CURRENT COURSE STRUCTURE FOR B.TECH.-M.TECH. (DUAL DEGREE) STUDENTS
ELECTRICAL ENGINEERING

	S E M E S T E R										
	FIRST	**SECOND**	**THIRD**	**FOURTH**	**FIFTH**	**SIXTH**	**SEVENTH**	**EIGHTH**	**SUMM.**	**NINTH**	**TENTH**
C O U R S	PHY102 MTH101 HSS-I-1/ ENG112N TA101 ESC102 PE101	PHY101 CHM101 PHY103 MTH102 ESC101 EE100 PE102	MTH203 CHM201 TA201 EE200 ESO202 OR ESO214	HSS-I-2 ESO209 ESO210 EE210 EE250	HSS-II-1 EE320 EE330 EE370 EE380 OE-1	SE-1 EE340 EE381 **3 OUT** OF EE301 EE311 EE321 EE60	DEL-1 HSS-II-2 OE-PG-1 OE-PG-2 OE-PG-3/	OE-PG-3/ DEL-2 OE-PG-4 OE-PG-5 DEL-3 EE699 4 Credits	DE-PG-1 EE699 4 Credits	EE699 12 Credits	EE699 16 Credits

CHM 201 Chemistry
Com-S 200 Communication Skills
ESO 202 Thermodynamics or
ESO 214 Nature & Properties of Materials
EE 200 Signals, Systems and Networks
TA 201 Introduction to Manufacturing
MTH 203 Mathematics III
ESO 209 Probability & Statistics
ESO 210 Introduction to Electrical Engg.
EE 210 Microelectronics - I
EE 250 Control System Analysis
HSS
EE 320 Principles of Communication
EE 330 Power Systems
EE 370 Digital Electronics & Micro-processor Technology
EE 380 Electrical Engineering Lab. - I
HSS
OE Open Elective
EE 340 Electromagnetic Theory
EE 381 Electrical Engineering Lab. - II
SE Science Elective
Three courses out of the following four:
EE 301 Digital Signal Processing
EE 311 Microelectronics II
EE 321 Communication Systems
EE 360 Power Electronics
SE Science Elective
OE Open Elective
DE Department Elective
DE Department Elective
EE 491 Project-I
HSS
DE Department Elective
OE Open Elective
OE Open Elective
EE 492 Project - II
Summer training and industrial tour are optional.

CORE COURSES

CHM 101 **CHEMISTRY LABORATORY**

L-T-P-D-[C]
0-1-3-0-[2]

Permanganometric Titrations, Acid - Base titrations, Iodometric titrations, Complexometric titrations, Dichrometric titrations, Recycling of aluminium, Preparation and analysis of a metal complex, Polynuclear metal complexes with multidentate briding ligands, Chromatography of natural pigments, Viscosity of solutions, Chemical kinetics, Heterogeneous equilibrium, Photochemical oxidation - reduction, Application of free electron model, Spectrophotometric estimation, Synthesis of antioxidants used as food preservatives, Preparation of polymer films, Preparation of azo-dyes and dyeing, Resolution of commercial Ibuprofen.

CHM 201 **CHEMISTRY**

L-T-P-D-[C]
3-1-0-1-[4]

Physical Principles: Experimental methods of structure determination, Systems at finite temperature, Molecular reaction dynamics. Chemistry of Molecules: Introduction to molecules, Principles and applications of Transition Metal ion chemistry, Organometallic chemistry, Green chemistry, Structure of organic molecules, Synthesis of organic molecules, Photochemistry of organic and biomolecules, Chemistry of life processes, Biotechnology and Biomedical applications.

ESC 101 **FUNDAMENTALS OF COMPUTING**

L-T-P-D-[C]
3-1-3-0-[5]

introduction to Linux, the programming environment, write and execute the first program, introduction to the object oriented (OO) approach-classes, objects, state through member variables, interface through member functions/ methods. Give many examples of (OO) approaches to problem solving in science and engineering, Procedural programming, Introduction to basic input-output - Assignment and expressions, Control: if, if-then-else, case, go, continue, break, Loops, interators, enumerations examples form algebraic equation solving, Function as a procedural abstraction, argument passing, references, Basic containers: Array, Vector, examples from solving systems of linear equations, Recursion, Object-oriented aspects, Programming using classes and objects, Scope, encapsulation, visibility, Inheritance, subtypes, static-dynamic binding, Primitive types, classes as types, wrapper classes for primitive types

Java i/o system, More container classes-list, hashtable, set, sortedset, algorithms which use these classes, Interfaces.

ESC 102 **INTRODUCTION TO ELECTRONICS**

L-T-P-D-[C]
3-1-3-1-[5]

Passive components, Signal sources, DC circuit analysis, Time domain response of RC and RL circuits, Discrete electronic devices, Sinusoidal steady state response, phasor, impedance, Two port network, basic feedback theory, frequency response, transfer function, DC Power supply, BJT biasing, Simple transistor amplifier, differential amplifier, Op-amp, Circuits using op-amp, Waveform generators, 555 timer, Simple active filters, Logic gates, multiplexers, combinatorial circuits, Combinatorial circuit design, K-map, Sequential circuits, Flip-flops, Counters, shift registers, sequence generators, DA converters, AD converters, Basic micro-computer architecture.

Laboratory Experiments : Familiarization with passive components, function generator and oscilloscope, Step and frequency response of RC and RL circuits, Some electronic components and their characteristics, DC power supply, Voltage amplifiers using op-amp, Comparators, Schmitt trigger and Active filters, Waveform generators using op-amp and 555 timer, Combinatorial circuits, Sequential circuits, Digital-to-analog converters and analog-to-digital converters.

ESO 202 **THERMODYNAMICS**

L-T-P-D-[C]
3-1-0-1-[4]

Definitions & concepts: SI Units; System; Property; Energy; Thermodynamic Equilibrium; Work, State Postulate; Zeroth Law of Thermodynamics; Temperature Scale, Thermodynamic Properties of Fluids: Mathematical, Tabular and Graphical representation of data; Ideal gas Van der Waals Equation of state; Compressibility chart; Thermodynamic Diagrams including Mollier diagram; Steam Tables, First law of Thermodynamics & its applications to Non flow processes, Applications of First Law of Thermodynamics of Flow Processes; Steady state Steady flow and Transient flow processes, Applications of First Law of Thermodynamics to Chemically Reacting Systems Second Law of Thermodynamics & its Applications, Thermodynamic Potentials, Maxwells Relations; Thermodynamic Relations and Availability, Power Cycles, Refrigeration Cycles; SI Units, Definitions & Concepts: System, Property, Energy, Thermodynamic Equilibrium, Work interaction & various modes of work, Heat, State Postulate, Zeroeth Law of Thermodynamics, Temperature Scale, IPTS.

Thermodynamic Properties of Fluids: Pure substance. Phase, Simple compressible substance, Ideal gas Equation of state, van der Waals Equation of State; Law of corresponding states, Compressibility chart, Pressure-volume; Temperature-volume and Phase diagrams; Mollier diagram and Steam tables.

First Law of Thermodynamics & its consequences, Applications of First Law for elementary processes, First Law analysis of Non-flow processes; Use of steam tables & Mollier diagram, Application of First Law of Thermodynamics for Flow Process-Steady state, steady flow processes, Throttling process; Transient Flow Processes-Charging & discharging of tanks.

First Law Applications to Chemically Reacting Systems: Fuels & Combustion, Theoretical Air/Fuel ratio, Standard heat of Reaction and effect of temperature on standard heat of reaction, Adiabatic flame temperature.

Second Law of Thermodynamics & its Applications: Limitations of the First Law of Thermodynamics, Heat Engine, Heat Pump/Refrigerator. Second Law of Thermodynamics - Kelvin Planck and Clausius statements & their equivalence, Reversible & irreversible processes, Criterion of reversibility, Carnot cycle & Carnot principles, Thermodynamic Temperature scale, Clausius inequality, Entropy, Calculations of entropy change, Principle of entropy increase, T- S diagram, II Law analysis of Control volume.

Thermodynamic Potentials; Maxwell relations; Available energy, Availability; Second law efficiency. Thermodynamic relations, Jacobian methods, Clapeyron and Kirchoff equations, Phase rule.

Power Cycles: Rankine cycle- Ideal, Reheat and Regenerative Rankine cycles. Gas Power Cycles: Otto cycle, Diesel cycle, Dual cycle and Brayton cycle, Refrigeration Cycles: Vapor compression refrigeration, Absorption refrigeration and Gas refrigeration Cycles.

