Curriculum for B. Tech (Electronics and Communication Engineering) of School of Electrical Sciences

Semester	Course Name	Code	L-T-P	Credit	Contact Hours
First	Mathematics-1	MA1L001	3-1-0	4	4
	Physics/ Chemistry	Ph1L001/ Cy1L001	3-1-0	4	4
	Mechanics/ English for communication or Learning English	ME1L001/ HS1L001 or HS1Loo2	3-1-0/ 3-0-2 or 3-1-0	4	4/ 5 or 4
	Electrical Technology/ Introduction to programming and data structures	EE1L001/ CS1L001	3-1-0	4	4
	Introduction to Manufacturing processes/ Engineering Drawing and Graphics	ME1P001/ CE1P001	0-0-3/ 1-0-3	2/3	3/4
	Physics Laboratory/ Chemistry Laboratory	PH1P001/ CY1P001	0-0-3	2	3
	Electrical Technology Laboratory/ Introduction to programming and data structures Laboratory	EE1P001/ CS1P001	0-0-3	2	3
	Extra Academic Activity- 1	ID1T001	0-0-3	1	3
			Total	**22/23 +1**	**28/ 30 or 26+3**
Second	Mathematics- II	MA1L002	3-1-0	4	4
	Chemistry/ Physics	Cy1L001/ Ph1L001	3-1-0	4	4
	English for Communication or Learning English/ Mechanics	HS1L001 or HS1Loo2/ ME1L001	3-0-2 or 3-1-0/ 3-1-0	4	5 or 4/4
	Introduction to Programming and Data Structures/ Electrical Technology	CS1L001/ EE1L001	3-1-0	4	4
	Engineering drawing and Graphics/ Introduction to Manufacturing processes	CE1P001/ ME1P001	1-0-3/ 0-0-3	3/2	4
	Chemistry Laboratory/ Physics Laboratory	Cy1L001/ Ph1L001	0-0-3	2	3
	Introduction to programming and data structures Laboratory/ Electrical Technology Laboratory	CS1P001/ EE1P001	0-0-3	2	3
	Extra Academic Activity- 2	ID1T002	0-0-3	1	3
		Total		**23/22+1**	**30 or 26/25+3**

Third	Breadth 1		3-0-0	3	3
	Math III	MA2L003	3-1-0	4	4
	Introduction to Material Science and Engineering	ID2L001	2-0-0	2	2
	Introduction to Bio Science and Technology	ID2L002	2-0-0	2	2
	Introduction to Electronics	EC2L001	3-1-0	4	4
	Signal and Systems	EC2L002	3-1-0	4	4
	Introduction to Electronics Lab	EC2P001	0-0-3	2	3
	Signal and Systems Lab	EC2P002	0-0-3	2	3
	Project Seminar	EE2S001	0-0-3	2	3
			Total	**25**	**28**
Fourth	Lateral 1		3-0/1-0	3/4	3/4
	Breadth 2		3-0/1-0	3/4	3/4
	Environmental Science Technology and Management	ID2L003	2-0-0	2	2
	Network Theory	EC2L001	3-1-0	4	4
	Digital Electronic Circuits	EC2L004	3-1-0	4	4
	Analog Communication	EC2L005	3-1-0	4	4
	Digital Electronics Circuit lab	EC2P004	0-0-3	2	3
	Analog Communication Lab	EC2P005	0-0-3	2	3
			Total	**24/26**	**26/28**
Fifth	Lateral 2		3-0/1-0	3/4	3/4
	Breadth 3		3-0/1-0	3/4	3/4
	Electromagnetic waves and Radiating Systems	EC3L005	3-1-0	4	4
	Digital Communication	EC3L006	3-1-0	4	4
	Microprocessor and Microcontroller	EC3L007	3-1-0	4	4
	Digital Communication Lab	EC3P003	0-0-3	2	3
	Microprocessor and Microcontroller Lab	EC3P004	0-0-3	2	3
			Total	**22/24**	**24/26**
Sixth	Lateral 3		3-0/1-0	3/4	3/4
	Breadth 4		3-0/1-0	3/4	3/4
	Digital Signal processing	EC3L003	3-1-0	4	4
	Control Systems	EE3L003	3-1-0	4	4
	VLSI Design	EC3L009	3-0-0	3	3
	Digital Signal Processing Lab	EC3P002	0-0-3	2	3
	Control Systems Lab	EE3P003	0-0-3	2	3
	VLSI Lab	EC3P004	0-0-3	2	3
			Total	**23/25**	**26/28**
Seventh	Communication Networks and Switching	EC4L005	3-0-0	3	3
	RF and Microwave Engineering	EC4L006	3-0-0	3	3
	Elective 1		3-0-0	3	3
	Elective 2		3-0-0	3	3
	Electronic System Design Lab	EC4P001	0-0-3	2	3
	Industrial Training Defence	EC4T001	0-0-0	2	3
	BTech Project 1	EC4D001	0-0-6	4	6
			Total	**20**	**24**

