Syllabus of B.Tech. Degree Programme in Electronics and Communication Engineering

Effective from Admission year 2023-24 & 2024-25 onwards

Department of Electronics & Communication Engineering

National Institute of Technology Sikkim

South Sikkim 737 139

Semester III

MA13101: Computational Mathematics

L	T	P	C
3	1	0	4

Module 1

Number Theory**:** Integers, divisibility, Prime numbers, Primality testing, Unique factorization, Chinese remainder theorem, congruence, Diophantine equations and arithmetic functions.

Module 2

Operation Research: Introduction to Linear Programming Model, Graphical method, Simplex Method, Nonlinear Optimization, Lagrange Method.

Module 3

Stochastic Process: Definition and examples of stochastic process, Poisson processes, Random walk, Markov chain; Discrete-time Markov chain: Definition and examples, Classification of states, Stationary probability, Finite Markov chain, Transition probability, and transition matrix**.**

Module 4

Random process: discrete and continuous time processes; mean, autocorrelation, and auto-covariance functions; Stationarity: strict-sense stationary (SSS) and wide-sense stationary (WSS) processes; Autocorrelation function of a real WSS process and its properties, cross-correlation function; Ergodicity and its importance; power spectral density, properties of power spectral density; cross-power spectral density and properties; auto-correlation function and power spectral density of a WSS random sequence, Random process through LTI systems.

Books:

1. David Burton, Elementary Number Theory, 7th edition, McGraw Hill.
2. H. A. Taha, Operation Research: An Introduction, 9th edition, Dorling Kindersley, Pearson.
3. Kenneth H. Rosen, Discrete Mathematics and Its Applications with Combinatorics and Graph Theory, 7th edition, McGraw Hill.
4. R. J. Wilson, Introduction to Graph Theory, 4th edition, Dorling Kindersley Pearson.
5. Sheldon M Ross, Stochastic Process, 2nd edition, Willey.
6. D. B. West, Introduction to Graph Theory, 2nd edition, Dorling Kindersley Pearson.

EC13101: Digital Electronics

L	T	P	C
3	0	0	3

Module 1

Signed number, Weighted codes - BCD, Excess-3 code, Gray Code. Logic gates and Boolean Algebra. Boolean function representation and minimization techniques: Standard and canonical representation and minimization of Boolean expressions using Karnaugh map.

Module 2

Combinational Logic Circuits: Half Adder, Full Adder, Half Subtractor, Full Subtractor, Full adder using half adder, BCD Adder. Carry Look ahead, Multipliers. Multiplexer/de-multiplexers, Encoders and Decoders.
Sequential Logic Circuits: Latches, Edge Triggered Flip Flops: SR, D, JK, Master-slave J-K, Excitation tables, conversion of Flip Flops. State Diagram, Concept of the state machine.

Module 3

Counters: Up/Down Counters, Design of Synchronous counters, Cascaded Counters, Counter Decoding, Counter applications. Design of Asynchronous sequential circuit and counters.
Shift registers: Shift register functions, Serial in/serial out shift registers, serial in parallel out/shift registers, Parallel In/ Parallel out shift registers, bidirectional Shift registers, Shift register counters, and Shift register Applications.

Module 4

Introduction to logic Families: DTL, RTL, TTL, CMOS.

Books:

1. Digital Design by M. Morris Mano,and Michael D. Ciletti, 6th Edition, Pearson, 2018
2. Digital Fundamentals by Thomas L. Floyd, Eleventh Edition, Pearson, 2017
3. Digital Circuits and Design by S. Salivahanan and S. Arivazhagan, Fifth Edition, Oxford, 2018

EC13102: Signals and Systems

L	T	P	C
3	0	0	3

Module 1

Signal: Types of signal; classification; signal operations: scaling, shifting and inversion.
System: Classification of systems; time-domain representation and analysis of LTI and LSI systems, convolution-convolution sum, convolution integral and their evaluation, Causality and stability considerations.

Module 2

Signal analysis: Signal space and orthogonal bases; Fourier series representation of continuous-time signal - continuous-time Fourier transform and its properties – Fourier Transform theorems – power spectral density and energy spectral density – Hilbert Transform.
Frequency domain analysis of LTI systems: Frequency response Function – signal transmission through a linear system – ideal filters – band width and rise time;

Module 3

Sampling: sampling theorem – Sampling with Zero Order Hold and reconstruction – interpolation
Frequency analysis of discrete time signals and systems – Discrete time Fourier series and Discrete time Fourier Transform – Frequency response function – Discrete Fourier Transform.

Module 4

Laplace transform: Region of convergence, Analysis of continuous time systems, Transfer function, Frequency response from pole – zero plot Z-transform: Region of convergence, Properties of ROC and Z transform.

Books:

1. Oppenheim A.V., Willsky A.S. &Nawab S.H., Signals and Systems, 2nd ed., TMH, 199
2. B. P. Lathi, Linear Systems and Signals, Oxford University Press, 2006.
3. Haykin S. &Veen B.V., Signals & Systems, 2nd Edition John Wiley, 2007.
4. Taylor F.H., Principles of Signals & Systems, McGraw Hill, 1994.
5. M. J. Roberts, "Signals and Systems - Analysis Using Transform methods and MATLAB", Tata McGraw Hill Edition, 2003.
6. Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons (SEA) Private Limited, 1995.