ESO 204 **MECHANICS OF SOLIDS, 3-1-0-1-4**

L-T-P-D-[C]
3-1-0-1-[4]

Free body diagram, Modelling of supports, Conditions for Equilibrium, Friction Force-deformation relationship and geometric compatibility (for small deformations) with illustrations through simple problems on axially loaded members and thin-walled pressure vessels, Force analysis (axial force, shear force, bending moment, and twisting moment diagrams) of slender members *(singularity functions not to be used*), Concept of stress at a point, Transformation of stresses at a point, Principal stresses, Mohr's circle (only for plane stress case), Displacement field, Concept of strain at a point, Transformation of strain at a point, Principal strains, Mohr's circle (only for plane strain case), Strain Rosette, Modelling of problem as a plane stress or plane strain problem, Discussion of experimental results on 1-D material behaviour, Concepts of elasticity, plasticity, strain-hardening, failure (fracture/yielding), idealization of 1-D stress-strain curve, Concepts of isotropy, orthotropy, anisotropy, Generalized Hooke's law

(without and with thermal strains), Complete equations of elasticity, Torsion of circular shafts and thin-walled tubes (*plastic analysis and rectangular shafts not to be discussed*), Bending of beams with symmetric cross-section (normal and shear stresses) (*shear centre and plastic analysis not to be discussed*), Combined stresses, Yield criteria, Deflection due to bending, Integration of the moment-curvature relationship for simple boundary conditions, Superposition principle (*singularity functions not to be used*), Concepts of strain energy and complementary strain energy for simple structural elements (those under axial load, shear force, bending moment, and torsion), Castigliano's theorems for deflection analysis and indeterminate problems, Concept of elastic instability, Introduction to column buckling, Euler's formula (*post-buckling behaviour not to be covered*)

ESO 208 **EARTH SCIENCE**

L-T-P-D-[C]
2-1-2-0-[4]

EARTH AS PLANET IN THE SOLAR SYSTEM: Introduction; Earth in relation to moon, meteorites and other members of the solar system; Comparison of internal structures; origin;

ATMOSPHERE AND OCEANS: Origin and evolution; Atmosphere-ocean interaction; Air pollution, Green house effect, Ozone layer; Ocean currents and waves

SOLID EARTH AND EARTH MATERIALS: Interior of the earth; Magmas, volcanoes and igneous rocks; Sediments and sedimentary rocks; Metamorphism and metamorphic rocks; Rock forming minerals; Crystal structure; Crystallographic methods; Optical properties; Radiometric age; Geological time scale.

PROCESSES THAT SHAPE THE EARTH'S SURFACE: Geomorphic processes and landforms; Weathering and soils; Streams and drainage pattern; Ground water, wind; Glacier; Shore processes; Impact of human activity; Natural hazards.

THE EVOLVING EARTH: Crustal deformation; Geologic structures and their representation; Applications of remote sensing; Isostasy; Continental drift; Sea-floor spreading; Paleo-magnetism, Plate tectonics; MINERAL RESOURCES: Ore-forming processes; Metallic and non-metallic deposits; Fossil fuels; Mineral resources of the sea; Geology of India and distribution of economic mineral deposits; *Tutorials*, *Laboratory Sessions*.

ESO 209 **PROBABILITY AND STATISTICS, 3-1-0-1-4** **Prereq. MTH 101**

L-T-P-D-[C]
3-1-0-1-[4]

Probability, Axiomatic Definition, Properties, Conditional probability, Bayes rule and Independence of Events, Random variables, Distribution function, Probability mass and density functions, Expectation, Moments, Moment generating function,

Chebyshev's inequality; Special distributions: Bernoulli, Binomial, Geometric, Negative Binomial, Hypergeometric, Poisson, Uniform, Exponential, Gamma, Normal, Joint Distributions, Marginal and Conditional Distributions, Moments, Independence of random variables, Covariance, Correlation, Functions of random variables, Weak law of large numbers, P.levy's Central limit theorem (i.i.d. finite variance case), Normal and Poisson approximations to Binomial; *STATISTICS: Introduction*: Population, sample, parameters; *Point Estimation*: Method of moments, MLE, Unbiasedness, Consistency, Comparing two estimators (Relative MSE), Confidence Interval, Estimation for mean, difference of means, variance, proportions. Sample size problem. *Tests of Hypotheses*: N-P Lemma, examples of MP and UMP tests, p-value, Likelihood ratio test, Tests for means, variance, two sample problems, Test for proportions, Relation between confidence intervals and tests of hypotheses, Chi-Square goodness of fit tests, contingency tables, SPRT *Regression Problem:* Scatter diagram, Simple linear regression, Least squares estimation; Tests for slope and correlation, prediction problem, Graphical residual analysis, Q-Q plot to test for normality of residuals, Multiple Regression; Analysis of Variance: Completely randomised design and Randomised block design, Quality Control, Shewhart control charts and Cusum charts

ESO 210 **INTRODUCTION TO ELECTRICAL ENGINEERING**

L-T-P-D-[C]
3-1-2-0-[5]

Introduction to Single-Phase Circuits, Power Calculations, Magnetic Circuits, Mutually Coupled Circuits, Transformers, Equivalent Circuit and Performance, Analysis of Three-Phase Circuits, *Direct-Current Machines*: Construction, Equivalent Circuit, Torque-Speed Characteristics, Applications; *Induction Machines*: Construction Equivalent Circuit, Torque-speed Characteristics, Speed Control, Starting, Applications *Synchronous Machines*: Construction, Equivalent Circuit, Generator & Motor Operation Power Angle Characteristics, Hunting, Pull-Out, Stepper Motors and controls, Principles of Industrial Power Distribution.

ESO 211 **DATA STRUCTURES AND ALGORITHMS-I**

L-T-P-D-[C]
3-0-0-0-[4]

Order Analysis: Objectives of time analysis of algorithms; Big-oh and Theta notations, Data Structures:- Arrays, Linked lists, Stacks (example: expression evaluation), Binary search trees, Red-Black trees, Hash tables, Sorting and Divide and Conquer Strategy:- Merge-sort; D-and-C with Matrix Multiplication as another example, Quick-sort with average case analysis, Heaps and heap-sort, Lower bound on comparison-based sorting and Counting sort, Radix sort, B-trees, Dynamic Programming: methodology and examples (Fibonacci numbers, matrix sequence, multiplication, longest common subsequence, convex polygon triangulation), Greedy Method: Methodology, examples (lecture scheduling, process scheduling) and comparison with DP (more examples to come later in graph algorithms), Graph Algorithms:- Basics of graphs and their representations,

BFS, DFS, Topological sorting, Minimum spanning trees (Kruskal and Prim's algorithms and brief discussions of disjoint set and Fibonacci heap data structures), Shortest Paths (Dijkstra, Bellman-Ford, Floyd-Warshall).

ESO 212 **FLUID MECHANICS AND RATE PROCESSES**

L-T-P-D-[C]

3-1-0-1-[4]

FLUID MECHANICS: Introduction to fluids, Fluid statics; pressure as a scalar, manometry, forces on submerged surfaces (NO moments NOR center of pressure), Description of flows; field approach, Euler acceleration formula, streamlines, streaklines, etc., Reynolds' transport theorem Conservation of mass; stream function, Linear (NOT angular) Momentum balance, Navier-Stokes' (NS) equation; *elementary* derivation; application; Poiseuille flow, Couette flow, Energy equation-Bernoulli equation, applications including flow measurement (Pitot tube, Orifice meters); Pipe flows and losses in fittings; Similitude and modelling: using non-dimensionali-zation of N-S equations and boundary conditions, simplifications for cases without free surfaces and without cavitation (scale factor approach should NOT be done); High Re flow: Prandtl's approximation; basic inviscid flow; need for boundary layer; Magnus effect (mathematical derivations be avoided), Boundary layers-elementary *results* for flat plates. Separation, flow past immersed bodies (bluff, streamlined); physics of ball-games (qualitative) *Heat Transfer:* Introduction, rate law and conservation law, Conduction equation; non-dimensionalization, various approximations, Steady state conduction-concept of resistances in series and of critical thickness of insulation, Unsteady conduction; significance of Biot and Fourier numbers, Heissler charts; Low Bi case; penetration depth, Essential nature of convection: transpiration cooling; writing energy equation without dissipation and pressure terms; one example (heat transfer to fluid flowing in a tube); non-dimen-sionalization, Nusselt number and correlations; *MASS TRANSFER*: Simple ideas of mass transfer; definitions (mass basis only), similarity with heat transfer. Use of steady 'conduction' concepts to solve simple steady cases in dilute solutions as well as in stationary solids, only.

Boundary conditions, Illustrative example: One example involving all three transport phenomena should be discussed, possibly from the bio-world or from microelectronics processing.

ESO 214 **Nature and Properties of Materials**

L-T-P-D-[C]

3-1-3-1-[5]

Examples of materials highlighting Structure-Processing-Property-performance relations. 14 space lattices, unit cells, cubic and HCP structures, Miller indices, Packing, interstitials, different ceramic structures; Non-crystalline/nanocrys-talline materials-definitions, concept of Tg, local order, different polymer structures.

Structure determination using X-ray diffraction (Bragg's diffraction and structure factor for cubic lattices); Point defects, edge and screw dislocations-their notation and concepts, energy of a dislocation, stacking fault, grains and grain boundaries, bulk defects;

PHASE EVOLUTION: Definition of diffusivity, concept of activation energy, examples of diffusion process; Definition of a phase, phase rule, unary and binary (eutectic, eutectic with terminal solid solutions) systems and examples, phase diagrams of important metal and ceramic systems, Nucleation and growth (homogeneous and heterogeneous), Introduction to TTT curves, examples of various transformations;

MECHANICAL BEHAVIOUR: Measures of mechanical response (fundamental measurable mechanical properties), engineering and true stress-true strain response, concept of yield point and Elastic modulus (composite materials) viscoelesticity, fracture toughness, stress intensity factor, fracture energy, comparison of these properties for different engineering materials.

Deformation of single and polycrystalline materials, slip systems, critical resolved shear stress, mechanisms of slip and twinning; Fatigue and creep properties of materials with suitable examples, Strengthening mechanisms, Fracture in ductile and brittle (Griffith's Theory) solids, ductile to brittle transition,

ELECTRONIC PROPERTIES: Drude theory of metals, free electron theory (density of states, Fermi energy, Fermi-Dirac statistics, band theory of solids, existence of metals and insulators, Brillouin zones), Semiconductors (structures of elements and compounds), equilibrium properties of semiconductors, conductivity as a function of temperature, measurement of band gap, doping, law of mass action, Hall effect, carrier concentration of mobility of non-generate semiconductors, Excess carrier generation, optical properties of semiconductors, concept of lifetime, I-V characteristics of p-n junction and their applications as LEDs, lasers and solar cells, Introduction to semiconductor crystal growth and processing modern methods of expitaxy (brief introduction to quantum wells and superlattices, if time permits), Dia-, para-ferro- and ferri magnetism; soft/hard magnetic materials.

