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**BRIEF SYLLABI OF  
B.Tech DEGREE PROGRAMME IN  
ELECTRONICS AND COMMUNICATION  
ENGINEERING**

**(Applicable from 2010 Admission onwards)**

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**DEPARTMENT OF ELECTRONICS AND  
COMMUNICATION ENGINEERING**



**NATIONAL INSTITUTE OF TECHNOLOGY CALICUT**

### MA 2001: MATHEMATICS III

L	T	P	C
3	1	0	3

Probability distributions:- Binomial distribution, Hyper-geometric distribution, Chebyshev's theorem, Poisson distribution, Geometric distribution, Normal Distribution, Uniform distribution, Gamma distribution, Beta distribution, Weibull distribution. Joint distribution of two random variables. Sampling distributions and Inference concerning means:- Population and samples, The sampling distribution of the mean ( $\sigma$  known and  $\sigma$  unknown), Sampling distribution of the variance, Maximum Likelihood Estimation, Point estimation and interval estimation, point estimation and interval estimation of mean and variance, Inference concerning variances proportions:- Estimation of variances, Hypothesis concerning one variance, Hypothesis concerning two variances, Estimation of proportions, Hypothesis concerning one proportion, Hypothesis concerning several proportions, Analysis of  $r \times c$  tables, Chi-square test for goodness of fit. Regression Analysis:- Bi-variate Normal distribution- joint, marginal and conditional distributions. Curve fitting, Method of least squares, Estimation of simple regression models and hypothesis concerning regression coefficients, Correlation coefficient- estimation of correlation coefficient, hypothesis concerning correlation coefficient. Estimation of curvilinear regression models, Analysis of variance.

**Total hours : 56**

### EC 2011: NETWORK THEORY

L	T	P	C
3	0	0	3

Review of Network Theorems: Network Topology: Analysis and formulation of network equations using tie-set and cut-set. Transient analysis of RLC circuits. Review of Laplace transform - S-Domain Analysis of Circuits - Node analysis and mesh analysis of the transformed circuit. Network functions - Impulse response and Transfer function - Poles and Zeros Steady state response and Frequency response from Laplace transform. Two port networks: Characterization in terms of impedance - Admittance - Hybrid and transmission parameters. Symmetrical two port networks. Two Port Reactive Filter design. Network Synthesis: Positive real functions and Driving point functions, Testing driving point functions Driving point synthesis of RC, LC and RL networks.

**Total hours: 42**

### EC 2012: LOGIC DESIGN

L	T	P	C
4	0	0	4

Review of number systems and Boolean algebra - Simplification of functions using Karnaugh map and Quine McCluskey methods - Variable Entered Mapping - Combinational Circuits - Design using Logic Gates - Combinational circuit design using MSI circuits - Sequential Circuits - Latches, Flipflops, Counters, Registers, Sequence Generators - Design and Analysis of Sequential Circuits- Finite State Machine - Practical Design Aspects - Logic Families - Fundamentals of RTL, DTL and ECL gates - TTL logic family- MOS gates - MOS inverter - CMOS inverter - Interfacing BJT and CMOS gates

**Total hours : 56**

## EC 2013: SOLID STATE DEVICES

L	T	P	C
4	0	0	4

Review of quantum mechanics, Schrödinger Equation, tunneling phenomenon, KP Model, Band theory of solids, E-k diagram, Electron effective mass, energy band gap- Direct and indirect band gap semiconductors, Charge carriers in semiconductors and statistics, intrinsic and extrinsic semiconductors, carrier transport, mobility, conductivity, carrier life time, quasi Fermi levels, drift and diffusion of carriers, continuity equation, PN junction biasing, steady state conditions, break down of junctions, transient and AC conditions, non ideal junctions MS contacts and current voltage characteristics, BJT operation, switching characteristics, minority carrier profiles, BJT models, Frequency limitations of BJTs, JFET characteristics, MOS capacitor, band diagrams, surface potential, CV characteristics, effects of real surfaces, work function difference, interface charge, threshold voltage, MOSFET characteristics, scaling effects.

**Total hours : 56**

## EC 2014: SIGNALS AND SYSTEMS

L	T	P	C
3	0	0	3

Elements of signal theory- signal models and operations on signals - Systems – system properties- LTI systems – Convolution, Signal analysis: Signals and vectors – inner product and norm- Fourier series and Fourier Transform -Hilbert Transform – In-phase and quadrature representation of bandpass signals , Frequency domain analysis of LTI systems: Frequency response Function. Sampling: sampling theorem – interpolation. Frequency analysis of discrete time signals and systems – DTFS and DTFT- DFT. Laplace transform and Z transform: Properties of ROC – Analysis of LTI systems – Transfer function – Frequency response from pole – zero plot

**Total hours: 42**

## EC 2018: BASIC ELECTRONICS LAB

L	T	P	C
0	0	3	2

Familiarization of CRO, Function Generators, Power Supplies and multi-meters, Diode characteristics, BJT characteristics; CB & CE, JFET characteristics, Uni-junction Transistor characteristics and relaxation oscillator, Design of filter circuits- passive filters- Low pass, high pass and band pass filters. Rectifiers- Half wave , Full wave & Bridge rectifiers, Resonance circuits - Series and Parallel resonance, Voltage regulators- Zener regulator - Series Voltage Regulator.

