rules, ESI Act and Rules, Labour Act (Abolition And Regulation), Right to Know.

Risk Assessment and Hazard Identification: Preliminary hazard analysis, What if analysis, Failure mode effect analysis, Hazard and Operability (HAZOP) studies, Hazard analysis techniques; Fault tree analysis, Event tree analysis, On-site and Off-site emergency preparedness.

Meaning and Scope of Safety in Construction: Basic parameters governing the safety in construction e.g.: Scaffolding, shuttering/form work, Working at Heights, Safe access, Good housekeeping, Safety in the use of construction machinery Safety with regard to storage, Stocking and Handling materials of construction. Safety in demolition operations; Safety precautions to be taken for and during demolition, Employee Participation in Safety- Purpose, Areas of participation, Methods, Role of trade union in Safety Health and Environment Protection.

Personal Protective Equipment: Need for personal protection equipment, selection, Applicable standards, Care and Maintenance of respiratory and Non-respiratory personal protective equipment. Non- respiratory personal protective devices: Head protection, Ear protection, Face and Eye protection. Hand protection, Foot protection, Body protection, Respiratory personal protective devices.

Text/Reference Books	1. Goetsch, D. L. (2010). Occupational safety and health. Pearson India. 2. Colling, D. A. (1990). Industrial safety: management and technology. Prentice Hall. 3. H. W. Heinrich; Industrial Accident Prevention; McGraw Hill Publication, New York. 4. Industrial Safety and Pollution Control Handbook; National Safety Council and Associate (Data) Publishers Pvt. Ltd. 5. R. K. Mishara; Construction Safety; AITBS Publishers, India. 6. Della D. E. and Giustina, Safety and Environmental Management. Van Nostrand Reinhold International Thomson Publishing Inc, 1996.

<table>
<tr><td>Subject Code
CV529</td><td>Advanced Geo-Environmental Engineering</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To create a awareness in the field of Geo-Environmental Engineering
• To impart the knowledge on Geotechnical aspects in the disposal of waste materials and the remediation of contaminated sites
• To familiarize design of landfill and know the effect of change in environment on soil properties.</td></tr>
<tr><td colspan="3">Introduction: Geo-synthetics, Forms of Waste and their Engineering Properties, Selection of Waste Disposal Sites, Landfills for Municipal and Hazardous Waste, Ash Pond and Mine Tailing Impoundments, Site Investigations for detection of Subsurface Contamination, Remediation, Geotechnical reuse of Waste Materials and Fills, Mechanics of Erosion and Erosion Control Methods, Landslides and Their Control.

Environmental cycles and their interaction with Geo-Technology. Particle Energy, Energy theory and its application.

Soil Mineralogy and Technology changes in respect of waste water flow. Thermal and Electrical properties of soil and Rock.

Application of Geo- Environmental Engineering: Load-Environmental factors design, soil structure- soil interaction, Bearing Capacity, Lateral Earth pressures, Pile foundation grouting and injection, Slope Stability of waste material, stability of landfills, Stabilization and remedial works.

Wetlands, Coastal Margins and Soil. Erosion problems and control / management. Arid lands, Desert and Anti-desertification. Special Topics related with Field Problems</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. R. N. Yong (2000) Geo-environmental Engineering: Contaminated Soils, Pollutant Fate, Mitigation Lewis Publication.
2. Reddi L.N and Inyang HI (2000) Geo-environmental Engineering: Principles and Applications, Marcel Dekker Inc Publication
3. Hari D. Sharma, Krishna R. Reddy (2004) Geo-environmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Publisher: John Wiley & Sons Inc.
4. Rowe, R.K., Geotechnical and Geo-environmental Engineering Handbook, Kluwer Academic publishers,2001
5. Dr. G V Rao and Dr. R S Sasidhar (2009) Solid waste Management and Engineered Landfills, Saimaster Geo environmental Services Pvt. Ltd. Publication.
6. Ayyar TSR (2000) Soil engineering in relation to environment, LBS centre for Science and Technology, Trivandrum.
7. Donald L. Wise, Debra J. Trantolo, Hilary I. Inyang, Edward J. Cichon (2000) Remediation Engineering of Contaminated Soils, Publisher: Marcel Dekker Inc.</td></tr>
</table>

<table>
<tr><td>Subject Code
CV530</td><td>Multi-Hazard Resistant Design</td><td>Credits: 3 (0-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Learn the causes of earthquake and effects of ground motion and modeling of structures.
• Study the response spectra and structural dynamics of MDOF systems.
• Discover the different analysis and design approaches like equivalent lateral force method and inelastic time history analysis.
• Be trained in the ductile detailing of reinforced concrete structures as per IS 4326 andIS13920.
• Learn the seismic analysis of masonry buildings.</td></tr>
<tr><td colspan="3">Earthquake Ground Motion: Engineering seismology - Seismic zoning map of India - Strong motion studies in India - Strong motion characteristics - Evaluation of seismic design parameters.

Structural Dynamics: Initiation into structural dynamics - Dynamics of SDOF systems - Theory of seismic pickup - Numerical evaluation of dynamic response - Response spectra - Dynamics of MDOF systems.

Concepts of earthquake resistant design of RCC structures: Basic elements of earthquake resistant design - Identification of seismic damages in RCC buildings - Effect of structural irregularities on performance of RCC buildings during earthquakes - Earthquake resistant building architecture.