Dielectric and ferroelectric materials ($BaTiO_3$ as an example); linear and non-linear behaviour.

ESO 216 **SIGNAL PROCESSING AND INSTRUMENTATION** **Prereq. ESc 101**

L-T-P-D-[C]
3-1-0-1-[4]

Physical quantities and their measurement. Different grades of measurability, scales and scale-invariant properties. Errors, precision (resolution), accuracy

and calibration standards. Study of quantities; mechanical (position, force, velocity, acceleration (electrical voltage, current, position, frequency, time), chemical (flow, pressure, temperature, pH), psychophysical (brightness, loudness) etc., Sensors (e.g. stain guages, pH electrodes, photodiodes, accelerometers, etc), actuators (eg. Relays, solenoids, valves, stepper motors), sources (eg. Voltage, current, light sources), Introduction to the study of signals and their processing. Familiarization and use of Virtual Instrumentation software, Signals and noise; signal representation and noise characterisation. Analog and digital signals; signal sampling and quantisation. The Fourier series and the Fourier Transform; magnitude and phase spectra; the DFT; Signal and noise filtering; noise reduction techniques; windowing, boxcar intergration, lock-in amplifiers, multipoint averaging; Signal conversion: A/D and D/A conversion techniques. Multiplexing; Basic instrumentation: meters, guages, milli and micro voltmeters. Various bridges for impedance and frequency measurement. Examples of advanced instrumentation: oscilloscopes and spectrum analyzers. NMR.

Data Acquisition and computer control. Interfacing with microcontrollers and personal computers. Virtual (Software) instrumentation.

ESO 218 **COMPUTATIONAL METHODS IN ENGINEERING**

L-T-P-D-[C]
3-1-0-0-[4]

Introduction, Engineering Systems, Physical and Mathematical Modeling, Error Analysis - Approximations and round off and Truncation errors, Roots of Equations- single variable -Method of Bisection, Method of Interpolation, Secant Method, One point Methods, Newton Raphson method, Secant Method, Multiple roots, Solution of Linear Simultaneous Equations-Direct Methods-Gauss Elimination, Gauss-Jordan, LU decomposition; Iterative Methods-Gauss-Seidel, Conjugate Gradient, Banded and Sparse systems, Solution of Nonlinear Simultaneous Equations, Curve Fitting-Least Square regression, Interpolation including splines, Fast Fourier Transforms, Regression Analysis for Multivariable, Eigen Values and Eigen Vectors- Power method, Relaxation Method, Diagonalization method. Numerical Differentiation and Integration-High-Accuracy Differentiation Formulas, Derivatives of Unequal Spaced Data. The trapezoidal Rule, Simpson's rule, Integration with unequal segments, Open Integration Formulas, Ordinary Differential Equations- Finite Difference method, Method of Weighted Residuals, Analytical versus Numerical Methods, Initial Value and Boundary Value Problems-Euler's method, Improvement of Euler's method, Runge-Kutta Method, Multiple Steps Method, Partial Differential Equations-Elliptic and parabolic Equations, Explicit and Implicit Methods, Crank Nicholson Method, ADI method; Introduction to Finite Element Method, Applications.

MTH 101 **MATHEMATICS - I**

L-T-P-D-[C]

3-1-0-1-[4]

Real numbers; Sequences; Series; Power series, Limit, Continuity; Differentiability, Mean value theorems and applications; Linear Approximation, Newton and Picard method; Taylor's theorem (one variable), Approximation by polynomials Critical points, convexity, Curve tracing; Riemann Integral; fundamental theorems of integral calculus Improper integrals; Trapezoidal and Simpson's rule; error bounds; Space coordinates, lines and planes, Polar coordinates, Graphs of polar equations, Cylinders, Quadric surfaces; Volume, Area, length; Continuity, Differentiability of vector functions, arc length, Curvature, torsion, Serret-Frenet formulas, Functions of two or more variables, partial derivatives. Statement only, of Taylor's theorem and criteria for maxima/minima/saddle points; Double, triple integrals, Jacobians; Surfaces, integrals, Vector Calculus, Green, Gauss, Stokes Theorems

MTH 102 **MATHEMATICS - II** **Prereq. : MTH 101**

L-T-P-D-[C]

3-1-0-1-[4]

Matrices; Matrix Operations (Addition, Scalar Multiplication, Multiplication, Transpose, Adjoint) and their properties; Special types of matrices (Null, Identity, Diagonal, Triangular, Symmetric, Skew-Symmetric, Hermitian, Skew-Hermitian, Orthogonal, Unitary, Normal), Solution of the matrix EquationAx=b; Row-reduced Echelon Form; Determinants and their properties, Vector Space R^n (R); Subspaces; Linear Dependence / Independence; Basis; Standard Basis of R^n; Dimension; Co-ordinates with respect to a basis; Complementary Subspaces; Standard Inner product; Norm; Gram-Schmidt Orthogonalisation Process; Generalisation to the vector space C^n (C), Linear Transformation from R^n to R^m (motivation, X - AX); Image of a basis identifies the linear transformation; Range Space and Rank; Null Space and Nullity; Matrix Representation of a linear transformation; Structure of the solutions of the matrix equation Ax = b, Linear Operators on R^n and their representation as square matrices; Similar Matrices and linear operators; Invertible linear operators; Inverse of a non-singular matrix; Cramer's method to solve the matrix equation Ax=b, Eigenvalues and eigenvectors of a linear operator; Characteristic Equation; Bounds on eigenvalues; Diagonalisability of a linear operator; Properties of eigenvalues and eigenvectors of Hermitian, skew-Hermitian, Unitary, and Normal matrices (including Symmetric, Skew-Symmetric, and Orthogonal matrices), Implication of diagonalisability of the matrix $A + A^r$ in the real Quadratic form $X^T AX$; Positive Definite and Semi-Positive Definite Matrices, 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, term by term differentiation, Taylor series, Laurent series, Zeros, singularities, poles, essential singularities, Residue theorem, Evaluation of real integrals and improper integrals.

MTH 203 **MATHEMATICS - III** **Prereq. : MTH 102**

L-T-P-D-[C]
3-1-0-1-[4]

Introduction & Motivation to Differential Eqns., First Order ODE, y'=f(x,y)-geometrical interpretation of solution, Eqns. reducible to separable form, Exact Eqns., integrating factor, Linear Eqns., Orthogonal trajectories, Picard's Thm. for IVP (without proof) & Picard's iteration method, Euler's Method, Improved Euler's Method, Elementary types of eqns. F(x,y,y')=0: not solved for derivative; Second Order Linear differential eqns: fundamental system of solns. and general soln. of homogeneous eqn, Use of known soln. to find another, Existence and uniqueness of soln. of IVP, Wronskian and general soln of nonhomogeneous eqns. Euler-Cauchy Eqn., extensions of the results to higher order linear eqns., Power Series Method - application to Legendre Eqn., Legendre Polynomials, Frobenius Method, Bessel eqn. Prop of Bessel functions, Sturm Liouville BVP, Orthogonal functions, Sturm comparison Thm., Laplace transform, Fourier Series and Integrals, Introduction to PDE, basic concepts, Linear and quasi-linear first order PDE, 2^{nd} order PDE and classification of 2^{nd} order semi-linear PDE (Canonical form), D'Alemberts formula and Duhamel's principle for one dimensional wave eqn., Laplace and Poisson's eqn., maximum principle with application, Fourier Method for IBV problem for wave and heat equation, rectangular region, Fourier method for Laplace equation in 3 dimensions, Numerical Methods for Laplace and Poisson's eqn.

PHY 101 **PHYSICS LABORATORY**

L-T-P-D-[C]
0-0-3-0-[2]

Introduction to Error Analysis and Graph Drawing; Spring Oscillation Apparatus; Trajectory of a Projectile on an inclined plane; Moment of Inertia of a bicycle wheel; Bar Pendulum; Torsional Pendulum; Coupled Pendulum; Study of collisions on an Air Track; Gyroscope; Current Balance; Measurement of Capacitance using Galvanometer; Charging of a plate capacitor; Electromagnetic Induction; Prism Spectrometer; Fraunhofer Diffraction using He-Ne laser; Magnetic Field in Helmholtz Coil; Resonance in Electrical Circuits.

PHY 102 **PHYSICS-I**

L-T-P-D-[C]
3-1-0-1-[4]

Coordinate Systems, elements of vector algebra in plane polar, cylindrical, spherical polar coordinate systems, Dimensional Analysis; Solutions for 1 dimensional equation of motion in various forms, Frames of reference, relative velocity and accelerations; Newton's laws and applications (to include friction, constraint equations, rough pulleys), Line integrals, gradient, curl, conservative forces, potential, Work-Energy theorems, Energy diagrams; Conservation of linear momentum and collisions, variable mass problems; Central forces, Gravitation, Kepler's law, hyperbolic, elliptic and parabolic orbits, Forced Oscillations, damping, resonance; Waves: Motion in Non-inertial frames, centrifugal

and Coriolis forces; Conservation of Angular Momentum and elementary rigid body dynamics; Special Theory of Relativity.