EC13103: Semiconductor Devices

L	T	P	C
3	0	0	3

Module 1

Band theory of solids: Review of quantum mechanics, wave nature of the electron, time-independent Schrödinger Equation, solutions for a free electron, infinite potential well, Heisenberg's uncertainty principle, tunneling phenomenon, E-k diagram, Electron effective mass, Direct and indirect band gap semiconductors.

Charge carriers in semiconductors, intrinsic and extrinsic semiconductors, carrier transport, mobility, conductivity, carrier lifetime, recombination, steady state carrier generation, quasi-Fermi levels, drift and diffusion of carriers, continuity equation.

Module 2

PN Junction: PN junction at equilibrium, Forward and reverse bias junctions, steady-state conditions, forward and reverse bias, breakdown of junctions, MS contacts: Rectifying and ohmic contacts, current-voltage characteristics, Fermi level measurement of carrier concentration, mass action law.

Module 3

Bipolar junction transistor: Fundamentals of BJT operation- saturation, active and cut-off characteristics, switching characteristics, minority carrier profiles, Distribution of carrier concentration, Quasi Fermi level, minority carrier concentration.

Module 4

Field Effect Transistors: The Junction FET - Pinch-off and Saturation- Gate control- transfer and drain characteristics. Metal-Insulator semiconductor devices: The ideal MOS capacitor, band diagrams, CV characteristics, threshold voltage, MOSFET, Output characteristics, and transfer characteristics.

Books:

1. Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, 7th Edition, Pearson Education.
2. Donald Neamen, and Dhrubes Biswas, by Semiconductor Physics and Devices**,** 4th Edition, McGraw Hill, 2017
3. S.M.Sze and Kwok K. Ng, by Physics of semiconductor devices, 3rd Edition, John Wiley
4. M. S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley and Sons, 2008

EC13104: Data Structure and Algorithms

L	T	P	C
2	1	0	3

Module 1

Concept of Data Structures, Abstract Data Type, Algorithms, Performance Analysis, - Time and Space complexity, Asymptotic Notations, Arrays: one dimensional, multi-dimensional, Sparse matrix representation: Elementary operations.

Module 2

Stack: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching, Queue: Simple queue, circular queue, dequeue, elementary operations and applications, Linked list: Linear, circular and doubly linked list, elementary operations and applications such as polynomial manipulation.

Module 3

Tree: Binary Tree, Representation, Binary Tree traversal, Threaded Binary Tree: operations, Heap Tree: Max, Min, Binary Search tree: operations, Height Balanced Tree: AVL Tree, Multiway search Tree: B Tree, Huffman Tree and applications of tree. Graph: Representation, Graph traversal: BFS, DFS, Topological sort, Minimum cost spanning tree: Prims, Kruskal, Shortest path: Dijkstra's, Floyd's Warshall.

Module 4

Sorting: Selection sort, bubble sort, quick sort, merge sort, heap sort, radix sort, Searching: linear and binary search, Hashing: hash tables, hash functions, open addressing, File structures: Introduction, File types, file organization, file access methods.

Books:

1. E. Horowitz, S. Sahni and S. Anderson-Freed, Fundamental of data Structure in C, W. H Freen Co.
2. A. V Aho, J. D Ullman and J. E Hopcroft, Data Structures and Algorithms, Addison Wesley.
3. S. Lipschutz, Data Structures, Schaum's Outlines Series, TMH.
4. Aaron M. Tenenbaum, Y. Langsam, Moshe J. Augenstein, Data Structures Using C.

EC13105: Network Analysis and Synthesis

L	T	P	C
3	0	0	3

Module 1

Review of Network Theorems: Thevenin's & Norton's theorem - Superposition theorem - Maximum power transfer theorem.

Introduction to Network Topology: Definition of basic terms – Incidence matrix – Tie-sets - Cut-sets: Analysis and formulation of network equations using tie-set and cut-set.

Module 2

Transients in linear circuits: Initial Conditions - Zero state response - Zero input response - Complete Response – Analysis of RC and RL circuits.

Module 3

Two port networks: Characterization in terms of impedance - Admittance - Hybrid and transmission parameters - Interrelationships among parameter sets - Interconnection of two-port networks - Series, parallel, and cascade. Symmetrical two-port networks: T and π Equivalent of a two-port network.

Module 4

Symmetrical Two Port Reactive Filters: Filter fundamentals - Pass and stop bands - Constant - k low pass filter - Constant - k high pass filter.

Synthesis: Positive real functions. Properties of positive real functions, Properties of Hurwitz polynomials. Synthesis of LC, RC and RL networks.

Books:

1. F. F. Kuo, "Network analysis and Synthesis," Wiley International Edition, 2008.
2. Valkenberg V., "Network Analysis," 3rd Ed., Prentice Hall International Edition, 2007.
3. Abhijit Chakrabarti "Circuit Theory Analysis and Synthesis" Dhanapat Ray & Co, 2018

Semester IV

EC14101: Analog Circuits

L	T	P	C
3	0	0	3

Module 1

Basic BJT amplifiers: Biasing schemes - Load line concept - Bias stability - Analyses and design of CC, CE and CB configurations - RC coupled and transformer coupled multistage amplifiers — Thermal runaway in BJT amplifiers
FET amplifiers: Biasing of JFET and MOSFET - Analyses and design of common source, common drain and common gate amplifier configurations – Thermal runaway in MOS amplifiers

Module 2

Frequency response of amplifiers – Low frequency response of BJT and FET amplifiers, lower cut off frequency - hybrid π equivalent circuit of BJT - high frequency response of BJT amplifiers –upper cut off frequency – transition frequency - miller effect , high frequency response of FET amplifiers.
Wide band amplifiers - Wide banding techniques – CC–CE /CD-CS cascade, cascode amplifier, Darlington pair – Wide banding using inductors.