Seismic analysis and modeling of RCC structures: Code based procedure for determination of design lateral loads - Infill walls - Seismic analysis procedure as per IS 1893 code - Equivalent static force method - Response spectrum method - Time history analysis - Mathematical modeling of multi-storey RCC buildings.

Earthquake resistant design of RCC structures: Ductility considerations - Earthquake resistant design of multi-storey RCC buildings and shear walls based on IS 13920 code - Capacity based design.

Earthquake resistant design of masonry structures: Identification of damages and non-damages in masonry buildings - Elastic properties of structural masonry - Lateral load analysis of masonry buildings - Seismic analysis and design of one-storey and two-storey masonry buildings</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. D J Dowrick, Earthquake Resistant Design and Risk Reduction, Willey India, 2011.
2. S.K. Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press, New Delhi,2007
3. Agrawal Pankaj & Shrinkhande Manish, “Earthquake Resistant Design of Structures” 1st Edition, Prentice Hall of India Pvt Ltd, New Delhi,2004.</td></tr>
</table>

Subject Code CV531	# Non-Conventional and Renewable Energy	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To exploit renewable energy resources and effective technologies • Understand the various forms of conventional energy resources. • Learn the present energy scenario and the need for energy conservation • Outline division aspects and utilization of renewable energy sources for both domestics and industrial application	

Statistics on conventional energy: Sources and supply in developing countries, Definition Concepts of NCES, Limitations of RES, Criteria for assessing the potential of NCES. Classification of NCES, Solar, Wind, Geothermal, Bio-mass, Ocean Energy Sources, comparison of these energy sources.

Solar Energy: Energy available form Sun, Solar radiation data, Solar energy conversion into heat, Flat plate and Concentrating collectors, Mathematical analysis of Flat plate collectors and collector efficiency, Principle of Natural and Forced convection, Solar engines-Stirling, Brayton engines, Photovoltaic, p-n junction, solar cells, PV systems, Stand-alone, Grid connected solar power satellite.

Wind energy conversion: General formula -Lift and Drag- Basis of wind energy conversion, Effect of density, frequency variances, angle of attack, and wind speed. Windmill rotors Horizontal axis and vertical axis rotors. Determination of torque coefficient, Induction type generators-working principle.

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India.

Text/Reference Books	1. B H Khan, "Non-Conventional Energy Resources", 2nd Edition, Tata Mc Graw Hill Education Pvt Ltd,2011 2. S.Hasan Saeed and D.K. Sharma , "Non-Conventional Energy Resources",3rd Edition, S.K. Kataria & Sons,2012 3. Ashok V Desai, Non-Conventional Energy, Wiley Eastern Ltd, New Delhi, 2003 4. Ramesh R & Kumar K U, Renewable Energy Technologies, Narosa Publishing House, New Delhi, 2004 5. Wakil MM, Power Plant Technology, Mc Graw Hill Book Co, New Delhi, 2004. 6. G.N.Tiwari and M.K. Ghosal, "Renewable Energy Resource: Basic Principles And Applications", Narosa PublishingHouse,2004

<table>
<tr><td>Subject Code
CV532</td><td colspan="2">Structural Dynamics</td><td>Credits: 3 (3-0-0)
Total Hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">

To expose the students to vibration theory and problems, earthquake hazards and earthquake engineering principles, earthquake disaster management.
To impart training to graduate students to the latest earthquake resistant design philosophies, codal design and design philosophies beyond code, so that the students can independently tackle earthquake engineering problems and they can handle the earthquake hazard mitigation projects.
To expose the graduate students to current national and international scenario on earthquake engineering and to motivate them in interdisciplinary involvement in earthquake related problems.
To orient the graduate students to high value research on Structural Dynamics and earthquake Engineering so that they get impetus to pursue lifelong learning.

</td></tr>
<tr><td colspan="4">
Engineering Geology of Earthquakes: Theory of tectonic plates, Faults, Seismic waves. Wave measuring instruments, Strong ground motions, Determination of epicenter, magnitude, Epicentral distances and Focal depth of earthquake, Micro-zonation, Concept of seismic hazard analysis. Importance of architectural features in earthquake resistant design, Indian seismic codes, Behavior of masonry structures during earthquakes.
Introduction to Methods of Analysis: Linear static analysis, Linear dynamic analysis, non-linear analysis, Modal analysis, Response spectrum method. Construction of response spectra. Equations of motion for SDOF and MDOF systems. Mode shapes and Frequencies of MDOF system.
Multi storied buildings: Response of multi storied building subjected to earthquake forces by Equivalent Static Load Method and Response Spectrum Method.
Design: Design of flexural members and compression members for earthquake load cases. Design of shear wall, Seismic repair, rehabilitation and retrofitting.
Detailing: Detailing of beams, columns, footings, beam-column junction as per IS 13920. Techniques used to reduce effect of earthquake on structures, Base isolation and Various types of dampers. P-Delta effects, Soil structure interaction.
</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">