PHY 103 **PHYSICS-II**

L-T-P-D-[C]
3-1-0-1-[4]

Vector Calculus; Electrostatics; Gauss law and applications, electrostatic potential and Curl of E; Work and energy in electrostatics, Laplace's Equation and (first) uniqueness theorem, method of images, multipoles (introduction), force and torque on dipoles; Polarization, bound charges, Electric displacement and boundary conditions, Linear dielectrics, force on dielectrics. Motion of charges in electric & magnetic fields; Magneto-statics: Current Density, Curl and divergence of B, Ampere's law and applications, magnetization, bound currents and bound pole densities, Magnetic field H, Magnetic susceptibility, Ferro, para and diamagnetism, Boundary conditions on, B and H Faraday's law, Energy in magnetic field, Displacement current, Maxwell's equations in Media, Poyntings Theorem, E.M. Waves: Wave equation, plane waves, polarization and types of polarization, Energy and momentum of plane E.M. waves. Propagation through linear media and conductors. Reflection and transmission at normal incidence from dielectric and metal interfaces. Magnetism as a relativistic phenomenon. Relativistic transformations of E B fields (simple illustrations only), Diffraction, Quantum Mechanics,* Photons, Uncertainty Principle, Electron diffraction experiments, De Broglie Hypothesis, Born interpretation, Schrodinger-Equation and application to 1-D box problem.

TA 101 **ENGINEERING GRAPHICS**

L-T-P-D-[C]
2-0-3-1-[4]

Orthographic projections; lines, planes and objects; Principles of dimensioning, sectional views. Machine part assemblies, auxillary views, Space geometry; lines and planes, true lengths and shapes, properties of parallelism, perpendicularity and intersections of lines and planes, simple intersections of solids and development of lateral surfaces of simple solids, Isometric views. Introduction to computer graphics.

TA 201 **INTRODUCTION TO MANUFACTURING PROCESSES**

L-T-P-D-[C]
2-0-6-0-[5]

Introduction to Manufacturing, Historical perspective; Importance of manufacturing; Classification of manufacturing processes, Engineering materials, Casting, Fundamentals of casting, Sand casting, Permanent mold casting including pressure die casting, Shell, investment & centrifugal casting processes, Continuous casting, Casting defects, Metal Forming, Basic concepts of plastic deformation, Hot & cold working, Common bulk deformation processes (Rolling, Forging, Extrusion and Drawing), Common sheet metal forming processes, Machining, Chip formation and generation of machined surfaces, Tool geometry,

tool material, tool wear and practical machining operations (turning, milling and drilling), Grinding processes, Finishing processes, Introduction to unconventional machining processes (EDM, ECM, UCM, CHM, LBM) etc., Welding & Other Joining Processes, Fundamentals of welding & classification of welding processes, Gas and arc welding, Brazing and soldering, Adhesive bonding, Mechanical fastening, Heat Treatment, Principles of heat treating; annealing, normalizing, hardening and tempering, Manufacturing of Polymer and Powder Products, Classification of polymers, Introduction to extrusion, injection molding, blow molding, compression and transfer molding , Green compacts from powders including slip casting of ceramics, Sintering, Modern Trends in Manufacturing.

EE 200 **SIGNALS, SYSTEMS AND NETWORKS** **Prereq. ESc 102**

L-T-P-D-[C]

3-1-0-0-[4] Continuous and discrete time signals; Fourier series, Fourier, Laplace and Z transform techniques; DFT. Sampling Theorem. LTI systems: I/O description, impulse response and system functions, pole/ zero plots, FIR and IIR systems. Analog and digital filters. Networks: topological description, network theorems, Two port analysis.

EE 210 **MICROELECTRONICS - I** **Prereq. ESc 102**

L-T-P-D-[C]

3-1-0-0-[4] I-V characteristics of BJTs and MOSFETs, Basic amplifier configurations, Current sources and active loads, output stages, Op-amps, Feedback amplifiers, Stability and compensation, Noise in Electronic circuits, Signal processing: D/A and A/D converters, Non-linear electronic circuits.

EE 250 **CONTROL SYSTEM ANALYSIS** **Prereq. EE 200 or #**

L-T-P-D-[C]

3-1-0-0-[4] Linear feedback control systems, frequency and time domain analysis, I/O relationships, transfer function, perfor-mance analysis, Routh-Hurwitz and Nyquist stability criteria, Bode diagrams, Nicholas chart, Root locus method, Feedback system design. Non-linear systems, phase-plane analysis, limit cycles, describing function.

EE 301 **DIGITAL SIGNAL PROCESSING** **Prereq. EE 200**

L-T-P-D-[C]

3-0-0-0-[4] Review of discrete time signals and systems. Sampling of CT signals: aliasing, prefiltering, decimation and interpolation, A/D and D/A conversion, quantization noise. Filter design techniques. DFT Computation. Fourier analysis of signals using DFT. Finite register length effects. DSP hardware. Applications.

EE 311 **MICROELECTRONICS - II** **Prereq. EE 210**

L-T-P-D-[C]

3-0-0-0-[4] Basics of semiconductor physics, p-n junction diodes, Metal-semiconductor contacts, BJTs, MOS capacitors, MOSFETs, optoelectronic devices, Advanced semiconductor devices: MESFETs, HBTs, HEMTs, MODFETs.

EE 320 **PRINCIPLES OF COMMUNICATION** **Prereq. EE 200**

L-T-P-D-[C]

3-1-0-0-[4] Communication problem and system models. Representation of deterministic and stochastic signals. Analog and digital modulation systems, Receiver structures, SNR and error probability calculations, Frequency and time division multiplexing. Digital encoding of analog signals. Elements of information theory, Multiple access techniques and ISDN.

EE 321 **COMMUNICATION SYSTEMS** **Prereq. EE 320**

L-T-P-D-[C]

3-0-0-0-[4]

Information measures. Source coding. ISI & channel equalization, partial response signalling. M-ary modulation systems, error probability calculations. PLLs and FM threshold extension. Error control coding, block and convolution codes. Combined modulation and coding, trellis coded modulation. Spread spectrum systems.

EE 330 **POWER SYSTEMS** **Prereq. ESO 210**

L-T-P-D-[C]

3-1-0-0-[4]

Introduction to generation, transmission and distribution systems, Substation arrangements. Mathematical modelling of power systems. Grounding in power systems. Power cables and lines - parameter calculations. Fault Calcula-tions. Current and voltage relations of lines and cables. Reactive power control. Switchgear and protection.

EE 340 **ELECTROMAGNETIC THEORY** **Prereq. PHY 103**

L-T-P-D-[C]

3-1-0-0-[4]

Basics of Static electric and magnetic fields, Energy in fields, Maxwell's equations, plane EM waves, Propagation in free space and in matter, Reflection and refraction, Guided EM waves, Transmission lines, Radiation of EM waves.

EE 360 **POWER ELECTRONICS** **Prereq. ESc 102**

L-T-P-D-[C]

3-0-3-0-[4]

Power semiconductor devices: structure and characteristics; snubber circuits, switching loss. Controlled rectifiers: full/half controlled converters, dual converters, sequence control. AC regulator circuits, reactive power compensators. dc-dc converters, switching dc power supplies. Inverters: square wave and pwm types, filters, inverters for induction heating and UPS.

EE 370 **DIGITAL ELECTRONICS & MICROPROCESSOR TECHNOLOGY**

L-T-P-D-[C] **Prereq. ESC 102**

3-1-0-0-[4]

Analysis of digital logic families: TTL, MOS, CMOS Inverters; interfacing between logic families; various logic functions and their implementation; Bistable circuits - R-S, J-K, D and PLA; Design of synchronous sequential circuits. Microprocessor based systems : Number systems, Arithmetic operations in integer and floating point systems; ASCII Code; General micro-processor organisation, Memory inter-facing, Assembly language and bus signals of 8085; interrrupts and their applications; Serial and parallel ports; DMA and its controller; 8253 timer; 8259 interrupt controller.

EE 380 **ELECTRICAL ENGINEERING LAB**

L-T-P-D-[C] **Prereq. ESc 102, ESO 210, EE 210, EE 250**

0-2-6-0-[4] Experiments from various areas of electrical engineering with emphasis on electronic devices, circuits, control systems and machines.

EE 381 **ELECTRICAL ENGINEERING LAB I**

L-T-P-D-[C] **Prereq. EE 320 or #, EE 370 or #, EE 380**

0-2-6-0-[4] Experiments from various areas of electrical engineering with emphasis on digital electronics, communications, machines, drives and power systems, and electromagnetics.

EE 403 **ADVANCED DIGITAL SIGNAL PROCESSING** **Prereq. EE 301**

L-T-P-D-[C]

3-0-0-0-[4] Review of linear algebra; functional analysis, time-frequency representation; frequency scale and resolution; uncertainity principle, short-time Fourier transform, Multi-resolution concept and analysis, Wavelet transforms. Wigner-ville distributions. Multi-rate signal processing; discrete-time bases and filter banks; 2D signals and systems, 2D sampling in arbitrary lattices, 2D-linear transforms, 1D/2D signal compression; introduction to DSP architecture.

EE 413 **SEMICONDUCTOR DEVICES TECHNOLOGY** **Prereq. EE 210**

L-T-P-D-[C]

2-0-3-0-[4] Semiconductor materials, Ultraclean technology, Single crystal growth, Thermal oxidation of silicon, Solid state diffusion, Ion implantation, Vacuum technology, Physical and chemical vapor deposition techniques, Wet and dry etching, Lithography techniques, VLSI/ULSI process integration, Fault diagnosis and characterization techniques.

EE 414 **LOW NOISE AMPLIFIERS** **Prereq. EE 320, EE 311**

L-T-P-D-[C]

3-0-0-0-[4] Noise and its characterisation, Noise figure calculations, Noise in semiconductors, P-N junction, Metal semiconductor junctions, Tunnelling: Varactors and their application as parametric amplifiers and multipliers. Tunnel diode amplifiers, Schottky diode Mixers, Masers, Design aspects of low noise amplifiers and mixers.