**Total hours: 42**

## EC 2019: ELECTRONICS WORKSHOP

L	T	P	C
0	0	3	2

Familiarisation and Testing methods of Active and Passive components. Voltage Multiplier circuits. Zener Voltage regulators.(Variable and Fixed types), Linear Voltage regulators.(Variable and Fixed types), Single stage Amplifier and troubleshooting methods, Multivibrators using Transistors and ICs, Waveform generators using OP Amps, Flip flops and oscillators using logic gates, Soldering and troubleshooting of working circuits, Mini project. (PCB fabrication and circuit development ), Assignment- (Project circuit simulation- using simulation tools)

**Total hours : 42**

## MA 2002: MATHEMATICS IV

L	T	P	C
3	1	0	3

Series Solutions and Special Functions : Power series solutions of differential equations, Theory of power series method, Legendre Equation, Legendre Polynomials, Frobenius Method, Bessel's Equation, Bessel functions, Orthogonal eigenfunction expansions. Partial differential Equations :, Linear Equations of the first order, Nonlinear Partial Differential Equations of the first order, Classification of second order partial differential equations, Modeling: Vibrating String, Wave equation, Use of Fourier Series, D'Alembert's Solution of the wave equation, Heat equation: Laplace equation, Solution of a Partial Differential Equations by Laplace transforms. Complex Numbers and Functions: Complex functions, Derivative , Analytic function, Cauchy- Reimann equations, Laplace's equation, Geometry of Analytic functions: Conformal mapping, Linear fractional Transformations, Schwarz - Christoffel transformation, Transformation by other functions. Complex Integration : Line integral in the Complex plane, Cauchy's Integral Theorem, Cauchy's Integral formula, Derivatives of analytic functions. Power series, Functions given by power series, Taylor series and Maclaurin's series. Laurent's series, Singularities and Zeros, Residue integration method, Evaluation of real Integrals.

**Total hours : 56**

## EC 2021: ELECTRONIC CIRCUITS I

L	T	P	C
4	0	0	4

BJT/FET/MOSFET Biasing, Configurations,, Thermal runaway, Multistage amplifiers. Power Amplifiers. Frequency Resposnse of amplifiers, Equivalent circuit. Wide band amplifiers and wide banding techniques. Negative feedback, feed back topologies, Stability and Stability analysis. Oscillators, Analysis of practical oscillators. Switching characteristics of BJT. Multivibrators and Time Base Generators

**Total hours : 56**

## EC 2022: ELECTROMAGNETIC FIELD THEORY

L	T	P	C
4	0	0	4

Coulomb's law, Gauss's law, Poisson's equation, Laplace's equation, solutions to electrostatic boundary problems, permittivity and dielectric constant, Lorentz force, Biot-Savart law, Ampere's law, magnetic susceptibility and permeability, electromagnetic induction, continuity equation, displacement current, Maxwell's equations, Poynting's theorem, energy and momentum in electromagnetic field, monochromatic plane waves, group velocity, Lorentz gauge, normal and oblique incidence of electromagnetic waves at boundaries, transmission lines, Smith chart.

**Total hours : 56**

## EC 2023: MICROPROCESSORS AND MICRO CONTROLLERS

L	T	P	C
3	0	0	3

Basics of computer architecture, CISC and RISC, Intel 8086 processor: The architecture of 8086 —use of MASM - Programming concepts- Programming using instructions for data transfer ,arithmetic, logical and shift and rotate operations String manipulations –Procedures-Macros-ASCII operations-high level language constructs –I/O instructions–Modular programming , Hardware and Interfacing: The pin configuration, clock and power on reset of 8086-minimum and maximum modes. Interfacing chips- PPI 8255 -Timer8253/54 –Keyboard Display Interface 8279-DMA Controller 8237-Programmable Interrupt Controller 8259, Intel 8051 microcontroller : architecture – ports, timers, interrupts, serial data transmission instruction set -programming

**Total hours : 42**

## EC 2024: FUNDAMENTALS OF COMMUNICATION

L	T	P	C
4	0	0	4

Random variables representation and manipulation, independent and uncorellated variables, functions of random variables, standard PDFs, first and second fundamental theorems in probability. Random process, stationarity and ergodicity, power spectral density, response of LTI systems to random process, white Gaussian noise, Carrier modulation schemes- Amplitude modulation (AM), Frequency modulation (FM), and Phase modulation (PM), Generation and demodulation, coherent and non-coherent detection, Super-heterodyne radio receivers, Performance analysis of analog modulation schemes in the presence of channel noise

**Total hours: 56**

## EC 2028: ELECTRONIC CIRCUITS LABORATORY – I

L	T	P	C
0	0	3	2

BJT and JFET Biasing schemes and Bias Stability comparison, Emitter follower – frequency and phase response, Single stage BJT amplifier – Frequency Response , Single stage JFET amplifier – Frequency Response, Power amplifier – Class A and Class AB, Two stage RC coupled amplifier – Frequency Response, Cascode Amplifier – Frequency Response, Feedback amplifiers, Phase Shift Oscillator, Colpitts/Hartley Oscillators, Astable, Monostable and Bistable Multivibrator with BJT

**Total hours: 42**

## EC 2029: LOGIC DESIGN LAB

L	T	P	C
0	0	3	2

Combinational Logic design using basic gates (Code Converters, Comparators), Combinational Logic design using decoders and MUXs. Arithmetic circuits - Half and full adders and subtractors, Arithmetic circuits – design using adder ICs, BCD adder, Flip flop circuit (RS latch, JK & master slave) using basic gates. Asynchronous Counters, Synchronous counters, Johnson & Ring counters. Sequential Circuit designs (sequence detector circuit). Transfer Characteristics , Measurement of Sinking and Sourcing currents etc. of TTL gates.

**Total hours: 42**

## EC 3011: ELECTRONIC CIRCUITS - II

**Pre-requisite: EC 2021**

L	T	P	C
4	0	0	4

BJT/FET Differential amplifier analysis, CMRR, Frequency response, Constant current source. Op-amp internal structure, Compensation, Op-amp parameters, CMOS Op-amp. Linear Op-amp circuits, Virtual short, Non-linear op-amp circuits, Filter approximations, Frequency transformation, Filter realisations, Gyrator, Switched capacitor filter. DACs and ADCs, Different types, Parameters, PLL, Typical applications of different ICs.

**Total hours: 56**

## EC 3012: DIGITAL COMMUNICATION

L	T	P	C
4	0	0	4

Sampling theorem for base-band and pass-band signals, Pulse modulation schemes: PAM, PPM, and PWM, Digital Pulse modulation: PCM, DPCM, Delta modulation, Adaptive delta modulation- Pulse Shaping, Nyquist criterion for zero ISI, Signaling with duobinary pulses - Digital band pass modulation schemes: ASK, FSK, PSK, MSK, DPSK – Digital M-ary modulation schemes – signal space representation, Gram-Schmidt orthogonalization procedure - Optimum waveform receiver in additive white Gaussian noise (AWGN) channels - Correlation receiver, Matched filter receiver and calculation of error probabilities - Performance comparison of digital modulation schemes.