A. K. Chopra; Dynamics of Structures; Pearson Education, 4th edition, 2012.
R R Craig, Andrew, “Fundamentals of structural dynamics”, John Wiley and Sons, 2nd edition,2006
James L. Stratta; Manual of Seismic Design; Pearson education Publication.
Mario Paz; Structural Dynamics; CBS publishers.
S. K. Duggal; Earthquake Resistant Design of Structures; Oxford Publication.
IS 1893: Part I-IV and IS 13920 and relevant IS Codes

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<table>
<tr><td>Subject Code
CV533</td><td>Design of Bridges</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To make the students familiar with the IRC classes of loading for detailed calculation of loadings and design of various components.
• To design the basic components of bridge structures like bridge deck slabs longitudinal girders transverse girders, piers and well foundations.</td></tr>
<tr><td colspan="3">General Types and Classification of Bridges: Arch, Slab, Box Culvert, Beam and Slab, Plate Girder, Composite Bridges, Components of bridges, Investigation and Planning for bridges, Design flood discharge, Linear waterways.

Loads for Bridges: IRC loadings, Dead load, Live load, Impact load, Wind load, Longitudinal and Horizontal forces.

Design of Concrete Bridges: Superstructure, Design of box culvert, Introduction, Design method and Design example.

Design of Beam and Slab Bridges: Design of interior panel of slab. Pigeauds method, design of longitudinal girder, Calculation of longitudinal moment design example.

Design of Reinforced Concrete Solid Slab Bridges: General design features, Effective width method. Simply supported slab bridge analysis and Design.

Stability Analysis of Abutments and Piers: General scour at abutments and Piers, Grip length, Types of abutments and Piers and Stability of abutments and Piers for different loading combinations.

Bridge Foundations: Types of bridge foundations, Stability of different types of foundations, Design of shallow, Pile, Well foundations and Pneumatic caissons.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. N. Krishna Raju; Bridge Engineering; 3rd edition Oxford and IBH Publishing Co., New Delhi, 2006
2. Johnson Victor, D, 2008, Essentials of bridge engineering, 6th Edition, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
3. Victor D.J, Essentials of Bridge Engineering, 6th Edition, Oxford and IBH Publishers, 2007.
4. T. R. Jagadeesh, M. A. Jayaram; Design of Bridge Structures; Phi Learning Pvt. Ltd, NewDelhi, 2009.
5. S. Ponnuswamy; Bridge Engineering; Tata McGraw Hill. 2nd edition -2015
6. IRC-6, IRC-22, IRC-37.</td></tr>
</table>

<table>
<tr><td>Subject Code
CV534</td><td>Rapid Transport System and Smart Cities</td><td>Credits: 3 (3-0-0)
Total hours:42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To study urban transportation planning.
• Learn about transportation economics.
• To study about smart cities and infrastructure</td></tr>
<tr><td colspan="3">Introduction to Intelligent Transportation Systems (ITS): Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS, ITS Data collection techniques, Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

Urban Transportation Planning: Urban morphology, Urbanization and travel demand, Urban activity systems and travel patterns, Systems approach, Trip based and Activity based approach, Urban Transportation Planning, Goals, Objectives and Constraints.

Transportation Economics: Introductory Concepts in Transportation Decision Making: Overall transportation project development, budgeting, financial planning, the process of transportation project development, models associated with transportation impact evaluation; Transportation costs, Classification of transportation costs, transportation agency costs, transportation user costs, general structure and behavior of cost functions and road pricing.

Smart cities and infrastructure: Defining a smart city, Smart infrastructure-smart buildings, smart mobility, smart energy, smart water, smart waste management, implementing smart infrastructure-The need to localize smart infrastructure, Policy instruments for promoting the localization of smart infrastructure, policy instruments for meeting smart city financial needs, Smart infrastructure design principles and policy approaches</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. AsierP, Unai H., Enrique O., Intelligent transport system: technologies and applications, Wiley 1st edition (2015)
2. Smart cities and urban development with special reference to planning and transportation, P. K. Garg, VC, UTU
3. Intelligent Transport Systems: Technologies and applications by Ignacio Julio García Zuazola, Enrique Onieva, Unai Hernandez-Jayo, Asier Perallos, Wiley 1st edition-2015
4. Transportation Planning Handbook, 4thEdition, Institute of Transportation Engineers, John Wiley
5. Transportation Economics, Herbert Mohring, Ballinger Pub. Co</td></tr>
</table>

<table>
<tr><td>Subject Code
CV535</td><td>Structural Stability</td><td>Credits: 3 (3-0-0)
Total Hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To determine the buckling loads for simple columns and frames,
• To have an understanding of the concept of effective length and its use in design and apply advanced numerical techniques to bucking analysis of structures</td></tr>
</table>

Introduction to potential energy methods for single degree-of-freedom elastic systems: Axioms connecting potential energy to equilibrium and stability. General Theory approach. Determination of bifurcation points and classification of stability of equilibrium for post-buckling responses for geometrically perfect systems. Imperfect systems: determination of imperfection-sensitivity.

Instabilities in struts and columns: direct equilibrium and energy formulations; Euler load and the elastica; effective length concept. Approximate methods of analysis: Rayleigh and Timoshenko methods. Ultimate strength of real columns using the Perry-Robertson formulation and the description of the method for designing steel columns in Eurocode 3.

Multiple degree-of-freedom elastic systems: diagonalized systems; elimination of passive coordinates; non-trivial fundamental paths; introduction to mode interaction.