Eighth	Elective 3		3-0-0	3	3
	Elective 4		3-0-0	3	3
	Elective 5		3-0-0	3	3
	Elective 6		3-0/1-0	3	3
	BTech Project 2	EC4D002	0-0-9	6	9
	RF and Microwave Engineering Lab	EC4P003	0-0-3	2	3
			Total	**20**	**24**
	Grand Total Credit and Contact Hours			**181/188**	**210/212 or 204/203+6**

List of Elective Courses

Subject Name	New Code	L-T-P	Credit	Contact Hour
Elective – 1, 2				
Computer Organization and Architecture	CS3L002	3-0-0	3	3
Compiler Design	CS4L001	3-0-0	3	3
Artificial Intelligence	CS4L003	3-0-0	3	3
Computational Intelligence	CS6L001	3-0-0	3	3
Semiconductor Devices	EC4L001	3-0-0	3	3
Opto-Electronics	EC4L002	3-0-0	3	3
Advanced Communication Engineering	EC6L001	3-0-0	3	3
Image and Video Processing	EC6L002	3-1-0	4	4
Statistical Signal Processing	EC6L005	3-0-0	3	3
Remote Sensing Systems	EC6L011	3-0-0	3	3
Antenna Theory	EC6L013	3-0-0	3	3
Speech Signal Processing	EC6L028	3-0-0	3	3
Renewable and Distributed Energy Sources	EE6L006	3-0-0	3	3
Industrial Instrumentation	EE6L007	3-0-0	3	3
Energy Storage Systems	EE6L011	3-0-0	3	3
Elective – 3, 4, 5, 6				
Networks and Systems Security	CS6L002	3-0-0	3	3
Operating Systems	CS3L005	3-0-0	3	3
Information Theory and Coding	EC4L009	3-0-0	3	3
Advanced Digital Signal Processing	EC6L004	3-0-0	3	3
Optical Communication	EC6L012	3-0-0	3	3
Photonic Network	EC6L014	3-0-0	3	3
Biomedical Signal Processing	EC6L015	3-0-0	3	3
Computational Electromagnetics	EC6L016	3-0-0	3	3
Semiconductor Device Modeling	EC6L017	3-0-0	3	3
Satellite Communication	EC6L018	3-0-0	3	3
Fiber Optic Sensors	EC6L019	3-0-0	3	3
Wireless and Mobile Communication	EC6L020	3-0-0	3	3
Microwave Design and Measurement	EC6L021	3-0-0	3	3
Modern Radar Systems	EC6L022	3-0-0	3	3
Adaptive Signal Processing	EC6L023	3-0-0	3	3
Array Signal Processing	EC6L024	3-0-0	3	3
Multimedia Network	EC6L025	3-0-0	3	3
Computer Networks	EC6L026	3-0-0	3	3