**Total hours: 56**

## EC 3013: DIGITAL SIGNAL PROCESSING

**Pre-requisite: EC 2014**

L	T	P	C
3	0	0	3

Fourier analysis of discrete-time signals and systems; Digital filters: FIR Filters, IIR Filters, Least squares filter design: Deterministic least squares, DSP Processors; Internal descriptions of digital filters; Finite length register effects.

**Total hours : 42**

## EC 3014: CONTROL SYSTEMS

L	T	P	C
3	0	0	3

Open loop and closed loop control systems – Transfer function - signal flow graph - Mason's gain formula - Block diagram reduction using direct techniques and signal flow graphs. Time domain analysis of first order and second order continuous time systems –determination of response for standard inputs using transfer functions - concept of stability - Routh- Hurwitz techniques - Bode diagrams - Root locus - Polar plots and theory of Nyquist criterion - theory of lag, lead and lag-lead compensators. Discrete time control system - sampling - sample and hold - pulse transfer function - system function - mapping between s plane and z plane - bilinear transformation - analysis of discrete time systems – stability - Jury's criterion – Routh-Hurwitz techniques - Bode diagrams - digital redesign of continuous time systems. State variable concept - state space models - diagonalization - solution of state equations - relation between transfer function and state space models for continuous and discrete cases - relation between poles and Eigen values – Controllability and observability

**Total hours : 42**

## EC 3018: ELECTRONICS CIRCUIT LABORATORY – II

L	T	P	C
0	0	3	2

Differential amplifier and Current Source, Measurement of Op-Amp parameters , Inverting & non-inverting amplifiers, Integrator, Differentiator – frequency response Instrumentation Amplifier using Op-amps , Op-amp in comparator application, Waveform Generators –Sine, square, Triangular and Ramp, Astable and Monostable Multivibrators using op-amp and 555IC, Low Pass Filter and High Pass Filter realizations using op-amps, Band Pass Filter and Band Stop Filter realizations using op-amps , DAC and ADC circuits using op-amp/ICs, Regulated power supply with 723 IC

**Total hours : 42**

## EC 3019: MICROPROCESSORS AND MICROCONTROLLERS LAB

L	T	P	C
0	0	3	2

Assembly language programming of 8086 -TSR ,matrix multiplication and Pascal's triangle, Stepper board interfacing to 8086, Hex keyboard interfacing to 8086, Multiplexed ,dynamic LED display interface to 8086, 8279 interface to 8086, 8255 interface to 8086, Assembly language programming of 8051, Timer programming of 8051 ,using status check, Timer programming of 8051 ,using interrupts, External interrupts programming of 8051, LCD interfacing to 8051 –project

**Total hours : 42**

## ME4104: PRINCIPLES OF MANAGEMENT

**Prerequisite:** Nil

L	T	P	C
3	0	0	3

Introduction to management theory, Characteristics, Systems approach, Task responsibilities and skill required, Process of management, Planning, Organizing, Directing, Controlling, Decision making process, Project management, Overview of operations management, Human resources management, Marketing management, Financial management.

**Total Hours: 42 hours**

## EC 3021: COMPUTER ORGANIZATION & ARCHITECTURE

L	T	P	C
3	0	0	3

Introduction to Processor Architecture – Design Methodology- CPU Organization - Instruction Sets – Instruction Formats – Instruction Types – Datapath Design –Arithmetic Logic Units – Combinational ALUs – Sequential ALUs – Floating Point Arithmetic – Pipeline Processing – Control Design : Basic Concepts – Introduction – Hardwired Control – Design Examples – Microprogrammed Control -Memory Organisation - Cache Memory - Virtual Memory , I/O Organization – Isolated Versus Memory Mapped I/O - Programmed I/O – DMA and Interrupts – I/O Processors – Operating Systems – Parallel Processing – Processor Level Parallelism – Multiprocessors – Fault Tolerance.

**Total hours ; 42**

## EC 3022: INFORMATION THEORY & CODING

L	T	P	C
4	0	0	4

Discrete memory-less sources, Entropy, Lossless source coding- Uniquely decodable codes- Optimal codes- Huffman code- Arithmetic code, Lempel-Ziv Code, Shannon's Source Coding Theorem, Discrete channels and Capacity- Shannon's Channel Coding Theorem and its converse, Continuous sources and channels, Differential Entropy, Band limited Gaussian channels, Shannon-Hartley Theorem, Shannon limit and Modulation trade-off parameters- Error control Coding, Linear block codes, Finite field arithmetic, Cyclic codes, BCH codes, LDPC codes, Convolutional codes, Construction and Viterbi decoding, Distance properties, Turbo codes

**Total hours ; 56**

## EC 3023: COMPUTER NETWORKS

L	T	P	C
3	0	0	3

Building blocks- Layering and protocols - OSI architecture - Internet architecture – Multiplexing -Circuit switching vs packet switching - Datagram Networks - Virtual Circuit networks - Reliable transmission - Multiple access protocols - Ethernet (IEEE 802.3) - wireless LAN (IEEE 802.11) - IPv4 – ARP - Routing- distance vector (RIP) - Link state (OSPF) - routing for mobile hosts - subnetting – CIDR - inter-domain routing (BGP) - IPv6 - UDP – TCP - congestion control - Broadband services and QoS issues - Integrated service architecture- Queuing Disciplines- Weighted Fair Queuing- Random Early Detection- Differentiated Services -RSVP- Multi protocol Label switching- Real Time transport protocol.

**Total hours ; 42**



### EC 3024: ENVIRONMENTAL STUDIES

L	T	P	C
3	0	0	3

Natural resources, role of an individual in conservation of natural resources, concept of an ecosystem, structure, features and function of an ecosystem, genetic, species and ecosystem diversity, hot-spots of biodiversity, threats to biodiversity, causes, effects and control measures of environmental pollution, electronic waste and management, social issues and the environment, human population and the environment.