EE 415 **LINEAR INTEGRATED CIRCUIT DESIGN** **Prereq. EE 311**

L-T-P-D-[C]

3-0-0-0-[4] Bipolar and MOS technology. Voltage regulators. Analog delay lines. IC transducers. Analog switches, S/H circuits. Noise in ICs, Special function ICs. Switched capacitor circuits. Opto-electronic ICs and systems. MOS analog circuits-building blocks, subcircuits, opamps. BiCMOS circuit design. Low power/voltage circuit design. Mixed signal design issues.

EE 416 **OPTO-ELECTRONICS** **Prereq. EE 210, EE 340**

L-T-P-D-[C]

3-0-0-0-[4] LEDs, semiconductor lasers, modulation of laser sources. Avalanche and PIN photodetectors and their characteristics. Solar cells. Optical fibers and their characteristics. Integrated optics. Fiber optic communication systems, system design consideration.

EE 417 **INTRODUCTION TO VLSI DESIGN** **Prereq. EE 210, EE 370 or #**

L-T-P-D-[C]

3-0-0-0-[4] Review of MOS device operation; fabrication and layout; combinational and sequential logic design; verification and testing; arithmetic blocks, memory; architecture design; floor planning; design methodologies; example of a chip design; analysis and synthesis algorithms including circuit, switch and logic simulation, logic synthesis, layout synthesis and test generation; packaging.

EE 422 **COMMUNICATION SYSTEM ENGINEERING** **Prereq. EE 320**

L-T-P-D-[C]

3-0-0-0-[4] Baseband signal characterisation-telegraphy, telephony, television and data; message channel objective; voice frequency transmission, radio wave propagation methods: random noise characterization in communication systems, intermodulation distortion : line of sight systems description and design; troposcattrer systems.

EE 431 **ELECTRICAL MACHINES** **Prereq. ESO 210**

L-T-P-D-[C]

3-0-0-0-[4] Magnetic circuits and transformers including three-phase transformers. Electro-mechanical energy conversion. General principle of AC machines. Synchronous machines including power system interfacing. Induction machine including starting and speed control of motors.

EE 432 **POWER GENERATION, 3-0-0-0-4** **Prereq. ESO 210**

L-T-P-D-[C]

3-0-0-0-[4] Power generation from conventional sources; thermal, hydro, nuclear and gas power plants - their functions and control; types of prime movers, generators and excitation systems; Economic considerations in power systems. Alternate sources of power generation - solar, wind, geo-thermal, ocean-thermal, tidal, wave and MHD.

EE 437 **FUNDAMENTALS OF HV ENGG & LABORATORY TECHNIQUES**

Prereq. EE 330

L-T-P-D-[C]

3-0-2-0-[5] Electromagnetic fields, field control, Dielectrics used in HV and their properties, Standard voltage wave-forms, Generation and measurement of HV ac, dc and impulse voltages, Non-destructive testing, HV bushings & insulators, Overvoltage phenomena & insulation coordination

EE 441 **MICROWAVES** **Prereq. EE 340**

L-T-P-D-[C]
3-0-0-0-[4]

Active devices: LHTs, klystrons, magnetrons, TWTs, BWOs, microwave transistors; point contact, tunnel, PIN, and GUNN diodes; Parametric amplifier masers. Microwave circuits-theory of guiding systems, scattering matrix impedance transformation and matching. Passive devices: ferrites & ferrite devices, microwave cavity.

EE 442 **ANTENNAS AND PROPAGATION** **Prereq. EE 340**

L-T-P-D-[C]
3-0-0-0-[4]

Retarded potential, radiation from current element and dipole, radiation patterns, impedance, reciprocity. Various types of antennas, interferometers and multi-element arrays, Antenna Measurements. Ground wave propagation, terrain and earth curvature effects.Tropospheric propagation; fading, diffraction and scattering; Ionospheric Propagation-refractive index, critical frequencies, effects of magnetic field.

EE 443 **RADAR SYSTEMS** **Prereq. EE 320**

L-T-P-D-[C]
3-0-0-0-[4]

Radar equation, CW and Frequency Modulated Radars, MTI and pulse Doppler radar, MTI delay line cancellors. MTI from moving platform, Tracking radars. Mono-pulse tracking in range/Doppler; Electronic scanning radars, Beam forming and Steering methods, Noise and Clutter; Ambiguity function; Radar signal processing; SAR.

EE 444 **RADIO ASTRONOMY** **Prereq. EE 340**

L-T-P-D-[C]
3-0-0-0-[4]

Fundamentals of astronomy, Co-ordinate systems, Structure of the universe, Radio astronomy fundamentals, Electromagnetic wave propagation, Radio telescope Antennas, Reflector Antennas, Antenna arrays, Interferometry and aperture synthesis. Radio astronomy receivers, General principles, low noise amplifiers, digital auto-correlation receivers, Description of radio sources.

EE 451 **ADVANCED CONTROL SYSTEMS** **Prereq. EE 250**

L-T-P-D-[C]
3-0-0-0-[4]

Modelling of physical systems, Concepts of state, state-space, Controllability and observability. Sensitivity and error analysis. Nonlinear systems, singular points, phase plane analysis, Lyapunov stability, describing functions, on-off and dual mode systems. Sampled Data Systems. Computer control systems.

EE 455 **TRANSDUCERS AND INSTRUMENTATION** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Measurement process; scales of measurement; configuration and functional description of measurement systems; performance characteristics; sensing

elements and transducers for measurement of motion, force, pressure, flow, temperature, light, vacuum, etc.; transducer interfacing; signal conditioning, transmission and recording; microprocessor based instrumentation.

EE 480 **ADVANCED ELECTRICAL ENGINEERING LABORATORY 1** **Prereq. EE480**

L-T-P-D-[C]
0-0-6-0-[4]

The purpose of this course is to allow students to do new and challenging experiment in emerging areas of Electrical Engineering under the guidance of an assigned department faculty member. This would also facilitate the task of developing new experiments for EE380/381 as well.

EE 481 **ADVANCED ELECTRICAL ENGINEERING LABORATORY 2** **Prereq. EE481**

L-T-P-D-[C]
0-0-6-0-[4]

The purpose of this course is to allow students to do new and challenging experiment in emerging areas of Electrical Engineering under the guidance of an assigned department faculty member. This would also facilitate the task of developing new experiments for EE380/381 as well.

EE 491 **PROJECT - I, 0-0-0-9-3, Fourth Year Standing EE 491**
PROJECT - II, 0-0-0-15-5, EE492 **Prereq. EE 491**

POST-GRADUATE COURSES

EE 600 **MATHEMATICAL STRUCTURES OF SIGNALS & SYSTEMS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Nature of definitions; Theory of measurement and scales; Symmetry, invariance and groups; Groups in signals and systems; Algebraic and relational structures of signal spaces and convolutional systems; Representation theory of groups, harmonic analysis and spectral theory for convolutional systems.

EE 601 **MATHEMATICAL METHODS IN SIGNAL PROCESSING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Generalized inverses, regularization of ill-posed problems. Eigen and singular value decompositions, generalized problems. Interpolation and approximation by least squares and minimax error criteria. Optimization techniques for linear and nonlinear problems. Applications in various areas of signal processing.

EE 602 **STATISTICAL SIGNAL PROCESSING I**

L-T-P-D-[C]
3-0-0-0-[4]

Power Spectrum Estimation-Parametric and Maximum Entropy Methods, Wiener, Kalman Filtering, Levinson-Durban Algorithms Least Square Method, Adaptive Filtering, Nonstationary Signal Analysis, Wigner-Ville Distribution, Wavelet Analysis.

EE 603 **ADVANCED TOPICS IN DIGITAL FILTERING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Multirate Processing of discrete Time Signals; Orthogonal Digital Filter Systems. Two-Dimensional Discrete Time Filters. VLSI Computing structures for Signal Processing.

EE 604 **IMAGE PROCESSING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Human visual system and image perception, monochrome & colour vision models, colour representation ; image sampling & quantization; 2-D systems; image transforms; image coding; stochastic models for image representation; image enhancement, restoration & reconstruction. Image analysis using multiresolution techniques.

EE 605 **INTRODUCTION TO SIGNAL ANALYSIS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Discrete and Continuous time signals and systems, LTI systems, Convolution, Difference equations. Frequency domain representation: Fourier transform and its properties. Random discrete signals. Sampling and reconstruction: Change of sampling rate. Normed vector spaces, basis, linear independence, orthogonality. Linear systems of equations. Over- and Underdetermined systems. Row- and Column spaces, Null spaces. Least square and minimum norm solutions. Inverse and pseudo inverse, Symmetry transformations. Eigenvectors and eigenvalues. Hilbert transforms, band pass representations and complex envelope. Base band pulse transmission, matched filtering, ISI, equalization. Coherent and noncoherent detection.

EE 606 **ARCHITECTURE AND APPLICATIONS OF DIGITAL SIGNAL PROCESSORS,**

L-T-P-D-[C] **Prereq. #**
3-0-0-0-[4]

Review of DSP fundamentals. Issues involved in DSP processor design - speed, cost, accuracy, pipelining, parallelism, quantization error, etc. Key DSP hardware elements - Multiplier, ALU, Shifter, Address Generator, etc. TMS 320C55 X and TM 320C6X and 21000 family architecture and instruction set. Software development tools - assembler, linker and simulator. Applications using DSP Processor - spectral analysis, FIR/IIR filter, linear-predictive coding, etc.