Subject Name	New Code	L-T-P	Credit	Contact Hour
Pattern Recognition	EC6L027	3-0-0	3	3
Natural Language Processing	EC6L029	3-0-0	3	3
Embedded Systems	EC6L030	3-0-0	3	3
Computer Vision	EC6L031	3-0-0	3	3
Smart Grid Technology	EE6L014	3-0-0	3	3

List of Lateral Courses for Other Schools

Subject Name	Code	L-T-P	Credit	Contact Hour
Lateral – 1 (Any one will be offered)				
Introduction to Signal Processing	EC2L006	3-0-0	3	3
Communication Systems	EC2L007	3-0-0	3	3
Lateral – 2 (Any one will be offered)				
Biomedical Systems	EC3L004	3-0-0	3	3
Lateral – 3 (Any one will be offered)				
Satellite Communication Engineering	EC3L008	3-0-0	3	3

Syllabus (B. Tech in Electronics and Communication Engineering)

Common Core

Subject Code: EE1L001	Name: Electrical Technology	L-T-P: 3-1-0	Credits: 4

Pre-requisite (s): None

Introduction: Sources of energy; General structure of electrical power systems, Power transmission and distribution via overhead lines and underground cables, Steam, Hydel, and Nuclear power generation; DC Networks: Kirchhoff's laws, node voltage and mesh current methods, Delta-star and star-delta conversion, Superposition principle, Thevenin's, Norton's theorems and Maximum power transfer theorem; Single phase AC Circuits: Single phase EMF generation, average and effective values of sinusoids, solution of R,L,C series circuits, the j operator, complex representation of impedances, phasor diagram, power factor, power in complex notation, solution of parallel and series – parallel circuits; Three phase AC Circuits: Three phase EMF generation, delta and Y – connections, line and phase quantities, solution of three phase circuits, balanced supply voltage and balanced load, phasor diagram, measurement of power in three phase circuits, Three phase four wire circuits; Magnetic Circuits: Ampere's circuital law, B – H curve, solution of magnetic circuits, hysteresis and eddy current losses; Transformers: Construction, EMF equation, ratings, phasor diagram on no load and full load, equivalent circuit, regulation and efficiency calculations, open and short circuit tests, auto-transformers; DC Machines: Construction, EMF and Torque equations, Characteristics of DC generators and motors, speed control of DC motors and DC motor starters; Electrical Measuring Instruments: DC PMMC instruments, shunt and multipliers, multimeters, Moving iron ammeters and voltmeters, dynamometer, wattmeter, AC watthour
meter, extension of instrument ranges.

Text Books:

1. E. Hughes, "Electrical Technology," Pearson Education, 2010.
2. V. Del Toro, "Electrical Engg Fundamentals," PHI Learning, 2009.

Reference Books:

1. I. J. Nagrath and D. P. Kothari, 'Basic Electrical Engineering' TATA Mc Graw Hill, 2009.
2. D. A. Bell, "Electric Circuits," 7th Ed., Oxford Higher Education, 2009.

Subject Code: CS1L001	Name: Introduction to Programming and Data Structures	L-T-P: 3-1-0	Credits: 4

Pre-requisite (s): None

Digital computer fundamentals, concepts of algorithms and introduction to programming – examples; Constants and variables – data types, operators and expressions - type conversions, types of expressions; Assignment statements, input-output statements - concepts of data formats; Control statements: branching – if-else statements; iteration – while, do-while, for statements. nested control structures, switch, break and continue statements; Functions and recursion – examples; concepts of parameter passing by values and by reference; Arrays – single and multidimensional, examples – searching and sorting; Introduction to pointers, character strings and arrays, pointers and arrays; Structures, linked lists, dynamic allocation, stacks and queues, binary trees and tree traversals; Data files – creating, opening, closing and operating data files; (The programming language C to be used as the basis language).