Instabilities in beams: direct equilibrium and energy formulations, critical moment for lateral-torsional buckling, general loading cases and effective lengths and design of steel beams

Instabilities in rigid framed structures: analysis using stability functions and limitations.

Instabilities in plates: critical and post-buckling of plated structures under compression and shear.

Text/Reference Books	1. W.F. Chen and E.M. Liu (1987), Structural Stability, Pearson 2. Timoshenko and Gere, Theory of structural stability, McGraw hill international book company, 1985.

<table>
<tr><td>Subject Code
CV536</td><td>Rock Mechanics and Engineering</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">1. To give details of Mechanics of rock failure and other aspects of stability of underground.
2. To determine properties and behavior of various types of rock under different loading conditions for underground and open excavations.
3. To study engineering classification of rocks.</td></tr>
</table>

Introduction: Definition, Development of rock mechanics, Objectives of rock mechanics, Application of rock mechanics, Similarities and difference between soil mechanics and rock mechanics, discontinuities in rocks

Physical Properties: Specific gravity, porosity, void index, unit weight, water absorption, Degree of saturation, slake durability index, rock sampling.

Compressive Strength of Rock: Stress distribution in specimen under compression, Modes of failure in compression, Failure mechanism of specimens in compression, Factors affecting compressive strength, End friction, specimen geometry, rate of loading, moisture and confining pressure.

Elastic Constants: Static and dynamic elastic constants, Significance and application, Determination of static and dynamic elastic constants, Typical stress-strain curves for rocks, Complete stress-strain curve,

Tensile Strength: Significance and application of tensile strength, Laboratory determination of tensile strength, Direct methods, Indirect methods, bending tests, Hydraulic extension tests, Diametral compression tests, other methods, Factors affecting tensile strength of rock.

Shear Strength: Significance and application, Various methods of estimating shear strength, single shear test, double shear test, punch shear test, oblique shear test, rock core direct shear test, Concept of shear strength of jointed rock.

Engineering Classification of Rocks: Necessity, aim, and process of classification, Classification of intact rocks- ISRM and Deere and Miller classification, Engineering Classification of rock mass- RQD, BGD and RMR systems of classifications.

In situ-Tests: Necessity, plate bearing test, pressure tunnel test, pressure meter test and direct shear test and field permeability tests

<table>
<tr><td>Text/Reference Books</td><td>1. Dr. BP Verna Engineering geology and rock mechanics,4th edition (2017)
2. Ramamurthy T., Engineering in Rocks for Slopes, Foundations and Tunnels, PHI Learning Pvt. Ltd.2010.
3. Deb Debasis, Verma Abhiram Kumar. Fundamental and applications of rock mechanics (2016)
4. R.J. Twiss and E.M.Moores, Structural Geology, W.H. Freeman and Co,2007.
5. Zhang Lianyang. Engineering Properties of Rocks. Elsevier, 2005.
6. Hand book on rock mechanics (Vol I to IV), Lama and Vutukuri</td></tr>
</table>

<table>
<tr><td>Subject Code
CV537</td><td>Ocean Engineering</td><td>Credits: 3 (3-0-0)
Total Hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To give an overview about the waves and its kinematics</td></tr>
<tr><td colspan="3">Introduction to ocean environment and ocean floor characteristics, waves, tides, currents, seawater properties; Linear wave theory: Governing Equation, Boundary Conditions and solutions, Dispersion relation, Constancy of wave period.

Wave Kinematics: Wave celerity, water particle velocities, accelerations, displacements and pressures. Approximations for deep and shallow water conditions.

Wave Transformations: Shoaling, bottom friction and damping, refraction, reflection and diffraction. Wave Breaking: Type of breaking, Surf similarity parameter.

Non-linear wave theories-Strokes, Cnoidal and Solitary wave theory. Mass transport velocity. Introduction to Random and directional waves.

Wave Loads: Non breaking wave forces on slender structures, Morison equation; Diffraction theory

Instrumentation for ocean applications: pressure sensors, current meters, CTD, depth sounder, buoy systems etc.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Mani, J. S. (2011). Coastal Hydrodynamics. PHI Learning Pvt. Ltd.
2. Sorenson, R.M., Basic Coastal Engineering, A Wiley-Interscience Publication, New York, 1978.
3. Shore Protection Manual Volume I and II, Coastal Engineering Research Centre, Dept, of the Army, US Army Corps of Engineers, Washington DC, 1984
4. Dean, R.G. and Dalrymple, R.A., Water wave mechanics for Engineers and Scientists, Prentice-Hall, Inc., Englewood Cliffs, New Jersey,1994
5. Ippen, A.T., Estuary and Coastline Hydrodynamics, McGraw-Hill Book Company, Inc., New York,1978</td></tr>
</table>

<table>
<tr><td>Subject Code
CV538</td><td>Computational Fluid Dynamics</td><td>Credits: 3 (3-0-0)
Total Hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To learn finite element method in fluid dynamics.
• Modelling of model and prototype with similar hydrodynamic properties.
• To understand various numerical methods pertaining to fluid dynamics.</td></tr>
</table>

Introduction: Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description.

Classification and Overview of Numerical Methods: Classification into various types of equations, parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods.

Finite Difference Technique: Finite difference methods; different means for formulating finite difference equation; Taylor series expansion, integration over element, local function method; treatment of boundary conditions; boundary layer treatment; variable property; interface and free surface treatment; accuracy of finite difference method.