Module 3

Feedback and stability – Introduction to negative feedback – Basic feedback concepts – Ideal feedback topologies - Voltage shunt, Voltage series, Current series and Current shunt feedback configurations – Loop gain , Oscillators – Basic principles of oscillators – Analysis of RC Phase Shift, Wein bridge, Colpitts, Hartley and Crystal oscillators. Astable, monostable and bistable multivibrators using BJT and negative resistance devices.

Module 4

Power amplifiers - Class A, B, AB, C, D & S power amplifiers - Harmonic distortion – Conversion efficiency and relative performance.

Books:

1. Boylested & Nashesky, Electronic Devices and Circuit Theory, Prentice Hall of India.
2. Razavi, Behzad. Fundamentals of microelectronics. Wiley, 2008.
3. A S Sedra & K C Smith: `Microelectronic Circuits', Oxford University Press.2014
4. Jacob Millman & Herbert Taub: Pulse, Digital & Switching Waveforms, TMGH 1995.
5. Millman & Halkias: `Integrated Electronics', MGH. 1996.
6. V. K. Mehta and Rohit Mehta: Principals of Electronics, S. Chand & Company.

EC14102: Analog Communication

L	T	P	C
3	0	0	3

Module 1

Introduction to Analog Communication: Elements of communication system - Transmitters, Transmission channels, and receivers. Concept of modulation, its requirements.
Amplitude modulation (AM): Time domain representation of AM signal, modulation index, frequency domain (spectral) representations, transmission bandwidth of AM. Generation and detection of AM: SSB, DSB, VSB - applications and comparison. Principle of Super heterodyne receiver.

Module 2

Angle Modulation: Frequency Modulation (FM) and Phase Modulation (PM): Time and Frequency domain representations, Spectral representation of FM and PM. Narrow and Wide-band angle modulation. Generation of FM: Basic block diagram representation, Concept of VCO. FM generation: Narrowband FM, Armstrong method, wideband FM, use of VCO. Demodulation of FM using Phase Locked Loop.

Module 3

Frequency Division Multiplexing (FDM); Stereo – AM and FM: Basic concepts with block diagrams; Random Signals and Noise in Communication System, Noise in receiving systems- Noise Temperature, Noise figure, Noise in cascaded system.

Module 4

SNR calculation for AM (SSB & DSB) and FM for additive channel noise. Analog Pulse Modulation: Sampling for base-band and pass-band signals, Pulse Amplitude modulation: generation and demodulation, PPM generation and demodulation, PWM, Spectra of Pulse modulated signals, SNR calculations for pulse modulation systems.

Books:

1. B.P. Lathi, Z.Ding and H.M. Gupta,Modern Digital And Analog Communication Systems, 4/e, Oxford University Press.
2. Simon Haykin, “An Introduction to Analog & Digital Communications”, Wiley
3. John G Proakis and M. Salehi, Communication System Engineering, 2/e, Pearson Education.
4. Taub and Schilling, “Principles of Communication Systems”, 2nd ed., Mc- Graw Hill

EC14103: Digital Systems Design

L	T	P	C
3	0	0	3

Module 1

Digital System Design Process, Hardware modeling, Introduction to hardware description language (HDL), Verilog language features, elements of Verilog, Top-Down, Bottom-up Design, Verilog operators, Data types in Verilog; net type, reg type, wire type.

Module 2

Verilog description styles, behavioral and structural design style, Verilog attributes; Gate level, data flow level, procedural assignment, blocking / non-blocking assignments, user-defined primitives, Verilog test bench, writing Verilog test benches.

Module 3

Finite state machines Modeling, Data-path and Controller Design, Synthesizable Verilog, Modeling memory, Modeling register banks, Switch level modeling.

Module 4

Basic pipelining concepts, Pipeline modeling, Pipeline implementation of a processor, and Verilog modeling of the processor.

Books:

1. Navabi, Z., 1999. Verilog digital system design. McGraw-Hill.
2. Palnitkar, S., 2003. Verilog HDL: a guide to digital design and synthesis (Vol. 1). Prentice Hall Professional.
3. Arnold, M.G., 1998. Verilog digital computer design: Algorithms into hardware. Prentice-Hall, Inc..
4. Lin, M.B., 2008. Digital system designs and practices: using Verilog HDL and FPGAs. Wiley Publishing.
5. Unsalan, C. and Tar, B., 2017. Digital system design with FPGA: implementation using Verilog and VHDL. McGraw-Hill Education.

EC14104: Electromagnetic Field Theory

L	T	P	C
3	0	0	3

Module 1

Vector Calculus recapitulation, Electrostatics: Coulomb's law, electric field, Gauss's law, electric potential, Poisson's equation, Laplace's equation, solutions to electrostatic boundary value problems, electric susceptibility and permittivity, boundary conditions, capacitors. Magnetostatics: Lorentz force, Biot-Savart law, magnetic flux density, Ampere's law, magnetic susceptibility and permeability, boundary conditions.

