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**