Finite Volume Technique: Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem.

Finite Element Methods: Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one- and two-dimensional elements; applications.

Methods of Solution: Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform.

Time integration Methods: Single and multilevel methods; predictor corrector methods; stability analysis; Applications to transient conduction and advection diffusion problems.

Numerical Grid Generation: Numerical grid generation; basic ideas; transformation and mapping.

Navier-Stokes Equations: Explicit and implicit methods; SIMPLE type methods; fractional step methods.

Turbulence modelling: Reynolds averaged Navier-Stokes equations, RANS modelling, DNS and LES.

Text/Reference Books

1. Ferziger, J. H. and Peric, M. (2003). Computational Methods for Fluid Dynamics. Third Edition, Springer Verlag, Berlin.
2. JiyuanTu, Guan Yeoh and Chaoqun Liu, "Computational Fluid Dynamics", Elsevier, 2nd edition,2012
3. Versteeg, H.K. and Malalasekara, W, "Introduction to Computational Fluid Dynamics" The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education,2008

<table>
<tr><td>Subject Code
CV539</td><td>Green Building Design</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To create interest among students in green buildings and motivate them to acquire knowledge in this field.
• To study IGBC rating system.
• To gain basic knowledge of green buildings and related terminology</td></tr>
<tr><td colspan="3">Introduction: Definition of green buildings, Terminologies, Objectives, Benefits, Rating systems of IGBC, Green concepts in various building types viz., Industrial, Residential, Commercial complexes, Educational institutes, Global trends in green buildings, Tangible and Intangible Benefits.

IGBC Rating System: Introduction to rating systems, IGBC rating systems, Understanding of green building measures in the areas of Site Preservation, Energy Efficiency, Materials, Water conservation and Indoor air quality.

Tools and Resources: Introduction to quantification and Design calculations, Energy simulation basics, Fundamentals of lighting simulation, Economics of building green

Basic Knowledge of Materials, Systems and Technologies: Fundamentals of HVAC, Innovative cooling technologies, Lighting, Building Management Systems, Rain water harvesting, Water treatment and Recycling techniques, Building materials, Paints, Glass and Glazing, Insulation, Interiors, Landscaping.

Incentives and Policies: Carbon trust, Carbon credit, Returns on investments, Savings, Policies towards electrical power in India. Tax credits, Grants</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Arun Solanki, Anand Nayyar. Green building management and smart automation (2019)
2. Anthony Floyd; Green Buildings: Professional Guide to Concepts, Codes and Innovations; Cenage Learning India Pvt. Ltd., 1st edition New Delhi. (2011)
3. Ross Spiegel and Dru Meadows; Green Building Materials: A Guide to Product Selection and Specification; John Wiley and Sons.3rd Edition (2010)
4. RS Means: Green building: Project planning & cost estimating,3rd edition (2010)
5. IGBC Green Homes, Detailed Reference Guide; IGBC, Hyderabad.</td></tr>
</table>

<table>
<tr><td>Subject Code
CV540</td><td>Wind Resistant Designs</td><td>Credits: 3 (3-0-0
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To impart the basic principles of wind engineering and estimation of the design wind speed.
• To understand the fundamental concepts of design of structures subjected to wind loads.
• To study behaviour of various structural systems under wind loads.</td></tr>
<tr><td colspan="3">Introduction to wind terminologies and wind map of India from IS 875 Part 3, 2015
Importance of K1, K2, K3 and K4 factor, Calculation of wind force.
Internal and external pressure coefficients.
Calculation of gust wind and cross winds for square and rectangular buildings as per IS 875 part 3, 2015.
Different structures subjected to wind forces (canopy, grand stands, buildings, curved structures, different types of roofs.)
Design of beams, columns and other structural elements for wind force.
Ductile Detailing of beams and columns.
Case study and model analysis of high rise building subjected to wind forces.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. IS 875 Part 3 (2015), Bureau of Indian Standards.
2. Holmes, J. D., “Wind loading on Structures”, Spon Press, London, U. K., 2001.
3. Dyrbye, C., Hansen, S. O., “Wind loads on structures”, John Wiley, New York,1997.
4. Simiu, E., Scanlan, R. H., “Wind Effects on Structures: fundamentals and applications to design”,3rd Edition, John Wiley & Sons, New York,1996.</td></tr>
</table>

<table>
<tr><td>Subject Code
CV541</td><td>Repair and Rehabilitation of Structures</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Assess deterioration and deficiency in ageing infrastructure
• Understand the current repair practices employed in the field
• Suggest materials and techniques for repairing and rehabilitation of deteriorated concrete structures
• Apply cost effective retrofitting strategies for repairs in buildings and bridges</td></tr>
<tr><td colspan="3">Introduction: Cause of deterioration of concrete structures, Overview of current repair practices. Diagnostic methods and Experimental investigations; Concrete strength assessment by Rebound hammer tests, Ultrasonic pulse velocity tests, Penetration resistance tests, Pull out tests and core sampling tests. Corrosion potential assessment by half-cell potentiometer tests and Resistivity measurements.

Influence on Serviceability and Durability: Effects due to temperature, Chemicals, Design and Construction errors, Corrosion mechanism. Effects of cover thickness and Cracking.