Module 2

Maxwell's equations: Faraday's law of Electromagnetic induction, Continuity equation and displacement current. Plane waves in lossy and lossless mediums. Energy Conservation and Poynting theorem, Electromagnetic wave propagation in non-conducting medium.

Module 3

Transmission Lines: Parameters, Lumped element model, lossless and distortion less line, Propagation constant, Characteristic Impedance; Standing Waves and VSWR.
Fundamentals of Radiation; Radiated field of a Hertzian dipole; Basic Antenna Parameters.

Books:

1.Matthew N. O. Sadiku: Principles of Electromagnetics, Fourth Edition, Oxford University Press.
2. Antennas and Radio Wave Propagation, R. E. Collin, McGraw-Hill.
3. Antenna Theory and Design, C. A. Balanis Third edition, John Wiley &Sons.
4. Jordan and Balmain: Electromagnetic waves and radiating systems, Second Edition-PHI.
5. Introduction to Electrodynamics-David Griffiths, third edition-Prentice-Hall

EC14105: Microprocessor and Microcontroller

L	T	P	C
3	0	0	3

Module 1

Introduction to Microprocessor, Microcontroller, Microcomputer; 8085 Microprocessor Architecture, Pin Description, Bus concept and organization, Multiplexing and Demultiplexing of Buses; Static and Dynamic RAM, ROM, Memory map; Signals and Timings, Classification of Instructions, Instruction Format, Instruction Set, Addressing Modes.

Module 2

Assembly Language Programming and Debugging – Simple Assembly Programming, Directives used in Assembly Language, Counter and Time delay, Stack organization and implementation, Macros and Subroutines; Debug and Testing of Assembly Language Programs. Interrupts - Types, Applications and Handling; 8259 Programmable Interrupt Controller.

Module 3

Interfacing with 8085 Microprocessor – Interfacing of Simple input/output devices (Switches, LEDs); 8255 Programmable Peripheral Interface; 8254 Programmable Interval Timer; 8279 Keyboard/Display Controller; 8251 USART; Memory Interfacing. Serial Interface - RS232C and RS422A; Parallel Interface.

Module 4

8051 Microcontroller – Introduction of 8051 family; Block diagram description of AT89C51;Internal Architecture - System Clock and Oscillator Circuits, CPU Registers, SFRs, Memory Map, I/O Ports. Simple program and application development.

Books:

1. Ramesh S. Gaonkar, “Microprocessor Architecture, Programming and Applications with the 8085”, Penram Publishers
2. Aditya P. Mathur, “Introduction to Microprocessors”, Tata McGraw Hill
3. Muhammad Ali Mazidi, D. MacKinlay, “The 8051 Microcontroller & Embedded Systems using Assembly and C”, Pearson Education.
4**.** Douglas V. Hall, “Microprocessors and Interfacing”, Tata McGraw Hill
5. Kenneth J. Ayala, “The 8051 Microcontroller – Architecture, Programming and Applications”, Penram Publishers
6. John Uffenbeck, “Microcomputers and Microprocessors – The 8080, 8085 and Z80 Programming, Interfacing and Troubleshooting”, Tata McGraw Hill, 3 rd Edition

EC14106: Control System Engineering

L	T	P	C
3	0	0	3

Module 1

General schematic diagram of control systems - open loop and closed loop systems – the concept of feedback - modeling of continuous-time systems – Review of Laplace transform – transfer function - block diagrams – signal flow graph – Mason's gain formula - block diagram reduction using direct techniques and signal flow graphs - examples - derivation of the transfer function of simple systems from physical relations - low pass RC filter – RLC series network - spring mass damper

Module 2

Analysis of continuous time systems - time domain solution of first-order systems – time constant - time domain solution of second order systems - determination of response for standard inputs using transfer functions – steady state error – the concept of stability - Routh- Hurwitz techniques - construction of bode diagrams - phase margin - gain margin – construction of root locus - polar plots and theory of Nyquist criterion - theory of lag, lead and lag lead compensators

Module 3

Basic elements of a discrete time control system - sampling - sample and hold - Examples of sampled data systems – pulse transfer function - Review of Z-transforms - system function - mapping between s plane and z plane - analysis of discrete-time systems –- examples - stability - bilinear transformation stability analysis after bilinear transformation.

Module 4

Routh- Hurwitz techniques - construction of bode diagrams – phase margin - gain margin – digital redesign of continuous-time systems.

Books:

1. Ogata K., "Modern Control Engineering", Prentice Hall India,1994
2. B. S. Manke, " Linear Control systems" khanna publishers, 11th edition, 2012
3. Kuo B.C., "Digital Control Systems", Second Edition, Oxford University Press, 1992
4. Nagarath I.J. &Gopal M., "Control System Engineering", Wiley Eastern Ltd,1995
5. B. C. Kuo, "Automatic Control System", PHI.
6. K.Ogata, "Discrete-Time Control System", PHI.

Semester V Subjects

HS15102: Engineering Economics and Management

L	T	P	C
3	0	0	3

Module1

Concept and scope of engineering economics; Engineering production function; Time value of money: single payment present, annual equivalent payment, and future worth; Economic analysis of project selection: Payback period method, Present worth method, Future worth method, Annual equivalent method, Rate of return method; Depreciation policies.