EE 607 **WAVELET TRANSFORMS FOR SIGNAL AND IMAGE PROCESSING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Basics of functional Analysis; Basics of Fourier Analysis; Spectral Theory; Time-Frequency representations; Nonstationary Processes; Continuous Wavelet Transforms; Discrete Time-Frequency Transforms; Multi resolution Analysis; Time-Frequency Localization; Signal Processing Applications; Image Processing Applications

EE 608 **STATISTICAL SIGNAL PROCESSING II** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Power Spectrum Estimation, model order selection, Prony, Pisarenko, MUSIC, ESPRIT algorithms, least square estimation, cholesky, LDU-OR, SV decomposition. Transversal & reasnic least square lattice filters, Signal Analysis with Higher order Spectra, Array processing, Beam foming, Time-delay estimation.

EE 609 **BASICS OF BIOMEDICAL SIGNAL AND IMAGE PROCESSING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Speech and pathology of vocal tract/ cords, Perpetual coding of audio signal and data compression, Spatio-temporal nature of bioelectric signals, cardiac generator and its models, Specific digital technique for bioelectric signals, Modes of medical imaging.

EE 610 **ANALOG/DIGITAL VLSI CIRCUITS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Analog MOS circuits, op-amps, frequency and transient responses, stability and compensation. Analog switches, sample-and-hold circuits, switched-capacitor circuits. MOS inverters and gate circuits, interfacing, transmission gates. MOS memory circuits. Digital building blocks - multiplexers, decoders, shift registers, etc. Gate array, standard cell, and PLA based designs. Digital -to-Analog and Analog-to-Digital converters.

EE 611 **FLUCTUATION PHENOMENA IN MICROELECTRONICS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Stochastic variables of interest in physical electronics (e.g. carrier concentration, potential, barrier heights, mobility, diffusion constant, G-R time, avalanche coefficients etc.). Thermodynamic considerations. Manifestation of stochastic processes in physical electronics. Instrumentation.

EE 612 **FIBER OPTIC SYSTEMS I** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Review of semiconductor physics - radiative recombination. LEDs, optical cavity, DH and other lasers. P-I-N and APD detectors, detector noise. Optical fibers - ray and mode theories, multimode and single-mode fibers, attenuation, dispersion. Gaussian beams. Power coupling, splices and connectors.

EE 613 **MEASUREMENTS, PARAMETER EXTRACTION AND SLSI TOOLS IN MICROELECTROMICS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Essentially a lab course aimed at imparting basic measurement, analysis and software skills relevant to microelectronics. Experiments related to BJT DC characteristics, MOS C-V measuremets, interface state density and DLTS. SPICE simulation of complex CMOS gate; full custom cell layout; logic simulation; multi-level logic minimization using VIEWLOGIC tools.

EE 614 **SOLID STATE DEVICES I** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Basic semiconductor physics. Diodes (P-N junction, Schottky, contact), Junction Transistors (BJT, HBT), Field Effect Transistors (JEFT, MESFET, MOSFET, HEMT). Other semiconductor devices.

EE 615 **HIGH FREQUENCY SEMICONDUCTOR DEVICES AND CIRCUITS**

L-T-P-D-[C] **Prereq. EE 614**
3-0-0-0-[4]

Review of Semiconductor properties - Crystal structure of semiconductors, band theory, occupation statistics, electrical properties, optical properties, recombination kinetics, avalanche process in semiconductors, photon statistics; MESFETs; Transport in low dimensional structures: HEMTs: Hetrojunction BJTs; Design of high frequency amplifiers and oscillators, Resonant tunneling structures, RTD oscillators; Intervalley scattering, Gunn diodes, IMPATT diodes; TRAPATTs; Mixer diodes; Step recovery diodes; Introduction to epitaxial growth for these structures; elements of device fabrication.

EE 616 **SEMICONDUCTOR DEVICE MODELLING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Models for metal-semiconductor contacts and heterojunctions. MOSFET - quantum theory of 2DEG, gradual channel approximation, charge control models, BSIM model, second-order effects. MESFET-Shockley, velocity saturation and universal models. HEFT - Basic and universal models. SPICE and small-signal models.

EE 617 **FIBER OPTIC SYSTEMS II** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Fiber optic transmitter and receiver designs. Link analyses. Line Coding. Coherent optical communication systems. Multiplexing schemes. Local area networks, FDDI, SONET and SDH. Fiber optic sensors and signal processing. Optical Amplifiers. Photonic Switching. Solitons in optical fibers.

EE 618 **INTEGRATED CIRCUIT TECHNOLOGY** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

IC components - their characterization and design. Anaysis and design of basic logic circuits. Linear ICs. Large Scale Integration. Computer simulation of ICs and layout design. High Voltage ICs. GaAs MESFET and GaAs ICs. Failure, reliability and yield of ICs. Fault modeling and testing.

EE 619 **VLSI SYSTEM DESIGN** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Emphasis on the synthesis based approach to VLSI Design. Relevant issues related to physical design automation such as placement, floor planning, routing and

compaction are covered. Combinational & sequential logic synthesis issues and algotithms are discussed. Detailed coverage of HDLs and high level synthesis algorithms and issues.

EE 620 **APPLICATION OF CDMA TO CELLULAR COMMUNICATIONS Prereq. EE 621**

L-T-P-D-[C]
3-0-0-0-[4]

Spread spectrum concept. Basics of CDMA. Properties and generation of PN sequences. Basics of Cellular and Mobile communications. Applications of CDMA to cellular communication systems. Walsh and Harr functions. Second and third generation CDMA systems/standards. Multicarrier CDMA. Synchronization and demodulation issues. Diversity techniques and Rake receiver. Cell coverage and capacity issues. Convolution and turbo codes. CDMA optimization issues.

EE 621 **REPRESENTATION AND ANALYSIS OF RANDOM SIGNALS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Review of probability, random variables, random processes; representation of narrow band signals. Transmission of signals through LTI systems; Estimation and detection with random sequences; BAYES, MMSE, MAP, ML schemes. K-L and sampling theorem representations, matched filter, ambiguity functions, Markov sequences, linear stochastic dynamical systems.

EE 622 **COMMUNICATION THEORY** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Rate Distortion Theory, Channel Coding Theorems, Digital Modulation Schemes, Trellis Coded Modulation, Digital Transmission over Bandlimited Channels, Fading Multipath Channels, Synchronization. Analog Modulation Schemes, Optimum/ Suboptimum Receivers; Diversity Combining; Cellular Mobile Communciation; Equalization.

EE 623 **DETECTION & ESTIMATION THEORY** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Classical Detection and Estimation Theory, Signal Representation, Detection of signals in Gaussian noise, Waveform estimation, Linear estimation problems, Wiener filtering, Kalman filtering.

EE 624 **INFORMATION & CODING THEORY** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Entropy and mutual information, rate distortion function, source coding, variable length coding, discrete memoryless channels, capacity cost functions, channel coding, linear block codes, cyclic codes. Convolutional codes, sequential and probabilistic decoding, majority logic decoding, burst error-correcting codes.

EE 625 **SATELLITE COMMUNICATION** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Introduction. Historical background and overall perspective; Satellite network modeling ; Link calculations; FM analysis; TV Transmission; Digital modulation; Error control; Multiple access; FDMA, TDMA, CDMA. Orbital considerations; Launching; Atmospheric effects; Transponders; Earth Stations; VSATs.

EE 626 **TOPICS IN STOCHASTIC PROCESSES** **Prereq. EE 621 or equiv. #**

L-T-P-D-[C]
3-0-0-0-[4]

Martingale convergence theorem, stopping times, sequential analysis. Ergodic Theory: Measure preserving transformations, stationary processes, mixing conditions, ergodic theorem, Shannon-Millan-Breiman theorem. Markov chains-asymptotic stationarity, indecomposability, ergodicity. Continuous time processes: Separability, continuity, measurability, stochastic integral.

EE 627 **SPEECH SIGNAL PROCESSING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Spectral and non-spectral analysis techniques; Model-based coding techniques; Noise reduction and echo cancellation; Synthetic and coded speech quality assessment; Selection of recognition unit; Model-based recognition; Language modelling; Speaker Identification; Text analysis and text-to-speech synthesis.

EE 628 **TOPICS IN CRYPTOGRAPHY AND CODING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Cryptography and error control coding in communication and computing systems. Stream and block ciphers; DES; public-key cryptosystems; key management, authentication and digital signatures. Codes as ideals in finite commutative rings and group algebras. Joint coding and cryptography.

EE 629 **DIGITAL SWITCHING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Network Architecture; time division multiplexing; digital switching; space & time division switching, cross point and memory requirements; blocking probabilities. traffic Analysis, models for circuit and packet switched systems, performance comparison; ISDN.

EE 630 **SIMULATION OF MODERN POWER SYSTEMS** **Prereq. #**

L-T-P-D-[C]
3-0-3-0-[5]

Modern power systems operation and control, Power system deregulation; static and dynamic modeling; Load flow and stability studies; Electromagnetic phenomenon; Insulation and partial discharge.

EE 631 **ADVANCED POWER SYSTEM STABILITY** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Detailed machine modeling, Modeling of turbine-generator and associated systems, excitation systems and PSS, Transient stability and small signal stability for large systems, SSR and system modeling for SSR studies, Voltage stability: P-V and Q-V curves, static analysis, sensitivity and continuation method; Dynamic analysis, local and global bifurcations, Control area, Margin prediction, Stability of AC-DC systems.

EE 632 **ECONOMIC OPERATION & CONTROL OF POWER SYSTEMS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Economic load dispatch, loss formula, introduction to mathematical programming, hydrothermal scheduling systems, power system security, optimal real and reactive power dispatch, state estimation, load frequency control, energy control center.