Methods of Corrosion Protection: Cathodic protection, Coatings, Corrosion inhibitors.

Selection of Repair Materials: Repair materials for concrete, Essential parameters for repair materials; Strength and Durability aspects, Costs and Suitability aspects.

Rehabilitation techniques: Important factors to be considered while selecting repair and Rehabilitation methods. Rehabilitation Techniques; Guniting, Shotcreting, Mortar repair for cracks, Reinforcement replacement, Resin/ Polymer modified slurry injection, Ferro cement jacketing, RCC jacketing, Plate bonding technique, Fiber wrapping technique. Repair and Strengthening of beams and columns.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Sidney, M. Johnson; Deterioration, Maintenance and Repair of Structures; McGraw hill.
2. Denison Campbell, Allen, Harold Roper; Concrete Structures, Materials, Maintenance and Repair; Longman Scientific and Technical.
3. R. T. Allen, S. C. Edwards; Repair of Concrete Structures; Blakie and Sons.
4. R. N. Raiker; Learning for Failure from Deficiencies in Design, Construction and Service; R and D Center (SDCPL).
5. CPWD handbook on repair and rehabilitation of RCC buildings, CPWD, New Delhi, 2002.
6. Modi and Patel, Repair and Rehabilitation of Concrete Structures, PHI Learning privateltd.,2016
7. B Vidivelli, Rehabilitation of Concrete Structures, Standard Publishers Distributors,2009</td></tr>
</table>

<table>
<tr><td>Subject Code
CV542</td><td>Engineering Optimization</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Formulate and solve deterministic optimization models including multi-variate optimization
• Apply deterministic optimization techniques for resource allocation, scheduling, inventory control and capacity expansion and transportation problems
• Introduction and overview of optimization problems including the notion of convergence and convexity</td></tr>
<tr><td colspan="3">Introduction to Optimization: Engineering application of Optimization, Statement of an Optimization problem - Optimal Problem formulation - Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima, Optimality criteria - Review of basic calculus concepts– Global optimality

Linear programming methods for optimum design: Review of Linear programming methods for optimum design, Post optimality analysis - Application of LPP models in design and manufacturing.

Optimization algorithms for solving unconstrained optimization problems: Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method.

Optimization algorithms for solving constrained optimization problems: direct methods, penalty function methods, steepest descent method - Engineering applications of constrained and unconstrained algorithms.

Modern methods of Optimization: Genetic Algorithms: Simulated Annealing, Ant colony optimization, Tabu search, Neural-Network based Optimization, Fuzzy optimization techniques, Applications.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. K Deb, Optimization for Engineering Design, PHI Learning Pvt. Ltd, 2^{nd} edition, 2012
2. Optimization concepts and applications in engineering, A. D. Belegundu and T. R. Chandrupatla, Cambridge University Press; 2^{nd} Esdition, 2011
3. S. Nash and A. Sofer, Linear and Nonlinear programming, Mc Graw Hill,1995</td></tr>
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<table>
<tr><td>Subject Code
CV543</td><td>Structural Optimization</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• Solve the problems using different optimization methodologies
• Understand the importance of classical and modern optimization methodology
• Optimization of the structural systems based on optimality conditions</td></tr>
<tr><td colspan="3">
Mathematical Statement of the Structural Optimization Problem: Definition and classification of constraints Solution process Analysis and design formulations

Classical Optimization Using Calculus of Variations: Applications to beams of maximum strength Columns and vibrating structures

Linear Programming: Simplex Method, Duality, Application to limit design of trusses and frames

Nonlinear Optimization: Use of Linear Programming for Solving (Nonlinear) Structural Optimization Problems, Separable programming Stewart and Griffith’s method Kelley’s cutting plane method

Unconstrained Optimization as a Prelude to Nonlinear Constrained Optimization: Conjugate directions method Gradient methods

Kuhn-Tucker Conditions for Optimality: Computations of Lagrange multipliers

Gradient Projection and Reduced Gradient Methods: Applications to solving structural optimization problems

Method of Feasible Directions: Applications to solving structural optimization problems

Penalty Method - Exterior and Interior Penalty Functions: Quadratic and cubic extended penalty functions Use of SUMT (Fiacco-McCormack’s sequential unconstrained minimization technique) for solving structural optimization problems

Introduction to Generalized Optimality Criteria and Dual Methods: Connection between optimality criteria and mathematical programming

Sensitivity Analysis: Direct and adjoint methods for sensitivity derivatives Approximation concepts

Recent Developments in Multilevel and Decomposition Techniques: Shape Optimization
</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Rao, S.S. (2014), Engineering Optimization: Theory and Practice, New Age International, New Delhi.
2. Raphael T. Haftka, Zafer Gürdal, (2012), Elements of Structural Optimization, Series in Solid Mechanics and its Applications, Vol. 11, Springer Science & Business Media, Netherlands.
3. Osvaldo M. Querin, Mariano Victoria, Cristina Alonso Gordoa, Rubén Ansola, Pascual Martí, (2017), Topology Design Methods for Structural Optimization, Butterworth-Heinemann.
4. Andrej Cherkaev, (2012), Variational Methods for Structural Optimization, Vol.140, Applied Mathematical Sciences, Springer Science & Business Media, Netherlands.</td></tr>
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<table>
<tr><td>Subject Code
CV544</td><td>Failure Forensics</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="2">• To provide the basics for the investigation of failures and understanding some of the pertinent legal aspects
• To prepare them for the eventual practice of forensic structural engineering.</td></tr>
<tr><td colspan="3">Failure of Structures: Review of the construction theory, performance problems, responsibility and accountability, case studies, learning from failures– causes of distress in structural members, design and material deficiencies, over loading