Module 2

Meaning of market; Structure of markets; Pricing and output determination in perfect competition, monopoly, monopolistic, and oligopoly; Macroeconomic concepts – National Income, Business Cycles, Inflation, Deflation, Stagflation; Monetary and Fiscal Policy.

Module 3

Evolution of management concepts; Scientific management techniques; Henry Fayol's 14 principles of management; Environmental factors; Organisational hierarchy; Financial statements: trading account, profit and loss account, balance sheets, ratio analysis; Working capital management: over capitalization vs. under capitalization; Capital budgeting.

Module 4

Human resource management; Change management; Introduction to marketing management; Organizational behavior; Organizational development; Overview of import and export; Introduction to Total Quality Management (TQM).

Books:

1. Panneerselvam, R., Engineering Economics, PHI, India, 2nd Edition, 2013.
2. Dornbusch, R., Fischer, S., Startz, R., Macroeconomics, McGraw-Hil, 11th Edition, 2011.
3. Koontz, H., and Weihrich, H., Essentials of Management: An International, Innovation and Leadership Perspective, McGraw Hill, 10th Edition., 2015.
4. Aswathappa K., Dash S., Human Resource Management: Text and Cases, McGraw Hill, 10th Edition, 2023.
5. Kotler, P., Keller, K.L., Chernev, A., Sheth, J.N., Shainesh, G., Marketing Management, Pearson Education, 16th Edition, 2022.
6. Robbins, S.P., Judge, T.A., Vohra, N., Organizational Behavior, Pearson Education, 18th Edition, 2022.
7. Mithal, A., Organizational Development Essentials You Always Wanted to Know (Self-learning Management Series), Vibrant Publishers, 2023.

EC15101: Digital Communication

L	T	P	C
3	0	0	3

Module 1

Introduction to Digital Communication; system block diagram. Digital transmission of analog signals**:** Sampling, Quantization: uniform – non-uniform, companding: μ-law & A-law, PCM, DPCM, Delta modulation, Adaptive delta modulation. Line coding techniques and spectrum.

Module 2

Signal space concepts: Geometric structure of the signal space, vector representation, distance, norm and inner product, orthogonality and orthonormality, signal constellation, geometric interpretation of signals, likelihood functions, Schwarz Inequality, Gram-Schmidt orthogonalization procedure.
Noise and impairments in digital signal transmission, Inter symbol interference, Pulse Shaping, Nyquist criterion for zero ISI, Eye diagram, Equalizer.
Detection of signals in AWGN Optimum receiving filter-Correlator, Matched filter.
Decision Procedure: Maximum A posteriori probability detector- Maximum likelihood detector, Error probability performance of binary signaling.

Module 3

Digital bandpass modulation schemes: ASK, FSK, PSK signal space representation. - Coherent & non-coherent detection – Differential modulation schemes – Power spectra of digitally modulated signals, Probability of error of digital modulation schemes-Performance comparison of digital modulation schemes.

Module 4

Introduction to: Minimum Shift Keying (MSK), Gaussian Minimum Shift Keying (GMSK), and Quadrature Amplitude Modulation (QAM). AM. FM, CDMA, FDMA and SDMA

Books:

1. B. Sklar and P.K. Ray, Digital Communication: Fundamentals and Applications, Pearson Education.
2. Digital Communications, S. Haykin, Wiley India.
3. John G. Proakis, Digital Communications, McGraw Hill, 2001.
4. Principles of Communication Systems, H. Taub and D.L.Schilling, TMH Publishing Co.
5. B.P. Lathi, Modern Digital and Analog Communication, Oxford University Press, 2017.

EC15102: Linear Integrated Circuits

L	T	P	C
2	1	0	3

Module 1

Basic BJT/FET Differential amplifier – DC transfer characteristics – Small signal analysis –Differential and Common mode gain and input impedance– Concept of CMRR – Methods to improve CMRR – Constant current source – active load - current mirror - Differential and Common mode frequency response various stages of an operational amplifier - simplified schematic circuit of op-amp 741 - need for compensation – dominant pole compensation - typical op-amp parameters - slew rate – CMRR,PSRR - open loop gain - unity gain bandwidth - offset current & offset voltage – CMOS op-amp with and without compensation

Module 2

Linear op-amp circuits - inverting and non-inverting configurations - analysis for closed loop gain - input and output impedances - virtual short concept - current to voltage and voltage to current converters – instrumentation amplifier - nonlinear op-amp circuits - log and antilog amplifiers - 4 quadrant multipliers and dividers - phase shift and wein bridge oscillators - comparators –555 timer- astable and monostable circuits - linear sweep circuits

Module 3

Butterworth, Chebychev and Bessel approximations to ideal low pass filter characteristics – frequency transformations to obtain HPF, BPF and BEF from normalized prototype LPF - active biquad filters - LPF & HPF using Sallen-Key configuration – all-pass filter (first & second orders) realizations.

Module 4

DACs and ADCs (in-depth design is not expected)-Digital to analog converters - Binary weighted - R-2R ladder - Accuracy - Resolution - Conversion speed – Offset error - Gain error - - Analog to digital converters. ADC conversion techniques - Flash converter – Two-step flash - Pipeline – Integrating - Staircase converter - Successive approximation converter - Dual slope ADC. Phase Locked Loop – Block schematic and analysis of PLL – Lock range and capture.