Text Books:

1. B. Gottfried, Programming with C," 3rd Ed., Tata McGrawHill, 2010.
2. E. Balaguruswamy, "Programming in ANSI C," 6th Ed., Tata McGraw-Hill, 2012.
3. Y. Kanetkar, "Let us C," 13th Ed., BPB Publications, 2012.
4. S. Lipschutz, "Data Structures, Schaum's Outlines Series," 1st Ed., Tata McGrawHill, 2005.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, "*The C Programming Language*," 2nd Ed., Pearson Education, 2015.
2. Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed, "*Fundamentals of Data Structures in C*," 2nd Ed., Orient Longman, 2008.
3. Andrew M. Tanenbaum, Data Structures using C, 1st Ed., Pearson India, 1998.

Subject Code: EC2L001	Name: Introduction to Electronics	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): None

Introduction to Electronic Devices: passive devices, Diode, bipolar junction transistor (BJT), metal oxide semiconductor field-effect transistor (MOSFET); Diode: basic structure and types, operating principle, current-voltage characteristic, large and small signal models; Diode Applications: rectifier circuits, zener voltage regulator Regards, clipper and clamper circuits; BJT and their Application: structure and modes of operation; NPN and PNP transistor in active mode, DC analysis, BJT as a switch and amplifier, small signal equivalent circuits, single stage CE amplifier; MOSFET and Applications: switch and amplifier; Operational Amplifier and applications: Basics, summing amplifier, inverting and non-inverting configuration, voltage follower, differentiator and integrator; Feedback: Basic concepts of feedback, ideal feedback topologies; Oscillators: Basic principle of sinusoidal oscillation, phase-shift oscillator, wien-bridge oscillator; Digital Electronics: Boolean algebra and rules of simplification and combinational circuits.

Text Books:

1. S. Sedra and K. C. Smith, "Microelectronic Circuits," Oxford University Press, India, 2005.
2. A. Malvino and D. J. Bates; "Electronic Principles," Tata McGraw Hill, India, 2007.

Reference Books:

1. R C Jaeger, T N Blalock, Microelectronic Circuit Design; Tata McGraw Hill, India, 2006.

Subject Code: EC2L005	**Name: Basic Electronics (for SMS and SIF)**	**L-T-P: 3-1-0**	**Credits: 4**

Pre-requisite (s): None.

Semiconductor devices: Diode, BJT, MOSFET, their structures and principle of operations; Amplifiers: Functionality, specifications (voltage gain, current gain, input resistance, output resistance, dynamic range, bandwidth, linearity, power efficiency etc.), effect of cascading, various applications and typical circuits; Filters: Low pass, high pass, band pass and band stop filters, single and higher order passive filter topologies (RC and LC); Feedback: Basic concept of negative and positive feedback, application of negative feedback in amplifiers, effect on gain, bandwidth, input resistance, output resistance and desensitivity to parameter variations; Oscillators: Barkhausen criterion, sinusoidal and non-sinusoidal oscillators, applications and typical circuits; Operational amplifier: Differential mode of operation, common mode rejection, typical op-amp specifications, inverting amplifier, non-inverting amplifier, integrator, differentiator, summing amplifier etc., concept of active filters; Power electronics: Half wave and full wave rectification, filtering, regulation with zener diode and linear regulators, switched mode power supply; Digital electronics: Review of Boolean algebra and signed number representation schemes in binary, implementation of Boolean functions using various logic gates, concept of combinatorial and sequential circuits, registers and counters from functional viewpoint, concept of programmable processors and microcontrollers.

Text Books:

1. A. Malvino and D. J Bates “Electronic Principles,” Tata McGrawHill Education, 2006.
2. D. A. Neamen, “Electronic Circuits,” Tata McGrawHill Education, 2006.