EE 633 **ELECTRIC POWER SYSTEM OPERATION AND MANAGEMENT UNDER RESTRUCTURED ENVIRONMENT** **Preq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Fundamentals of deregulation: Privatization and deregulation, Motivations for Restructuring the Power industry; Restructuring models and Trading Arrangements: Components of restructured systems, Independent System Operator (ISO): Functions and responsibilities, Trading arrangements (Pool, bilateral & multilateral), Open Access Transmission Systems; Different models of deregulation: U K Model, California model, Australian and New Zealand models, Deregulation in Asia including India, Bidding strategies, Forward and Future market; Operation and control: Old vs New, Available Transfer Capability, Congestion management, Ancillary services; Wheeling charges and pricing: Wheeling methodologies, pricing strategies.

EE 634 **ELECTRICAL INSULATION IN POWER APPARATUS AND SYSTEMS**

L-T-P-D-[C]
3-0-0-0-[4]

- Properties of dielectrics and breakdown mechanisms ; composites and novel materials; insulators for outdoor applications.
- Issues in design of insulators and insulator systems.
- Overvoltages and insulation coordination in transmission networks.
- Generation and measurement of testing Voltages –DC, AC, impulse and pulsed.
- Testing and Evaluation : Procedures and standards, ageing studies.

- On- line and off- line condition monitoring of sub-station equipment.
- Advances in measurement and diagnostic technologies : partial discharge monitoring, space charge charge measurements, dielectric spectroscopy, etc.
- Lab demonstrations

EE 635 **HVDC TRANSMISSION AND FLEXIBLE AC TRANSMISSION SYSTEMS**
L-T-P-D-[C] **Prereq. None**
3-0-0-0-[4]

General aspects of DC transmission, converter circuits and their analysis, DC link controls, faults and abnormal operation and protection;Mechanism of active and reactive power flow contro; Basic FACTS controllers: SVC, STATCOM, TCSC, TCPAR, UPFC; Modeling of FACTS Controllers; System static performance improvement with FACTS controllers; System dynamic performance improvement with FACTS controllers

EE 636 **ADVANCED PROTECTIVE RELAYING** **Prereq. #**
L-T-P-D-[C]
3-0-0-0-[4] Advanced protective relaying, basic protection schemes, relay terminology, relays as comparators, static relays, application of solid state devices, differential relaying systems, distance relaying schemes, protection of multiterminal lines, new types of relaying criteria, special problems, digital protection.

EE 638 **HIGH VOLTAGE ENGINEERING BEHAVIOUR OF DIELECTRICS** **Prereq. #**
L-T-P-D-[C]
3-0-0-0-[4] Electric fields and their numerical estimation; avalanche, streamer and leader processes; breakdown mechanisms, arcs, breakdown characteristics of gases, liquids and solids; intrinsic and practical strengths of dielectrics; ageing of solids, liquids and gases; gas insulated systems; effects of corona.

EE 640 **COMPUTATIONAL ELECTRO-MAGNETICS** **Prereq. #**
L-T-P-D-[C]
3-0-0-0-[4] Review of complex variables, conformal mappings, matrix calculus; Sturm Liouville equation; Eigenvalue problem; Guiding structures; Scattering media; Green's function approach; Variational formulation, FEM, Generalised scattering matrix and planar circuit approach.

EE 641 **ADVANCED ENGINEERING ELECTRO MAGNETICS** **Prereq. #**
L-T-P-D-[C]
3-0-0-0-[4] Transmission line theory; Green's function and integral transform techniques; Wave propagation and polarization parameters; reflection and transmission

across an interface; waveguides, cavity resonators, scattering by cylinders, wedges, spheres etc. Geometric theory of diffraction.

EE 642 **ANTENNA ANALYSIS & SYNTHESIS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Vector potential; antenna theorems and definitions; dipole, loop, slot radiators; aperture antennas; array theorems; pattern synthesis; self and mutual impedances; scanning antennas; signal processing antennas, travelling wave antennas; antenna measurements.

EE 643 **SMART ANTENNAS FOR MOBILE COMMUNICATIONS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Statistical signal processing concepts, Basics of mobile wireless communications. Radio-frequency signal modeling and channel characterization. Smart antennas and generalized array signal processing. Source localization problem. Joint angle and delay estimation. Smart antenna array configurations. Mobile communication systems with smart antennas.

EE 645 **MONOLITHIC MICROWAVE ICS** **Prereq. EE 340, EE 210**

L-T-P-D-[C]
3-0-0-0-[0]

Scattering parameters of n-ports, Conductor and dielectric losses in planar transmission lines, coupled lines, multi-conductor lines, discontinuities, GaAs MESFET fabrication devices, High electron mobility transistor, Heterojunction bipolar transistor fabrication and modeling, NMIC technology and design.

EE 646 **PHOTONIC NETWORKS AND SWITCHING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Optical communications: Introduction to basic optical communications and devices. Optical multiplexing techniques - Wavelength division multiplexing, Optical frequency division multiplexing, time division multiplexing, code division multiplexing. Optical Networks: Conventional optical networks, SONET / SDH, FDDI, IEEE 802.3, DQDB, FCS, HIPPI etc. Multiple access optical networks, Topologies, Single channel networks, Multichannel networks, FTFR, FTTR, TTFR and TTTR, Single hop networks, Multihop networks, Multiaccess protocols for WDM networks, Switched optical networks. Optical amplification in all-optical networks. All-optical subscriber access networks. Design issues. Optical switching: Motivation, Spatial light modulator, Relational and non-relational switching devices, Fundamental limits on optical switching elements, Switching architectures, Free-space optical switching. Wavelength routed networks and other special topics. Soliton based networks, Optical networks management issues.

EE 647 **MICROWAVE MEASUREMENTS AND DESIGN** **Prereq. #**

L-T-P-D-[C]
2-0-2-0-[4]

Experiments in basic microwave measurements; passive and active circuit characterization using network analyser, spectrum analyser and noise figure

meter; PC based automated microwave measurements; integration of measurement and design of microwave circuits.

EE 648 **MICROWAVE CIRCUITS** **Prereq. EE 340**

L-T-P-D-[C]
3-0-0-0-[4]

Transmission lines for microwave circuits; waveguides, stripline, microstrip, slot line; microwave circuit design principles; passive circuits; impedance transformers, filters, hybrids, isolators etc., active circuits using semiconductor devices and tubes, detection and measurement of microwave signals.

EE 649 **THE FINITE ELEMENT METHOD FOR ELECTRIC AND MAGNETIC FIELDS**

L-T-P-D-[C]
3-0-1-0-[4]

- Introduction : Review of Electromagnetic Theory.
- Introduction to the Finite Element Method using electrostatic fields : Galerkin 's method of weighted residuals, Minimum energy principle, Calculation of capacitance, electric field, electric forces from the potential solutions.
- Finite Element Concepts : Pre- processing, shape functions, isoparmetric elements, meshing, solvers, post- processing.
- finite Element Modeling : Conductive media, steady currents ; Magnetostatic fields, permanent Magnest, scalar and vector potentials ; Electromagnetic fields. eddy current problems, modeling of moving parts ; modeling of electrical circuits.

Laboratory :

Matlab and Femlab simulation

EE 650 **BASICS OF MODERN CONTROL SYSTEMS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Vector spaces, Linear systems, similarity transformations, Canonical forms, Controllability, Observability, Realisability etc. Minimal realization, Digital systems, Nonlinear systems, Phase-plane analysis, Poinca're theorems, Lyapunov theorem, Circle and Popov criterion; Robust control, Linear Quadratic Regulator (LQR), Linear Quadratic Gaussian (LQG) control, Loop Transfer Recovery (LTR), H-infinity control.

EE 651 **NONLINEAR SYSTEMS** **Prereq. EE 451**

L-T-P-D-[C]
3-0-0-0-[4]

Describing function, phase-plane analysis. Poincare's Index, Bendixson's theorem. Linearization. Lyapunov stability, stability theorems, variable-gradient technique

and Krasovskii's method for generating Lyapunov functions, statement of Lur'e problem, circle criterion, Popov criterion, input-output stability.

EE 652 **LINEAR STOCHASTIC DYNAMI-CAL SYSTEMS** **Prereq. EE 621**

L-T-P-D-[C]
3-0-0-0-[4]

Wiener processes; Markov chains & processes; Filtering, prediction & smoothing. Least squares, Minimum variance, ML and Minimax estimates, error bounds. Kalman and Wiener filters. Optimal control in presence of uncertainty, Synthesis of regulators and terminal controllers, Effect of noisy components on optimal control law. Partially characterised systems.

EE 653 **DIGITAL CONTROL** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Discrete-time signals and systems, Z-transform, pulse transfer functions. Compensator design by root locus, error coefficients and frequency response. State-space models of discrete time systems, controllability, observability, stability, state estimation, Kalman filtering. Linear regulation. Parameter estimation.

EE 654 **ROBUST CONTROL SYSTEMS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Linear Quadratic Regulators: return ratio & difference, sensitivity function. Kalman's optimality condition. Gain/phase margins, robustness to time delay and nonlinearity. Characterization of sensitivity. Kharitonov theorem robustness. Singular values - properties, application in stability, robustness and sensitivity. Robustness of discrete time LQR systems.

EE 655 **OPTIMAL CONTROL** **Prereq. EE 650**

L-T-P-D-[C]
3-0-0-0-[4]

Basic mathematical concepts. Conditions for optimality, variational calculus approach, Pontryagin's maximum principle and Hamilton Jacobi-Bellman theory. Structures and properties of optimal systems. Various types of constraints; singular solutions. Minimum time problems.