Books:

1. Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', McGraw Hill 1998
2. Jacob Baker R., Li H.W. & Boyce D.E., 'CMOS- Circuit Design, Layout & Simulation', PHI 2007.
3. Gobind Daryanani, 'Principles of Active Network Synthesis & Design', John Wiley 2003
4. Sedra A.S. & Smith K.C., "Microelectronic Circuits', Oxford University Press 1998

5. Fiore J.M., 'Operational Amplifiers and Linear Integrated Circuits', Jaico Publishing House 2006.
6. Gaykward, Operational Amplifiers, Pearson Education, 1999
7. Coughlin R.F. & Driscoll F.F., 'Operational Amplifiers and Linear Integrated Circuits', Pearson 2002.
8. Horenstein M.N., 'Microelectronic Circuits & Devices', PHI, 1995.

EC15103: Digital Signal Processing

L	T	P	C
3	0	0	3

Module 1

Discrete time complex exponentials and other basic signals—scaling of the independent axis and differences from its continuous-time counterpart—system properties (linearity, time-invariance, memory, causality, BIBO stability)—LTI systems —autocorrelation, Fourier Series, Fourier Transform. Z-Transform: Generalized complex exponentials as eigensignals of LTI systems—z-transform definition—region of convergence (RoC)—properties of RoC—properties of the z-transform—inverse z-transform methods (partial fraction expansion, power series method, contour integral approach)

Module 2

Fourier analysis of discrete-time signals and systems: Discrete Fourier Series, Discrete Time Fourier Transform, Discrete Fourier Transform - Properties; Approximation of Fourier transform through DFT, Fast algorithms for DFT: The FFT algorithm (radix-2, decimation-in-time, decimation-in-frequency), Convolution; Linear and circular convolution, Short-time Fourier transform.

Module 3

Digital filters: FIR Filters: Impulse response, Transfer function, Linear phase properties, Design: window based design, frequency sampling design, minimax design. IIR Filters: Impulse response, Transfer function, Pole-zero representation; Butterworth, Chebyshev, inverse Chebyshev and elliptic filter concepts, Approximation problem for IIR filter design: Impulse in variance method, Bilinear transform method, Matched z-transform method.

Module 4

Structures for discrete-time systems: Signal flow graph representation, basic structures for FIR and IIR systems (direct, parallel and cascade), transposition theorem, ladder and lattice structures.

Books:

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications," Prentice Hall of India Pvt. Ltd., 1997.
2. Oppenheim A. V., Schafer R. W., "Discrete-Time Signal Processing," Prentice Hall India, 1996.
3. Boaz Porat, "A Course in Digital Signal Processing," Prentice Hall Inc, 1998.
4. Mitra S. K., "Digital Signal Processing: A Computer Based Approach," McGraw-Hill Publishing Company, 1998.
5. Lonnie C. Ludeman, "Fundamentals of Digital Signal Processing," John Wiley& Sons, NY, 1986.

EC15104: Microwave Engineering

L	T	P	C
3	0	0	3

Module 1

Introduction to Microwaves- Microwave Frequency bands and general applications in various bands.
Microwave Transmission-Concept of Modes; Characteristics of TEM, TE, TM and Hybrid Modes; Losses associated with microwave transmission; Coaxial Line; Rectangular Waveguide; Circular waveguide; Stripline; Microstrip Line.
Vacuum tube Microwave devices - Klystron - velocity modulation and bunching, Reflex Klystron, traveling wave tube - slow wave structure, Magnetron, Gunn Source

Module 2
Passive Microwave components: S-matrix formalism, Directional Coupler, Power Divider; Magic Tee, attenuator, resonator; isolator, circulator. Microwave filters based on MMIC
Microwave Active components: IMPATT diodes, TRAPATT diode, Schottky Barrier diodes, PIN diodes, Parametric Amplifier

Module 3
Modern Trends in Microwaves Engineering**:** Medical and civil applications of microwaves, Electromagnetic interference / Electromagnetic Compatibility, Effects of Microwave radiation

Module 4
Microwave Antennas: Reflector antennas, Printed antennas; Realization of microwave filters using Planar Periodic Structures, Partially Reflective Surfaces, Radome

Books:

1. David M. Pozar, "Microwave Engineering", Third Edition, Wiley India.
2. Samuel Liao, “Microwave devices and circuits”, PHI
3. R.E. Collin, "Foundations for Microwave Engineering", Second edition, IEEE Press.
4. Microwave Engineering, A. Das & S. Das, TMH.

EC15105: Artificial Intelligence

L	T	P	C
3	0	0	3

Module 1
Intelligent agents: reactive, deliberative, goal-driven, utility-driven, and learning agents Artificial Intelligence programming techniques. Problem-solving through Search: forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications.

Module 2
Knowledge Representation and Reasoning: ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications.

Module 3
Planning: planning as search, partial order planning, construction and use of planning graphs. Representing and Reasoning with Uncertain Knowledge: probability, connection to logic, independence, Bayes rule, bayesian networks, probabilistic inference, sample applications.

Module 4
Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications.