**Total hours: 42**

### EC 3028: ANALOG COMMUNICATION LAB

L	T	P	C
0	0	3	2

AM generation, AM detection with simple and delayed AGC, DSBSC generation, RF Mixer using JFET/BJT Implementation of intermediate frequency amplifier, FM generation (reactance modulator), FM demodulation: Foster-seely discriminator and ratio detector, PAM generation and demodulation, Generation and demodulation of PWM and PPM, PLL characteristics, FM modulation/demodulation using PLL

**Total hours ; 42**

### EC 3099: MINI PROJECT

L	T	P	C
0	0	3	1

The mini project should be on Hardware Design and/or Fabrication in any of the areas in Electronics and Communication Engineering. Microcontroller/DSP/PLD based hardware design is also permitted. Project work can be carried out individually or by a group of maximum of five students under the guidance of a faculty from ECE Department. A committee of the faculty will evaluate the projects during the sixth semester. This course is normally engaged by the department at the beginning of sixth semester

**Total hours ; 42**

### MS 4003: ECONOMICS

L	T	P	C
3	0	0	3

The syllabus is divided into four modules. The first module gives basic foundations in Micro Economics which includes topics like demand analysis, elasticity and forecasting. Concepts on cost and short run and long run cost analysis, followed by market structures are dealt in Module two. In the third module, the focus will be on macro and monetary economics where is topics like national income, inflation and constituents of financial system like commercial banks, Reserve Bank of Indian and Indian stock market are discussed. Fourth module sheds light on International economics which deals with foreign exchange market and role of international institutions like World Bank, IMF.

**Total hours ; 42**

## EC 4011: FUNDAMENTALS OF WIRELESS COMMUNICATION

L	T	P	C
4	0	0	4

Wireless Channel Characterisation – Frequency and Time Characterisation – Communicating through Fading Channels – Diversity Techniques Cellular Mobile Architecture – Interference Aspects - Handoff Mechanisms – Spread Spectrum Systems Synchronisation Issues

**Total hours ; 56**

## EC 4018: DIGITAL SIGNAL PROCESSING LAB

**Pre-requisites: EC3013**

L	T	P	C
0	0	3	2

MATLAB/C/C++, Assembly language of TI/AD Signal Processors; Construction of z- plane - poles and zeros, phase and magnitude responses; Linear convolution, Frequency response of FIR filters - Minimum Phase filters, Linear phase filters; Convolution of long sequences - Overlap-save and overlap-add methods; FIR Filter Design; Discrete Fourier transform - Fast Fourier Transform algorithms - Convolution with DFT; IIR filter Design; Companding and nonuniform quantization - A-law and  $\mu$ - law companding - Digital realization; Digital coding of waveforms; Lattice structure realization of digital filters; Linear prediction - Algorithms

**Total hours ; 42**

## EC 4019: DIGITAL COMMUNICATION LAB

L	T	P	C
0	0	3	2

Pulse code modulation, Delta modulation, Manchester encoder and timing recovery, Frequency Shift Keying Modem: Hardware Implementation, BPSK Modem: Simulation and Error probability evaluation, BPSK generation and detection: Hardware Implementation, BPSK Modem: Simulation and Error probability evaluation, Linear block codes-generation and detection, Cyclic encoder and decoder, Differential encoder and decoder, Digital microwave links, Digital TDM, CDMA spreader and de-spreader

**Total hours ; 42**

## EC 4098: MAJOR PROJECT

L	T	P	C
0	0	6	3

The duration of major project is for two continuous semesters from seventh. The project can be analytical work, simulation, hardware design or a combination of these in the emerging areas of Electronics and Communication Engineering under the supervision of a faculty from the ECE Department. Project work can be carried out individually or by a group of maximum of five students. The UG evaluation committee of the department shall evaluate the project during seventh semester for 3 of total of 7 credits assigned for the project.

**Total hours : 84**

## EC 4094: SEMINAR

L	T	P	C
0	0	3	1

Each student shall present a seminar in the eighth semester on a topic relevant to Electronics and Communication Engineering for about 30 minutes. The topic should not be a replica of what is contained in the syllabus. The topic shall be approved by the Seminar Evaluation Committee of the Department. The committee shall evaluate the presentation of students. A seminar report in the prescribed form shall be submitted to the department after the approval from the committee.

**Total hours : 42**

## EC 4099: MAJOR PROJECT

L	T	P	C
0	0	6	4

The duration of major project is for two continuous semesters from seventh. The project can be analytical work, simulation, hardware design or a combination of these in the emerging areas of Electronics and Communication Engineering under the supervision of a faculty from the ECE Department. Project work can be carried out individually or by a group of maximum of five students. The UG evaluation committee of the department shall evaluate the project during eighth semester for 4 of total of 7 credits assigned for the project.

**Total hours : 84**

## ELECTIVES

### EC 3031: TELEVISION ENGINEERING

L	T	P	C
3	0	0	3

Principles of television - video and sound signal modulation – television signal propagation –antennas. Television receiver circuits – Horizontal and vertical deflection circuits. Colour TV - colour TV camera and picture tube - modulation - principles of NTSC, PAL and SECAM coder and decoder. Digital TV - composite digital standards- Cable TV - cable frequencies - cable decoders

**Total hours : 42**

### EC 3032: POWER ELECTRONICS

L	T	P	C
3	0	0	3

Power diodes - power transistors - BJT, MOSFET and IGBT - thyristors - basic structure - static and dynamic characteristics - device specifications and ratings - methods of turning on - gate triggering circuit using UJT - methods of turning off - commutation circuits - TRIAC Line frequency phase controlled rectifiers using SCR - SCR inverters -pulse width modulated inverters - AC regulators - cycloconverter - choppers - principle of operation - step-up and step-down choppers - speed control of DC motors and induction motors - Switching regulators - buck regulators - boost regulators - buck-boost regulators - cuk regulators - switched mode power supply .

**Total hours : 42**

### EC 3033: MICROELECTRONICS TECHNOLOGY

L	T	P	C
3	0	0	3

Material properties, crystal structure, characterization of material based on band diagram and bonding, Crystal growth techniques, wafer cleaning, Epitaxy, Clean room and safety requirements, Oxidation-Kinetics, Deal-Grove model and Improvements in Deal-Grove method for thin and ultra thin oxide layers, thickness characterization methods, multi dimension oxidation modeling, Diffusion and Ion Implantation, Deposition & Growth, Growth of High k and low k dielectrics, Etch and Cleaning, Wet etch, Dry etch, Plasma etching, RIE etching, etch selectivity/selective etch, Photolithography, Planarization Techniques, Chemical Mechanical Polishing, Metallization and Interconnects, Copper damascene process, Metal interconnects; Multi-level metallization schemes, Process integration..