Reference Books:

3. Malvino and Brown, “Digital Computer Electronics,” Tata McGraw - Hill Education, 2001.
4. Samuel C. Lee, “Digital Circuits and Logic Design,” PHI Learning, 2009.
5. R. A. Gayakwad, “Op-Amps and Linear Integrated Circuits,” PHI Learning, 2009.

Vertical Theory (Core)

Subject Code: EC2L002	Name: Signals and Systems	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Mathematics –1

Objective and overview, signal and system types and classifications, LTI system: Causality, stability, step response, impulse response and convolution integral; Periodic signal analysis: Fourier series and properties; Aperiodic signal analysis : Fourier Transform - its properties and sinusoidal steady state analysis of systems; Discrete-time Fourier transform; Fourier transform for periodic signals; Time and frequency characterization of signals and systems: magnitude-phase representation of Fourier transforms; Unilateral and Bilateral Laplace Transforms and properties: Analysis and characterization of LTI systems using Laplace transform; System function and block diagram representation, Bode plot; Discrete signals: Sampling, digitization and reconstruction of analog signals; Fourier transform of discrete signals: DFT, z-transforms; Discrete systems, transfer functions and convolution; Analog filter design: Butterworth, Sallen Key, frequency transformation and scaling.

Text Books:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and Systems," 2nd Ed., Pearson Prentice Hall, 2015.
2. S. Haykin and B. V. Veen, "Signals and Systems," 2nd Ed., Wiley India, 2007.

Reference Books:

3. H. P. Hsu, "Signals and Systems – Schaum's Outline Series," McGraw Hill, 1995.

Subject Code: EC2L004	Name: Digital Electronic Circuits	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Introduction to Electronics

Logic gates – AND, OR, NOT, XOR, XNOR, NAND, NOR; Combinational logic circuits: Switching functions, Boolean algebra – axioms and laws, minimization of switching functions – algebraic method, K-map, Quine-McCluskey's method; Number systems & representation – binary, octal, decimal and hexadecimal, code conversion of numbers. Addition and subtraction of binary and decimal numbers; Comparators, multiplexer-demultiplexer, codes and code conversion, PLA; Universal logic gates – NAND-NOR, circuit realization; TTL logic family – circuit operations, fan-in and fan-out, noise margin, tri-state, open-collector circuits; CMOS – circuit operations, fan-in and fan-out, noise margin; TTL-to-CMOS and CMOS-to-TTL interfacing; IC555 chip circuit operation and applications; Astable, monostable, bistable multivibrators – discrete component and IC555 based circuits; Different types of flip-flops – RS, JK, D and T flip-flops; gated, master-slave and edge triggered flip-flops; Different types of Registers; Counters - asynchronous and synchronous counters, design of synchronous counter; Finite state machine – Moore and Mealey models; Synchronous sequential circuit synthesis: state transition diagrams, state tables, minimization, state assignments, realization with different types of flip-flops; Analysis of synchronous sequential circuits; Concepts of asynchronous sequential circuits - races.

Text Books:

1. S. Lee, "Digital Circuits and Logic Design," 1st Ed., Prentice Hall India, 2008.
2. D. P. Leach, A. P. Malvino and G. Saha, "Digital Principles and Applications," 8th Ed.,

McGraw Hill Education, 2014.

3. M. Morris Mano, "Digital Logic and Computer Design," 1st Ed., Prentice Hall, 1979, 15th Reprint 2013.

Reference Books:

1. Z. Kohavi and N. K. Jha, "Switching and Finite Automata Theory," 3rd Ed., Cambridge Univ Press, 2011.

Subject Code: EC2L005	**Name: Analog Communications**	**L-T-P: 3-1-0**	**Credits: 4**