Books:
1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 2nd Ed, Prentice Hall, 2003
2. E. Rich and K. Knight, Artificial Intelligence, McGraw Hill, 1991.
3. P. H. Winston and B. K. P. Horn, Lisp, 3rd Ed, Addison-Wesley, 1989.
4. P. Norvig, Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp, Morgan Kauffman, 1991.
5. I. Bratko, Prolog Programming for Artificial Intelligence, 3rd Ed, Addison-Wesley, 2001.

Semester VI

HS16102: Entrepreneurship and Start-up

L	T	P	C
2	0	0	2

Module 1 Need, scope, relevance of entrepreneurship:

Foundation of entrepreneurship; Role of entrepreneurs; Entrepreneurial traits; Classifications of entrepreneurship - Entrepreneurship vs. Small business management, Entrepreneurship vs. Self-employment vs. Intrapreneurship

Module 2 Environment scanning, Identifying opportunities, and Market survey:
Identification of business opportunities; Market survey; SWOT analysis; Product analysis; Estimation and evaluations

Module 3. Achievement motivation training: Motives for entrepreneurship; Development of entrepreneurial competencies; Group exercises

Module 4 Business plan preparation and Fundraising:
Requisites of preparing a business plan; Key elements of a business plan; Contents of a DPR; Sources of finance – Venture capital, Angel investment, Crowdfunding, Bootstrapping, Govt. initiatives and incentives

Module 5 Management of small enterprises:
Entrepreneurship and MSMEs; Basics of management and managerial functions of an entrepreneur; Interaction with successful entrepreneurs

Module 6 Legal issues:
Firm or company registration – Intellectual property rights (IPR), Patents, Trademarks, Copyrights; Pollution control; Taxation – GST and Income tax.

Module 7 Mini project:
Preparation of a business plan in groups – Presentation, DPR and Mock interview.

Books:

1. Desai, V., Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, India, 6th Edition, 2020.
2. Mohanty, S.K., Fundamentals of Entrepreneurship, PHI Learning, 2017.
3. Kuratko, D.F, Entrepreneurship – Theory, Process, and Practice, Cengage Learning, 9th Edition, 2014.
4. Khanka, S.S., Entrepreneurial Development, S. Chand and Co. Ltd., New Delhi, 2013.
5. Bansal, R., Stay Hungry Stay Foolish, Westland Ltd., 2012.
6. Bansal, R., Arise, Awake, Westland Ltd., 2015.

EC16101: Embedded Systems

L	T	P	C
3	0	0	3

Module 1

Introduction to Embedded systems: Embedded system examples, Parts of Embedded System- Processor, Power supply, clock, memory interface, interrupt, I/O ports, Buffers, Programmable Devices, ASIC,etc. interfacing with memory and I/O devices. Memory Technologies – EPROM, Flash, OTP, SRAM, DRAM, SDRAM etc.

Module 2

Embedded System Design: Embedded System product Development Life cycle (EDLC), Hardware development cycles- Specifications, Component selection, Schematic Design, PCB layout, fabrication and assembly. Product enclosure Design and Development.

Embedded System Development Environment – IDE, Cross-compilation, Simulators/Emulators, Hardware Debugging. Hardware testing methods like Boundary Scan, In-Circuit Testing (ICT) etc. Bus architectures like I2C, SPI, AMBA, CAN etc.

Module 3

Operating Systems: Concept of firmware, Operating system basics, Real Time Operating systems, Tasks, Processes and Threads, Multiprocessing and Multitasking, Task scheduling, Task communication and synchronization, Device Drivers.

Module 4

System Design Examples: System design using ARM/PSoC/MSP430 processor

Books:

1. Shibu K.V.: Introduction to Embedded Systems, Tata McGraw Hill, 2009
2. Tim Wilmshurst: An introduction to the design of small-scale embedded systems, Palgrave, 2001.
3. Device data sheets of ARM/PSoC/MSP430
4. Web Resources

.

EC16102: Information Theory & Coding

L	T	P	C
3	0	0	3

Module 1

Introduction to source coding, logarithmic Information, mutual Information. Different type of source and source Entropy. Lossless source coding**,** Uniquely decodable codes- Instantaneous codes- Kraft's inequality – Average code word length, Optimal codes- Shannon's Source Coding, Huffman coding, Lempel-Ziv Coding.
Channel Capacity**:** Discrete memory-less channel (DMC) and channel transition probabilities, Shannon's Channel Capacity Theorem for DMC. Different types of channels-BSC, BEC.

Module 2

Introduction to channel coding, block codes, single-parity-check codes, Hamming codes, minimum distance of block codes, hard decision and soft decision decoding.
Linear block codes: Introduction**,** Generator Matrices. The standard array, Parity checks matrices, Error syndromes, Error detection and correction.
Cyclic codes: Introduction, Generator Polynomials, Encoding and decoding, Parity check polynomials, Dual codes, Generator and Parity check matrix. Linear feedback shift registers for encoding and decoding of cyclic codes.

Module 3

Galois fields, Primitive field elements, Irreducible and primitive polynomials, Minimal polynomials. BCH Codes: Construction, Error Syndromes, Decoding, Error location polynomial, The Peterson-Gorenstein-Zierler decoder, Reed-Solomon codes.

Module 4

Convolutional codes- Convolutional Encoder, Trellis Representation. Viterbi Decoder for convolutional codes. Puncturing, Interleaving, Turbo encoders and Turbo Decoders.