**Total hours : 42**

## EC 3034: MODELING AND TESTING OF DIGITAL SYSTEMS

L	T	P	C
3	0	0	3

**Pre-requisite: EC2012**

Introduction to HDL based Digital Design: –Behavioural modelling – Process constructs – Complex signal assignments – Dataflow modelling – delay models – Structural modelling - Advanced VHDL features: modelling examples – state machine modelling using VHDL- review of FPGA architectures and design using FPGA. Practical design exercises on VHDL simulator /synthesizer, Digital System Testing: Fault models – fault equivalence – fault location fault dominance – single and multiple stuck faults – Testing for single stuck faults – Algorithms – random test generation – Testing for bridging faults, Design for Testability: Ad-hoc design for testability techniques – Classical scan designs – Boundary scan standards – Built-in-self-test – Test pattern generation – BIST architecture examples

**Total hours : 42**

## EC 3035: MOS DEVICE MODELING

**Pre-requisite : EC2013**

L	T	P	C
3	0	0	3

Semiconductor surfaces, Ideal MOS structure, MOS device in thermal equilibrium, Non-Ideal MOS, states, band diagrams flatband voltage, electrostatics of a MOS (charge based calculations), MOS as a capacitor (2 terminal device), Three terminal MOS, effect on threshold voltage, MOSFET (Enhancement and Depletion MOSFETs), characteristics, mobility, effect of source bias and body bias on threshold voltage and device operation, Scaling, Short channel and narrow channel effects- High field effects, MOS transistor in dynamic operation, SOI concept, PD SOI, FD SOI and their characteristics, threshold voltage of a SOI MOSFET, Multi-gate SOI MOSFETs, Alternate MOS structures.

**Total hours : 42**

## EC 3036: VLSI CIRCUITS & SYSTEMS

L	T	P	C
3	0	0	3

**Pre-requisites: EC2012 & EC2013**

Switches and Boolean operation-MOSFET as switch- CMOS inverters-Stick diagram and layout -Multiple input CMOS logic circuits, Pass transistor and transmission gate logic styles, Dynamic circuits, sequential circuits, Cell based design, Logic and circuit design of arithmetic circuits-Adders, multipliers and barrel shifters, SRAM and DRAM cells, Driving large capacitive loads, Wire delay models, Latch up, ESD protection, Scaling and short channel effects

**Total hours : 42**

## EC 3037: ACTIVE NETWORK SYNTHESIS

L	T	P	C
3	0	0	3

**Pre-requisites: EC 2011, EC 3011**

Network functions - Types of filters - Butterworth, Chebyshev, Elliptic and Bessel filters - Sensitivity - Definition and basic properties - Function sensitivity - Coefficient sensitivity - Q and  $\omega_0$  sensitivity- Amplifiers and fundamental active building blocks - Opamps, OTAs, CCIIs, Integrators, gyrators and immittance converters Second-order filters - Higher order filter realization - Cascade realizations, pole-zero pairing - Multiple-loop feedback realizations - LC ladder simulations Fully integrated high-frequency filter realisations - Transconductance filters - Log-domain filters - Switched-capacitor filters

### EC 3038: EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

Embedded system examples, Parts of Embedded system, Interfacing, Memory Technologies, Embedded system Product development cycle, Development Environment, Debugging, Bus Architectures, Firmware, Operating systems, Real Time Operating Systems, System Design using embedded controller.

**Total hours : 42**

### EC 3039: MULTIRATE SYSTEMS

L	T	P	C
3	0	0	3

**Pre-requisites: EC3013**

Multirate System Fundamentals: Basic multirate operations- Identities of multirate operations- Polyphase representation of signals and systems- Multirate Filter Banks- Maximally decimated filter Errors in filter banks- PR condition; Design of an alias free QMF bank -M-channel Perfect Reconstruction Filter Banks -Filter banks with equal pass bandwidth, filter banks with unequal pass bandwidth -Necessary and sufficient condition for perfect reconstruction-Design of PR systems- Linear Phase Perfect Reconstruction (LPPR) Filter Banks- Necessary conditions for linear phase property; Lattice structures for LPPR FIR QMF banks -Quantization effects - Types of quantization effects in filter banks - Implementation - Coefficient sensitivity effects-dynamic range and scaling.

**Total hours : 42**

### EC 3040: DIGITAL IMAGE PROCESSING

L	T	P	C
3	0	0	3

Basic ideas in digital image processing: problems and applications - Image representation and modeling Sampling and quantization - Two dimensional systems 2-D convolution; 2-D correlation. Image perception – basic definitions and image models - monochrome vision models - image fidelity criteria - colour representation. Image transforms. Image enhancement & Restoration techniques: Histogram processing: spatial and transform domain filters, Inverse filtering, Wiener filtering. Image compression: Fundamental concepts of image compression - Compression models - Information theoretic perspective – Lossy and Lossless coding methods, Image compression standards. Image segmentation: Local and global processing, Hough transform, Region based segmentation.

**Total hours : 42**

### EC 4031: MICROWAVE COMMUNICATION

L	T	P	C
3	0	0	3

**Pre-requisite: EC 2022**

Communication satellite subsystems, payload, orbital parameters, satellite trajectory, geostationary satellites, non-geostationary constellations, antenna and feed systems, satellite tracking system, fixed and mobile satellite service earth stations, terrestrial microwave links, communication link design, VSAT design issues, multiple access techniques.