Diagnosis and Assessment of Distress: Visual inspection, non-destructive tests, ultrasonic pulse velocity method, rebound hammer technique, ASTM classifications, pullout tests, Bremor test, Windsor probe test, crack patterns- crack detection techniques, case studies, single and multi-storey buildings, Fibre optic method for prediction of structural weakness assessments

Environmental Problems and Natural Hazards: Effect of corrosive environments, chemical and marine environments, pollution and carbonation problems– detection and measurement of corrosion durability of RCC structures, damage due to earthquakes and strengthening of buildings, provisions of BIS 1893 and 4326

Modern Techniques of Retrofitting: Structural elements - first aid after a disaster, guniting, jacketing. Use of chemicals in repair, application of polymers– ferrocement, fiber composites and fiber reinforced concrete as rehabilitation materials, strengthening by pre-stressing, case studies, bridges, water tanks, cooling towers, heritage buildings, high rise buildings.</td></tr>
<tr><td>Text/Reference Books</td><td colspan="2">1. Sidney M Johnson, Deterioration, Maintenance and Repairs of Structures, McGraw Hill Book Company, New York
2. Dovkaminetzky, Design and Construction Failures, Galgotia Publication., New Delhi
3. Jacob Field and Kennenth L Carper, Structural Failures, Wiley Europe.</td></tr>
</table>

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<tr><td>Subject Code
CV545</td><td colspan="2">Structural Health Monitoring</td><td>Credits: 3 (3-0-0)
Total hours: 42</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• Examines the use of low-cost, long term monitoring systems to keep civil infrastructure under constant surveillance, ensuring structural integrity
• The concepts of rapid after disaster assessment of civil infrastructure.</td></tr>
<tr><td colspan="4">Introduction to SHM: An Overview of Structural Health Monitoring, Structural Health Monitoring and Smart Materials, Structural Health Monitoring versus Non Destructive Evaluation, A broad Overview of Smart Materials, Emerging SHM Technologies using Piezo Sensors SHM using Magnetostrictive Sensors, SHM using Optical Fibres and other sensors, Overview of Application Potential of SHM Notable Applications of SHM, Aerospace and Civil Applications, Underground Structures and Other Applications, Understanding Piezoelectric Material, Understanding Magnetostrictive Material, Optical Fibre and Lambwave method, Solution Domain for SHM Other Damage Indices.

Vibration control for SHM: Vibration Control using SHM, introduction to FE formulation, Constitutive Relationship, Element Stiffness Matrix for High Precision Finite Element analysis, Mass Matrix for High Precision Finite Element analysis, Developing Actuator and Sensor Influence Matrix, Estimating Sensor Voltage, Active Control of Damping, SHM of Ribbon Reinforced Composite Laminate

SHM using piezo and magnetostrictive layers: Delamination Sensing using Piezo Sensory Layer, Voltage Response from Piezopatch, Electrical Impedance Method: basic theory, SHM using Magnetostrictive Sensory Layer, Basics of Magnetization and Hysteresis Delamination, Sensing using Magnetostrictive Sensory Layer, Constitutive relationship with composite relationship, MS Layer in symmetric Laminate, MS Layer Away from the Midplane in Asymmetric Laminate, Case Studies related to MS Layer based SHM.

SHM using LDV: Experimental Modal Analysis using LDV - introduction What is LDV? Velocity and Displacement Measurement using LDV Case Study for Symmetric Laminate Case Study for Cross-ply</td></tr>
<tr><td>Text/Reference Books</td><td colspan="3">1. Gandhi and Thompson, Smart Materials and Structures, Springer Science & Business Media, 1992
2. Fu Ko Chang, Structural Health Monitoring: Current Status and Perspectives, CRC Press</td></tr>
</table>

Subject Code CV546	# Tunnel and Underground Structures	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• Identify the types of underground excavations • Understand the parameters affecting tunnel design • Understand the working and application of a tunnel boring machine • Examine the methodologies for excavation of large tunnels and special tunnel applications	

Introduction: Scope and application, historical developments, art of tunnelling, tunnel engineering, future tunnelling considerations.

Types of Underground Excavations: Tunnel, adit, decline, shaft; parameters influencing location, shape and size; geological aspects; planning and site investigations.

Tunnelling Methods: Types and purpose of tunnels; factors affecting choice of excavation technique; Methods - soft ground tunnelling, hard rock tunnelling, shallow tunnelling, deep tunnelling; Shallow tunnels, cut and cover, cover and cut, pipe jacking, jacked box excavation techniques, methods of muck disposal, supporting, problems encountered and remedial measures.

Tunnelling by Drilling and Blasting: Unit operations in conventional tunnelling; Drilling - drilling principles, drilling equipment, drilling tools, drill selection, specific drilling, rock drillability factors; Blasting - explosives, initiators, blasting mechanics, blast holes nomenclature; types of cuts- fan, wedge and others; blast design, tunnel blast performance - powder factor, parameters influencing, models for prediction; mucking and transportation equipment selection.