Pre-requisite(s): Signals and Systems

Introduction: Signals, Fourier Series, Complex Fourier Spectrum, Fourier Transform, Convolution, Parseval's Theorem, Linear Systems; Analog Modulation: Concept Of Modulation, Amplitude modulation: Double-Sideband Suppressed Carrier, Double-Sideband Full Carrier, Single Sideband and vestigial sideband modulation; Demodulation: Carrier Recovery in AM, coherent Demodulation, Envelope Detector, Square-Law Demodulator; Integrated Circuit Modulators And Demodulators, Superheterodyne Receiver; Angle Modulation: Frequency Modulation, Phase Modulation, Narrow Band Angle Modulation, Wideband FM, Modulators, Demodulators, Broadcast FM And Stereo, QAM; Effects Of Noise In Analog Modulation Systems. Sampling, Pulse amplitude modulation, pulse width modulation, pulse position modulation, PCM.

Textbooks:

1. J. G. Proakis and M. Salehi, "Fundamentals of Communication Systems," Prentice Hall, 2004.
2. S. Haykin, "Communication Systems," John Wiley & Sons, 5th Ed., 2009.

Reference Books:

1. B.P. Lathi and Z. Ding, "Modern Digital and Analog Communication Systems," 4th Ed., Oxford University Press, 2009.
2. Louis E. Frenzel, "Principles of Electonic Communication Systems," 3rd Ed., Tata McGraw-Hill, 2008.
3. Dennis Roddy and John Coolen, "Electronic Communications," 4th Ed., Pearson, 2008.

Subject Code: EE2L001	**Name: Network Theory**	**L-T-P: 3-1-0**	**Credits: 4**

Pre-requisite: Signals and Systems

Nodal and Loop Analysis: Review, modified nodal analysis; Network Theorems: Substitution theorem, Compensation theorem, Reciprocity theorem, Maximum power transfer theorem, Millman's theorem, Tellegen's theorem; Transient analysis of dynamic circuits using Fourier series, Fourier transforms and Laplace transforms; Network functions: poles and zeros, driving point and transfer functions, restrictions on poles and zeros for network functions, time domain behaviour, frequency response plots; Two port networks and passive filters: z-parameters, y-parameters, h-parameters and ABCD parameters; Reciprocity and symmetry in two port networks; Introduction to network topology: Graph theory: Tree, Co-tree, fundamental cut-set, fundamental loop analysis of network; State variable analysis of networks.

Text Books:

1. M. E. Valkenburg, "Network Analysis," 3rd Ed., Pearson Prentice Hall, 2006.
2. F. F. Kuo, "Network Analysis and Synthesis," 2nd Ed., Wiley India, 2007.

Reference Books:

1. W. H. Hyat, J. E. Kemmerly and S. M. Durbin, "Engineering Circuit Analysis," 6th Ed.,, Tata McGraw Hill, 2007.
2. R. A. DeCarlo and P-M Lin, "Linear Circuit Analysis," 2nd Ed., Oxford University Press, 2007.

Subject Code: EC3L005	Name: Electromagnetic Waves and Radiating Systems	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Mathematics – 1, Mathematics – 2

Vectors analysis: Vector algebra, vector calculus - divergence, gradient, curl, Laplacian; Coordinate systems - Cartesian, cylindrical and spherical; Electrostatics: Coulomb's law, Gauss's law, electric scalar potential, Laplace and Poisson's equations, conduction and polarization, boundary conditions, resistance and capacitance; Magnetostatics : Biot-Savart law, Ampere's law, magnetic vector potential, Lorentz force, magnetization, boundary conditions, magnetic energy and inductance; Electrodynamics : Maxwell's equations, Faraday's induction, displacement current, Plane wave propagation in free space and in materials; Poynting vector, reflection and transmission of plane waves at media boundary, Transmission lines, Smith chart; Advanced Topics: Antenna fundamentals, dipole antenna, Microstrip transmission lines, Waves along guiding structures

Text Books:

1. J. D. Kraus and D. A. Fleisch, "Electromagnetics: with Applications," McGraw Hill, 1999.
2. D. K. Cheng, 'Field and Wave Electromagnetics,' Addison-Wesley series, 1989.