**Total hours : 42**

## EC 4032: SPEECH PROCESSING

**Pre Requisite: EC 3013**

L	T	P	C
3	0	0	3

Digital models for the speech signal - mechanism of speech production - acoustic theory – Portnoff's equations- lossless tube models – complete speech production model- digital models - Speech analysis:-linear prediction of speech - Solution of LPC equations - Levinson Durbin algorithm - Levinson recursion - Schur algorithm - lattice formulations and solutions – PARCOR coefficients -Speech synthesis - pitch extraction algorithms - homomorphic speech processing - complex Cepstrums-Spectral analysis of speech - short time Fourier analysis – STFT interpretations- Automatic speech recognition systems - isolated word recognition - connected word recognition - speaker recognition systems

**Total hours : 42**

## EC 4033: WAVELET THEORY

L	T	P	C
3	0	0	3

**Pre-requisites: EC 2014, EC 3013**

Fourier and Sampling Theory, Short-time(windowed) Fourier transform, Time-frequency analysis - uncertainty relation, Fundamental notions of the theory of sampling. Theory of Frames, Frame projector, Example - windowed Fourier frames. Wavelets, The basic functions, Specifications, Admissibility conditions, Continuous wavelet transform (CWT), Wavelet frames., The multiresolution analysis (MRA) of  $L_2(\mathbb{R})$ , Construction of wavelets, Regularity and selection of wavelets - Smoothness and approximation order – Criteria for wavelet selection with examples; Splines, Cardinal B-spline MRA, Subband filtering schemes, Compactly supported orthonormal wavelet bases. Wavelet transform, Discrete wavelet transform (DWT) - Wavelet decomposition and reconstruction of functions in  $L_2(\mathbb{R})$ , Fast wavelet transform algorithms - Relation to filter banks, Wavelet packets - Representation of functions, Selection of basis. Biorthogonality and biorthogonal basis, Biorthogonal system of wavelets - construction, The Lifting scheme.

**Total hours : 42**

## EC 4034: RF CIRCUITS

L	T	P	C
3	0	0	3

Characteristics of passive IC components at RF frequencies, classical two-port noise theory, noise models for active and passive components, High frequency amplifier design, neutralization and unilateralization, low noise amplifier design, mixers, RF power amplifiers, Oscillators & synthesizers.

**Total hours : 42**

## EC 4035: HIGH SPEED DIGITAL CIRCUITS

L	T	P	C
3	0	0	3

Frequency, Time and Distance, High speed properties of logic gates, Modelling of wires, Transmission lines, Power supply distribution and isolation. Noise Sources, Signaling over transmission media, Terminations, Transmitter and receiver circuits, Timing, Signals and events, Clock Distribution, Metastability, PLL and DLL.

**Total hours : 42**

## EC 4036: ANTENNA THEORY

**Pre-requisite: EC 2022**

L	T	P	C
3	0	0	3

Antenna properties, Potentials and radiation fields-Lienard- Wiechert potentials, electric dipole radiation, magnetic dipole radiation, power radiated by a point charge, duality and reciprocity theorems, Monopole and Dipole antennas, linear dipole antenna arrays-Broadside and Endfire Arrays, Binomial Array, Dolph-Tschebyscheff Array, Antenna Synthesis- Schelkunoff polynomial method, Fourier transform method, Helical antenna, Yagi – Uda antenna, parabolic antenna, Frequency independent antennas, RF antennas – Microstrip antenna, Fractal antenna Smart Antennas and beamforming techniques.

**Total hours : 42**

## EC 4037: ANALOG MOS INTEGRATED CIRCUITS

L	T	P	C
3	0	0	3

**Pre-requisites: EC2013, EC2021 & EC 3011**

Review of MOSFET, MOSFET models, Noise in MOS transistors, Voltage dividers, Current sources and sinks, Cascode connection, Bandgap referenced biasing, voltage references, Single stage amplifiers, Output stages, differential amplifier, comparator, analog multiplier, switched capacitor circuits, switched capacitor filters

**Total hours : 42**

## EC 4038: HIGH SPEED SEMICONDUCTOR DEVICES

L	T	P	C
3	0	0	3

Important parameters governing the high speed performance of devices and circuits, Transit time of charge carriers, junction capacitances, ON-resistances and their dependence on the device geometry and size, carrier mobility, doping concentration and temperature; important parameters governing the high power performance of devices and circuits: Break down voltage, resistances, device geometries, doping concentration and temperature, Merits of III –V binary and ternary compound semiconductors (GaAs, InP, InGaAs, AlGaAs, SiC, GaN etc.), different SiC structures, silicon-germanium alloys and silicon carbide for high speed devices, as compared to silicon based devices, outline of the crystal structure, dopants and electrical properties such as carrier mobility, velocity versus electric field characteristics of these materials, electric field characteristics of materials and device processing techniques, Band diagrams, homo and hetero junctions, electrostatic calculations, Band gap engineering, doping, Material and device process technique with these III-V and IV – IV semiconductors, MS contacts, MESFETs, Velocity overshoot effects and the related advantages of GaAs, InP and GaN based devices for high speed operation, MOSFET scaling, HEMT, MODFET, InGaAs/InP HEMT structures, HBTs, GaAs and InP based HBT for stable high gain high frequency performance, SiGe HBTs and the concept of strained layer devices, High Frequency resonant – tunneling devices, Resonant-tunneling hot electron transistors

**Total hours : 42**

## EC 4039: NANOELECTRONICS

L	T	P	C
3	0	0	3

Challenges going to sub-100 nm MOSFETs, interconnect issues, fundamental limits for MOS operation, multiple gate MOSFETs, silicon-on-insulator, silicon-on-nothing, FinFETs, vertical MOSFETs, strained Si devices, quantum wells, quantum wires and quantum dots, single electron devices, Type I, II and III heterojunctions, Si-Ge heterostructure, heterostructures of III-V and II-VI compounds, resonant tunneling devices, carbon nanotubes based devices, spin-based devices.

**Total hours : 42**

## EC 4040: OPTO-ELECTRONIC COMMUNICATION SYSTEMS

L	T	P	C
3	0	0	3

Solution to Maxwell's equation in a circularly symmetric step index optical fiber, single mode and multimode fibers, graded index fibers, attenuation mechanisms in fibers, dispersion in single mode and multimode fibers, attenuation and dispersion limits in fibers, Kerr nonlinearity, self phase modulation, nonlinear Schrodinger equation, fundamental soliton solution, LED and laser diode, PN detector, pin detector, avalanche photodiode, semiconductor amplifier, rare earth doped fiber amplifier, Raman amplifier, Brillouin amplifier, intermodulation effects, saturation induced crosstalk, wavelength range of operation.