Tunnelling by Roadheaders and Impact Hammers: Cutting principles, method of excavation, selection, performance, limitations and problems.

Tunnelling by Tunnel Boring Machines: Boring principles, method of excavation, selection, performance, limitations and problems; TBM applications.

Supports in Tunnels: Principal types of supports and applicability.

Ground Treatment in Tunnelling: Adverse ground conditions and its effect on tunnelling; introduction to ground control.

Tunnel Services: Ventilation, drainage and pumping.

Methods of Sinking Shafts: Vertical and inclined, decline; shaft/raise boring machines and their application.

Tunnelling Hazards: Explosion, flooding, chimney formation, squeezing ground.

Text/Reference Books

1. Bickel, J.O., Kuesel, T.R., and King, E.H., 1996, Tunnel Engineering Handbook (Second Edition), Chapman & Hall, 544pages.
2. Bieniawski, Z.T., 1992, Design Methodology in Rock Engineering, A.A. Balkema, 196pages.
3. Whittaker, B. N. and Frith, R. C. (1990): Tunneling: Design, Stability and Construction, London: Institution of Mining and Metallurgy
4. Hoek, E and Brown, E.T. (1980): Underground Excavation in Rock, The Institution of Mining and Metallurgy, London
5. Mahtab, M.A., and Grasso, P., 1992, Geomechanics Principles in the Design of Tunnels and Caverns in Rocks, Elsevier Press, 250pages.
6. Bieniawski, Z. T. (1984): Rock Mechanics Design in Mining and Tunneling, Balkema.

Subject Code CV547	# Offshore Structures	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• To impart the fundamentals behind all types of fixed offshore structures • To understand the design, construction and risk-based maintenance for offshore platforms, specifically, the theory and process of such design.	

Introduction: Different types of ocean structures, Various structural systems deployed for shallow, medium, deep and ultra-deep waters

Structural Systems: Jacket or Tension leg structures, Tower, Caissons, Concrete gravity platforms, Steel, Gravity platforms, FPSO spar platforms, Hybrids, Compliant structures, factors governing selection.

Operational loads: Environmental loads due to wind, wave, current and buoyancy, Morison's Equation, Maximum wave force on offshore structure, Concept of Return waves, Principles of Static and dynamic analyses of fixed platforms, Use of approximate methods, Design of structural elements.

Fixed Platform: Concepts of Fixed Platform, Jacket and Deck Steel Tubular Member, Design Tubular Joint, Design for Static and Cyclic Loads

Offshore construction: Drilling techniques, logging methods, location of drill sites, Completion of walls, Marine survey, Welding, Checks on welding and codes, Corrosion and its prevention measures.

Text/Reference Books

1. Chakrabarti, S.K. 1990. Non-linear Method in Offshore Engineering, Elsevier Science Publisher, The Netherlands.
2. Chakrabarti, S.K. 1994. Offshore Structure Modeling: World Scientific, Singapore.
3. Chandrasekaran, S. and Bhattacharyya, S.K. 2011.Analysis and Design of Offshore Structures. HRD Center for Offshore and Plant Engineering (HOPE), Changwon National University, Republic of Korea,
4. Cowell RG, Dawid AP, Lauritzen, SL, Spiegelhalter, DJ., Probabilistic networks and expert systems. New York: Springer; 1999.
5. Srinivasan Chandrasekaran. 2014.Advanced Theory on Offshore Plant FEED Engineering, Changwon National University Press, Republic of South Korea,
6. Srinivasan Chandrasekaran. 2015.Advanced Marine structures, CRC Press, Florida,
7. Srinivasan Chandrasekaran. 2015. Dynamic analysis and design of ocean structures. Springer.
8. Srinivasan Chandrasekaran. 2016, Offshore structural engineering: Reliability and Risk Assessment. CRC Press, Florida,
9. API RP 2A, Planning, Designing and Constructing Fixed Offshore Platforms, API

Subject Code CV548	# Hazardous Waste Management	Credits: 3 (3-0-0) Total hours: 42
Course Objectives	• Understand the regulations involved in municipal solid waste disposal • Identify the classes and disposal methods of different types of hazardous wastes • Understand the sources and disposal techniques of radioactive wastes • Assess the physicochemical and biological treatment techniques of hazardous wastes	

Relevant Regulations Municipal solid waste: Management and handling rules; hazardous waste (management and handling) rules; biomedical waste handling rules; fly ash rules; recycled plastics usage rules; batteries (management and handling) rules.

Hazardous Waste Management: Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects.

Radioactive Waste Management: Fundamentals Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options.

Environmental Risk Assessment: Defining risk and environmental risk; methods of risk assessment; case studies.

Physicochemical Treatment: Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation.

Biological Treatment: Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation.
Landfill design Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration.

Text/Reference Books	1. S.C. Bhatia, Solid and hazardous waste management, Atlanticedition,2008 2. John Pichtel, Waste Management Practices CRC Press, Taylor and Francis Group 2005. 3. La Grega, M.D, Buckingham, P. L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Edition, New York, 2001. 4. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997. 5. Rao and Sultana, Solid and Hazardous Waste management, B S Pubications, 2012