EE 656 **CONTROL SYSTEM DESIGN** **Prereq. #**

L-T-P-D-[C]
3-0-3-0-[5]

Linear multivariable control systems. Equivalence of internal and external stability of feedback control systems and the stabilization problem. Stable factorization approach for solving stabilization problem. Feedback system design. Solutions of H_2 and H_a problems. Robust stabilization, graph topology and graph metric.

EE 657 **MATHEMATICAL METHODS IN CONTROL SYSTEMS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Real and complex Euclidean spaces, Infinite dimensional inner product, complete spaces, Linear functionals and operators, Eigenvalues and eign vectors, complete

orthognal representations, Errors solutions to systems of linear equations, Matrix inversion, pivoting eigenvalue and eigen vector calculations, SVD, Non linear equations, probability theory, concepts, random variables, distribution functions, moments and statistics of multiple variables, MS estimations, stochastic processes.

EE 658 **FUZZY SET, LOGIC & SYSTEMS AND APPLICATIONS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Introduction, Uncertainity, Imprecision and Vagueness, Fuzzy systems, Brief history of Fuzzy logic, Foundation of Fuzzy Theory, Fuzzy Sets and Systems, Fuzzy Systems in Commercial Products, Research Fields in Fuzzy Theory, Classical sets and Fuzzy sets, Classical Relations, Fuzzy relations, Membership Functions, Fuzzy to crisp conversions, Fuzzy arithmetic, Numbers, Vectors and the extension principle, Classical logic and Fuzzy logic, Mathematical background of Fuzzy Systems, Classical (Crisp) vs, Fuzzy sets, Representation of Fuzzy sets, Types of Membership Functions, Basic Concepts (support, singleton, height, a-cut projections), Fuzzy set operations, S-and T- Norms, Properties of Fuzzy sets, Sets as Points in Hypercube, Cartesian Product, Crisp and Fuzzy Relations, Examples, Liguistic variables and hedges, Membership function design. Basic Principles of Inference in Fuzzy Logic, Fuzzy IF-THEN Rules, Canonical Form, Fuzzy Systems and Algorithms, Approximate Reasoning, Forms of Fuzzy Implication, Fuzzy Inference Engines, Graphical Techniques of Inference, Fuzzyifications/ DeFuzzification, Fuzzy System Design and its Elements, Design options. Fuzzy Events, Fuzzy Measures, Possibility Distributions as Fuzzy Sets, Possibility vs, Probability, Fuzzy Systems as Universal Approximators, Additive Fuzzy Systems (standard additive model).

EE 660 **BASICS OF POWER ELECTRONICS CONVERTERS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Power semiconductor devices, BJT, MOSFET, IGBT, GTO and MCT: AC-DC Converters; Forced communication; synchronous link converters, DC-AC converters, buck, boost, buck-boost, cuk, flyback configuration, resonant converters, PWM inverters; active filters.

EE 661 **POWER ELECTRONICS APPLICATIONS IN POWER SYSTEMS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Basics of flexible AC transmission systems, Controlled rectifier and energy storage plants, Tap changers and phase shifters, Thyristor controlled VAR compensation and series compensation, Modern (synchronous link converter) VAR compensators, Unified power flow controller (UPFC) and Interline power flow controller, Power quality conditioners, Power electronics in power generation.

EE 662 **CONTROL TECHNIQUES IN POWER ELECTRONICS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

State space modeling and simulation of linear systems, Discrete time models, conventional controllers using small signal models, Fuzzy control, Variable

structure control, Hysteresis controllers, Output and state feedback switching controllers

EE 663 **MODELING AND SIMULATION OF POWER ELECTRONIC SYSTEMS Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Machine modeling, DC, induction motor and synchronous machines; simulation of transients; simulation tools: SABER, PSPICE, and MATLAB-SIMULINK; Simulations of converters, inverters and cyclo-converters etc.

EE 664 **FUNDAMENTALS OF ELECTRIC DRIVES** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Motor load dynamics, starting, braking & speed control of dc and ac motors. DC drives: converter and chopper control. AC Drives: Operation of induction and synchronous motors from voltage and current inverters, slip power recovery, pump drives using ac line controller and self-controlled synchronous motor drives.

EE 665 **ADVANCED ELECTRIC DRIVES** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Closed loop control of solid state DC drives, Scalar and vector control of induction motor, Direct torque and flux control of induction motor, Self controlled synchronous motor drive, Vector control of synchronous motor, Switched reluctance motor drive, Brushless DC motor drive, Permanent magnet drives, Industrial drives.

EE 666 **SPECIAL TOPICS IN POWER ELECTRONICS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

PWM inverters, Multilevel inverters, Neutral point controlled inverters, Soft switching converters: DC-DC resonant link inverters, Hybrid resonant link inverters, Quasi resonant link converters, Switched mode rectifiers, Synchronous link converters.

EE 671 **NEURAL NETWORKS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Theory of representation; Two computational pradigms; Multi-layer networks; Auto-associative and hetero-associative nets; Learning in neural nets: Supervised and unsupervised learning; Application of neural nets; Neural network simulators.

EE 672 **COMPUTER VISION AND DOCUMENT PROCESSING** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Human and computer vision, Image reprentation and modelling, Line and edge detection, Labeling, Image segmentation, Pattern recognition, Statistical, structural

neural and hybrid techniques, Training & classification, Document analysis and optical character recognition, object recognition, Scene matching & analysis, Robotic version, Role of knowledge.

EE 673 **DIGITAL COMMUNICATION NETWORKS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

OSI model, queueing theory, physical layer, error detection and correction, data link layer, ARQ strategies, framing, media access layer, modelling and analysis of important media access control protocols, FDDI and DQDB MAC protocols for LANs and MANs, network layer, flow control & routing, TCP/IP protocols, ATM.

EE 674 **Architecture of advanced Microprocessors and Microcontrollers**

L-T-P-D-[C] **Prereq. EE 370**
3-0-0-0-[4]

Introduction to the general structure of advanced microprocessors and microcontrollers. Discussions on architectures, instruction sets, memory hierarchies, pipelining and RISC principles. Specific details of MC68HC11, MC68000 and Power PC 601. Laboratory based experiments and projects with these devices.

EE 675 **DIGITAL CIRCUIT DESIGN** **Prereq. EE 370**

L-T-P-D-[C]
3-0-0-0-[4]

Combinational circuit design; implemen-tation using programmable logic devices & field programmable gate arrays. Synchronous & asynchronous sequential circuits. Micro-programming and use of AMD 2909 micro-sequencer in sequential circuits. Issues related to fault detection, fault tolerance, and reliable design.

IEEE 488.2, serial interfacing - RS 232C, RS 422, RS 423, RS 485, CAMAC, VXI, SCXI, PXI, Sensors and transducers; Interfacing signal conditioning, Signal analysis techniques, Networking methods and their applications in instrumentation.

EE 676 **DIGITAL, MOBILE RADIO SYSTEMS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Introduction to Mobile Radio networks, channel description and analysis, Propagation Effects, Technologies, TDMA/CDMA Techniques, Architectures, Cellular Systems, GSM Systems, Mobile Satellite Communication, Wireless ATM, Third Generation Cellular, Universal Mobile Telecommunication Systems (UMTS).

EE 677 **KNOWLEDGE BASED MAN MACHINE SYSTEMS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Knowledge representation, state-space techniques, logic, semantic networks, frames, script. Production system, object oriented and ANN models. Applications in robotic vision and processing of documents, natural languages and speech. Course Project involving extensive programming is compulsory.

Combinational and sequential circuits, Logic families, Number systems, Arithmetic circuits using SSI/MSI chips. Basic microprocessor architecture, Essentials of a microcomputer system, Instruction sets, Machine cycles, Interrupt structures. Parallel /serial I/O, Analog I/O, DMA operation. Peripheral controllers.

EE 678 **NEURAL SYSTEMS AND NETWORKS, 2-0-3-4** **Prereq. #**

L-T-P-D-[C]
2-0-3-0-[4]

Memory: Eric Kandel's momery and its physiological basis, Explicit and Implicit memories, Short Term and Long Term potentiation (STP and LTP), Hopfield's Model of Associative Memories, its comparison with Kandel's model, Stability of Hopefield net, its use as CAM, Hamming's Model and comparision of number of weights, Learning: Supervised and Unsupervised nets, Learning Methods, Neural systems: Different types of neurons, dendrites, axons, role of Na^+ K^+ *AT* Pase and resting potentials, synaptic junctions and transmission of action potentials, Consciousness and its correlation with respiratory sinus arrythmia, a bioinstrumentation scheme for its measurement; Neural nets for technical applications: Bidirectional Associative Memories, (SAMs), Radial Basic, Function nets. Boltzmann machine, Wavelet nets, Cellular Neural Nets and Fuzzy nets.

EE 679 **QUEUEING SYSTEMS** **Prereq. #**

L-T-P-D-[C]
3-0-0-0-[4]

Review of probability and stochastic processes, Markov chains, Little's theorem, modelling & analysis of M/M-/- queues, Burke's Theorem, Reversibility, Method of stages, Analysis of M/G/1 queues, Queues with vacations, Work conservation principle, Priority queues, Queues served in cyclic order, Fluid-flow and diffusion approximations.

EE 680 **INTELLIGENT INSTRUMENTATION**

L-T-P-D-[C]
2-0-3-0-[4]

Introduction, data flow and graphical programming techniques, Virtual instrumentation (VI), advantages, VIs and Sub-VIs, Data acquisition methods, DAQ hardware, PC hardware; Structure, Operating system, ISA, PCI, USB, PCMICA buses, Instrumentation buses. IEEE 488.1 and

EE 698 **Special Topics in Electrical Engineering,**

Courses contents will be decided by the instructor

EE 699 **M. Tech. Thesis**

EE 799 **Ph. D. Thesis**