**Total hours : 42**

## EC 4041: COMMUNICATION SWITCHING SYSTEMS

**Pre-requisite: EC 3012**

L	T	P	C
3	0	0	3

Basics of a switching system - stored program control - space division switching - strict-sense non-blocking switches - re-arrangeable networks- multi-stage time and space switching - implementation complexity of the switches - blocking probability analysis of multistage switches - signaling principles - CCITT signaling system No: 7 - signaling system performance - Fast packet switching - self routing switches - Banyan network - ATM switches. Traffic Analysis - lost calls cleared - Erlang-B formula, lost calls cleared model with finite sources, delay systems, Erlang-C formula, M/G/1 model, non-preemptive priority models.

**Total hours : 42**

## EC 4042: RADAR ENGINEERING

**Pre requisites: EC 2022, EC 2024**

L	T	P	C
3	0	0	3

Introduction-Radar Equation-Block diagram-Radar frequencies- Applications- Prediction of range performance -Pulse Repetition Frequency and Range ambiguities -Antenna parameters-System losses, CW Radar-The Doppler Effect- FM-CW radar- Multiple frequency radar - MTI Radar- Principle- Delay line cancellors- Staggered PRF - Range gating- Noncoherent MTI-Pulse Doppler radar- Tracking Radar -Sequential lobbing-Conical Scan- Monopulse - Acquisition, Radar Transmitters- Modulators-Solid state transmitters, Radar Antennas- Parabolic-Scanning feed-Lens-Radomes, Electronically steered phased array antenna-Applications, Receivers-Displays-Duplexers, Detection of Radar signals in noise -Matched filter criterion-detection criterion - Extraction of information and waveform design, Propagation of radar waves -Radar clutter, Special purpose radars-Synthetic aperture radar- HF and over the horizon radar- Air surveillance radar- Height finder and 3D radars - Bistatic radar-Radar Beacons- Radar Jamming and Electronic Counters .

**Total hours : 42**



### EC 4043: CRYPTOGRAPHY: THEORY AND PRACTICE

L	T	P	C
3	0	0	3

Divisibility – Prime numbers – Diophantine equations – Euler function - Fermat's little theorem – Euler theorem - Groups and fields - Field extension , Classical Cryptography – Block cipher – Standards – Data Encryption Standard – AES – Linear and differential cryptanalysis ,Stream cipher – Standards– Linear feed back shift registers and sequences – Attacks on LFSR based stream ciphers, Public key cryptosystems – RSA crypto system- Elgamal crypto system — Diffie Hellmann key exchange – Elliptic curves – cryptographic applications of elliptic curves, Message authentication requirements – Hash function – features of MD5 and SHA algorithms – Message Authentication Codes – Digital Signatures – Elgamal DSA –Electronic mail security – Secret sharing.

**Total hours : 42**

### EC 4044: OPTO-ELECTRONIC DEVICES AND SYSTEMS

L	T	P	C
3	0	0	3

Electron hole recombination, absorption, Franz-Keldysh effect, Stark effect, quantum confined Stark effect, deep level transitions, Auger recombination, heterojunction lasers, distributed feedback lasers, quantum well lasers, tunneling based lasers, modulation of lasers, PIN, APD, modulated barrier photodiode, Schottky barrier photodiode, wavelength selective detection, Franz-Keldysh and Stark effect modulators, quantum well electro-absorption modulators, electro-optic modulators, quadratic electro-optic effect quantum well modulators, optical switching and logic devices, Optoelectronic ICs.

**Total hours : 42**

### EC 4045: SIGNAL COMPRESSION

L	T	P	C
3	0	0	3

**Pre-Requisites: EC 3013, EC 3022**

Compression Techniques – Lossless and Lossy Compression – Modeling and Coding – Mathematical Preliminaries for Lossless Compression – Huffman Coding - Arithmetic Coding - Dictionary Techniques Predictive Coding –Burrows Wheeler Transform –Dynamic Markov Compression - Mathematical Preliminaries for Lossy Coding – Rate distortion theory- Design of Quantizers: Scalar Quantization – Uniform & Non-uniform – Adaptive Quantization – Vector Quantization – Linde Buzo Gray Algorithm – Tree Structured Vector Quantizers – Lattice Vector Quantizers – Differential Encoding Schemes. Mathematical Preliminaries for Transforms , Subbands, and Wavelets –Transform coding - Subband coding – Wavelet Based Compression – Analysis/Synthesis Schemes – Speech, Audio, Image and Video Compression Standards.

**Total hours : 42**

### EC 4046: MICROWAVE DEVICES & CIRCUITS

**Pre-requisite: EC 2022**

L	T	P	C
3	0	0	3

Analysis of Rectangular and circular metallic waveguides, mode excitation, re-entrant cavity, microwave resonators, strip lines and microstrip lines, filter implementation with transmission lines and strip lines, passive microwave components, S matrix formalism, impedance matching with single stub and double stub, klystron, reflex klystron, traveling wave tube, tunnel diode, Gunn diode, IMPATT diode, TRAPATT diode, heterojunction bipolar transistors, masers, parametric amplifiers.

**Total hours : 42**

## EC 4047: ADVANCED WIRELESS COMMUNICATION

L	T	P	C
3	0	0	3

Capacity of Wireless Channels- Outage and Ergodic Capacity - Capacity of MIMO channels – MIMO receivers and Diversity – Space Time Codes – Multiple Access and Multicarrier Systems - Cooperative Communication and Network Coding

**Total hours : 42**

## EC 4048: SIGNAL ESTIMATION & DETECTION

L	T	P	C
3	0	0	3

Estimation Theory and Techniques- Minimum variance unbiased(MVU) estimators, Cramer-Rao Lower Bound, Linear Modeling. Deterministic Parameter Estimation- LS, BLU and ML Estimation Techniques. Random Parameter Estimation- MMSE Estimator, Prediction, Filtering, The Kalman Filter. Fundamentals of Detection Theory- Binary Hypotheses Testing-Bayes', MAP, ML, Minimum Probability of Error, Min-Max, and Neyman-Pearson Detectors, Multiple Hypothesis Testing, Receiver Operating Characteristic Curves. Binary and M-ary Detection of Known Signals in WGN, Matched Filter