Books:

1. Thomas M. Cover and Joy A. Thomas, "Elements of Information Theory", John Wiley & Sons.
2. Salvatore Gravano, "Introduction to Error Control Codes", Oxford.
3. Shu Lin and Daniel. J. Costello Jr., "Error Control Coding: Fundamentals and applications", 2nd Ed., Prentice Hall Inc.
4. Ranjan Bose, Information theory, coding and cryptography, TMH.

EC16103: Analog MOS Integrated Circuits

L	T	P	C
3	0	0	3

Module 1

Introduction to Analog Design. Basic MOS device physics. MOSFET I-V characteristics. threshold voltage, current, 2^{nd} order effects: Channel length modulation, body bias effect and short channel effects, MOS switch, MOSFET capacitances, MOS small Signal Model.

Module 2

Single – stage amplifiers: CS stage with registive load, CS stage with diode-connected load, CS stage with triode load, Cs stage with source degeration. Common Gate stage, Cascode stage.

Module 3

Differential Amplifier: single-ended and Differential operation. Basic Differtial Pair: qualitative Analysis, quantative Analysis. Common Mode Response. Differential Pair with MOS loads. Gilbert Cell. Passive and active current mirrors.

Module 4

Frequency Response of Amplifiers.Miller effect, CS, CG, CD, Cascode stage, Differential Pair. Noise: Statistical Characteristics of Noise. Types of Noise.Representation of Noise in circuits. One stage Op-Amps.

Books:

1. Behzad Razavi"Design of Analog CMOS Integrated Circuits" McGraw Hill Education.
2. Phillip E. Allen, Douglas R Holberg, South Asia Edition, Oxford University Press.

EC16104: Fundamentals of Wireless Communication

L	T	P	C
3	0	0	3

Module 1

Introduction to wireless communication and systems, Cellular Structure, Frequency Reuse, Cell clustering, Capacity enhancement techniques for cellular networks, cell splitting, antenna sectoring, Co-channel and Adjacent channel interferences, Channel assignment schemes – Fixed channel, Dynamic channel and Hybrid channel, mobility management – location management and handoff management, handoff process, different types of handoff. Call blocking in cellular networks.

Module 2

Large scale signal propagation: free space propagation model - ground reflection model, refraction, diffraction and scattering propagation mechanism; Indoor and outdoor propagation model; large scale path loss and lognormal shadowing.
Fading channels: multipath and small scale fading- Doppler shift, statistical multipath channel models, parameters of a mobile multipath channel; power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, fading models, average fade duration and level crossing rate.

Module 3

Fundamental concepts of spread spectrum systems - pseudo noise sequence - performance of direct sequence spread spectrum systems - analysis of direct sequence spread spectrum systems - the processing gain and anti jamming margin - frequency hopped spread spectrum systems - synchronization of spread spectrum systems.
Multiple access schemes: FDMA, TDMA, and CDMA.

Module 4

Diversity techniques for wireless radio systems: time, frequency and space diversity, selection diversity, MRC, RAKE receiver, Interleaving.
Basic architecture of GSM (900 MHz) mobile communication and GSM call set-up process.

Books:

1. Rapport Thoedore S., Wireless Communications, Principles and Practice, PHI,

2. Lee W.C.Y., Mobile Cellular Telecommunication, MGH, 2002
3. Andrea Goldsmith, Wireless Communications, Cambridge University Press.
4. G. L. Stuber, Principles of mobile communications, 2nd Ed., Springer.
5. Simon Haykin and Michael Moher, Modern Wireless Communication, Pearson education.

EC16105: Machine Learning

L	T	P	C
3	0	0	3

Module 1

Introduction to Machine Learning: Introduction, Examples of Various Learning Paradigms, Perspectives and Issues, Version Spaces, Finite and Infinite Hypothesis Spaces, PAC Learning, VC Dimension.

Module 2

Supervised Learning: Decision Trees: ID3, Classification and Regression Trees, Regression: Linear Regression, Multiple Linear Regression, Logistic Regression, Support vector machines: Linear and Non-Linear, Kernel Functions, K-Nearest Neighbors

Module 3

Ensemble Learning: Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, boosting: Adaboost, Stacking. Unsupervised Learning: Introduction to clustering, Hierarchical: AGNES, DIANA, Partitional: K-means clustering, K-Mode Clustering, Expectation Maximization, Gaussian Mixture Models. Probabilistic Learning: Bayesian Learning, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks

Module 4

Neural Networks and Deep Learning: Perceptron, Multilayer Perceptron, Representational limitation and gradient descent training. Multilayer networks and back propagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks. Re-enforcement Learning: Q-Learning.

Books:

1. Introduction to Machine Learning by Ethem Alpaydin, MIT Press, PHI, 3rd Edition 2014.
2. Applied Machine Learning by M. Gopal, TMH.
3. Machine Learning by Tom Mitchell, McGraw Hill, 3rd Edition,1997.
4. Foundations of Machine Learning by Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, MIT Press, 2012.
5. Artificial Intelligence and Machine Learning by Vinod Chandra and Anand Harindra, PHI.

6. Machine Learning: A Probabilistic Perspective by Kevin P. Murphy, The MIT Press,2012.
7. Data Mining –Concepts and Techniques by Jiawei Han and Micheline Kambers and Jian Pei, 3rd edition, Morgan Kaufman Publications, 2012.