**Total hours : 42**

## EC 4049: ARCHITECTURE OF ADVANCED PROCESSORS

**Pre –requisites: EC 3019, EC 3021**

L	T	P	C
3	0	0	3

Fundamentals: Technology trend -Performance measurement –Comparing and summarizing performance-quantitative principles of computer design –Amdahl's law-Case studies. Principles of processor performance - Processor performance optimization- Performance evaluation methods, Features of advanced Intel processors: Enhancements of 80386 and Pentium -Hardware Features, PVAM,-Memory management unit-Virtual Memory and concepts of cache -32 bit programming, Instruction and thread level parallelism: Instruction level parallelism and concepts - - Limitations of ILP- Multiprocessor and thread level parallelism- Pipelining: Issues and solutions- Instruction flow techniques -Program control flow and control dependences, Superscalar and multi core techniques: General principles of superscalar architecture - -Basics ,Pipelining, The in-order front end, The out-of-order core, The reorder buffer, Memory subsystem- Multi core processing – facts and figures - Virtualization – concepts

**Total hours : 42**

## EC 4050: RADIATION AND PROPAGATION

L	T	P	C
3	0	0	3

**Pre-requisite: EC2022**

Field and power calculations with currents assumed on the antenna - electric and magnetic dipole radiators - Radiation patterns and antenna gain - radiation resistance – methods of feeding wire antennas - Radiation from fields over an aperture – fields as sources of radiation –Examples of radiating apertures excited by plane waves – electromagnetic horns – arrays of elements – radiation intensity with superposition of effects – array of two half-wave dipoles – linear arrays - Yagi - Uda arrays – frequency-independent arrays - Effect of earth's conductivity on antenna pattern, effect of earth's conductivity and shape on surface wave propagation, effect of earth's magnetic field on EM waves in ionosphere, plasma and cyclotron frequencies, skip distance, maximum usable frequency

**Total hours : 42**

## EC 4051: ELECTRONIC INSTRUMENTATION

L	T	P	C
3	0	0	3

Measurement of voltage, current, power, noise, resistance, capacitance, inductance, time, frequency, charge and pulse energy Designing for EMC - EMC regulations, typical noise path, methods of noise coupling, methods of reducing interference in electronic systems. Capacitive & inductive coupling - shielding - effect of shield - shielding properties of various cable configurations Safety grounds- signal grounds - single and multi-point ground systems, hybrid grounds, functional ground layout, practical low frequency grounding, hardware grounds, grounding of cable shields, ground loops, shield grounding at high frequencies, guarded instruments. Protection Against Electrostatic Discharges: Static generation, human body model, static discharge, ESD protection in equipment design

**Total hours : 42**

## EC 4052: STATE OF THE ART AND FUTURE MEMORIES

**Prerequisite: EC2013 or equivalent**

L	T	P	C
3	0	0	3

Review of MOS based devices, band diagrams, scaling effects, tunneling phenomenon, direct tunneling, Fowler-Nordheim tunneling, direct band to band tunneling, SOI MOSFET, PDSOI, FDSOI, current characteristics, Classification of memories, Volatile memories: SRAM, Low voltage SRAMs, SOI SRAMs, Content addressable memories (CAM), 3-transistor DRAM, 1 transistor DRAM, functionality, architecture, timing diagrams, performance and timing specifications, sense amplifier, word line driver, leakage mechanisms in a DRAM, retention, retention time calculations, non-volatile memories: FLASH Memories, floating gate theory, structure and working of a SONOS cell, structure and working FLOTOX Memories, multi level flash memories, NOR based flash memories, NAND based flash memories, SOI Based RAM: Parasitic BJTs in a SOI, Z-RAM, Thyristor RAM, Non silicon based memories: PCRAM, MRAM, FeRAM, array device considerations for non silicon based memories

**Total hours : 42**

## EC 4053: RELIABILITY OF SEMICONDUCTOR DEVICES

**Prerequisites: EC2013 or equivalent**

L	T	P	C
3	0	0	3

Introduction to Reliability Physics, generation and recombination of carriers, Types of Defects in a Semiconductor, various breakdown phenomenon, MOSFET scaling and its effects on scaling, Mathematics of Reliability: Weibull statistics, PDF, NBTI, Frequency Independence, and Duty Cycle Dependence, Field Acceleration of Negative Bias Temperature Instability, Dispersive vs. Arrhenius Diffusion, Circuit Implications of NBTI, Scaling Theory of Hot Carrier Degradation, Voltage Dependence of Trap Generation, Lucky Electron Model, Characterization of Interface Traps, Subthreshold and linear drain current Measurements, Charge-pumping, DC-IV, and GIDL Techniques for Interface Traps, Spin-Dependent Recombination, Breakdown mechanisms of thick dielectrics and thin dielectrics, Time-Dependent Dielectric Breakdown, Kinetics of Trap Generation, Theory of Soft and Hard Breakdown, Statistics of Soft-breakdown by Markov Chain, Measurement Techniques: VT, SILC, QY, and Floating Probe, ESD, human body model, machine model, methods to contain ESD

**Total hours : 42**

## **EC 4054: SILICON ON INSULATOR AND ADVANCED MOSFET BASED STRUCTURES**

**Prerequisite: EC2013 or equivalent**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

Review of MOS device, band diagrams, MOSFET characteristics, mobility models, scaling of MOSFET, short channel and narrow channel MOSFET, high-k gate dielectrics, ultra shallow junctions, source and drain resistance, SOI MOSFET comparison with bulk MOSFET, short channel effects, current-voltage characteristics: Lim&Fossum model and  $C-\infty$  model, transconductance, impact ionization and high field effects: Kink effect and Hot-carrier degradation, Floating body and parasitic BJT effects, self-heating, Multiple gate SOI MOSFETs: double gate, FINFET, triple gate, triple-plus gate, GAA, device characteristics, short channel effects, threshold effect, volume inversion, mobility, FINFET, Physical view of nano scale MOSFET, Nator's theory of the ballistic MOSFET, role of quantum capacitance, scattering theory, MOSFET physics in terms of scattering, transmission coefficient under low and high drain biases, silicon nano wires, evaluation of the I-V characteristics, I-V characteristics of non-degenerate and degenerate carrier statistics

**Total hours : 42**