Reference Books:

1. W. H. Hayt, "Engineering Electromagnetic", 5th Ed., TMH, 1999.
2. J. A. Edminister, "Schaum's Outline of Theory and Problems in Electromagnetics," 1984.

Subject Code: EC3L006	Name: Digital Communications	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Analog Communications

Introduction to Digital Communications, Nyquist Sampling Theorem, Information Sources, Random process, Quantization, Pulse Code Modulation, Delta Modulation, Signal Space Representation: Orthogoal expansion of signals, Gram-Schmidt Procedure, Representation of digitally modulated signals; Digital Transmission over the AWGN Channel, Matched Filters, ML and MAP Receivers, Power Density Spectra and Probability of Bit Error; Modulation for Bandwidth-Limited Channels: Intersymbol interference, Equalization, error performance; Passband Digital Transmission via Carrier Modulation: BPSK, QPSK, MPSK, BFSK, MFSK, CPFSK, OQPSK, MSK, GMSK and Continuous phase modulation, , Communication over fading channels, Spread spectrum systems: direct sequence modulation and frequency hopping Case study — code division multiple access (CDMA); Multichannel and multicarrier systems: OFDM; Introduction to information theory: Entropy, Channel Capacity in AWGN;

Text Books:

1. J. G. Proakis and M. Salehi, "Fundamentals of Communication Systems," Prentice Hall, 2004.
2. S. Haykin, "Communication Systems," John Wiley & Sons, 5th Ed., 2009.

Reference Books:

1. B.P. Lathi and Z. Ding, "Modern Digital and Analog Communication Systems," 4th Ed., Oxford University Press, 2009.
2. U. Madhow, "Fundamentals of Digital Communication," Cambridge Univ. Press, 2008.
3. T. M. Cover and J. A. Thomas, "Elements of Information Theory," Wiley Student Edition, 1999, Reprint 2009.

Subject Code: EC3L003	**Name: Digital Signal Processing**	**L-T-P: 3-1-0**	**Credits: 4**

Pre-requisite(s): Signals and Systems

Introduction to DSP, Signals and Systems Characterization, FIR and IIR : Recursive and Non Recursive, Z-Transform, Discrete Time Signals and Systems in Frequency Domain, Sampling, Quantization, Discrete Fourier Transform, Fast Fourier Transform, Short-time Fourier Transform, Digital Filter Structure, Analog Filter Design, Digital Filter Design.

Text Books:

1. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications, 4th Ed., Pearson, 2012.
2. A. V. Oppenheim and R. W. Shafer, "Discrete-Time Signal Processing," Prentice Hall, 2009.

Reference Books:

1. R. G. Lyons, "Understanding Digital Signal Processing," 3rd Ed., Prentice Hall, 2010.
2. V. K. Ingle and J. G. Proakis, "Digital Signal Processing using MATLAB," Thomson Learning, 2000.

Subject Code: EE3L003	Name: Control Systems	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Signals and Systems

Introduction to Control Systems: Definition, Examples of control systems, Open loop and closed-loop control systems, Review of Laplace and inverse Laplace transforms; System Modeling: Signal flow graph, Block diagram, Transfer function, Poles and zeros, Block diagram reduction using signal flow graph and block diagram reduction techniques, Mechanical, electrical and electromechanical systems, First and second order models; Transient Response and Steady State Error Analysis: Definitions of transient response parameters, analysis of second order system as prototype, Routh-Hurwitz stability criterion, Classification of systems based on steady state characteristics, Steady state error coefficients; Root Locus Method: Definition of root locus, Properties of root locus, Sketching of root locus, Effect of open loop poles and zeros, Root locus design concepts; Frequency Response Analysis: Bode diagram, Polar plot, Nichols plot, Nyquist stability criterion: nonmathematical description of Nyquist criterion, interpretation of stability, Relative stability – Gain and Phase margin, Closed loop frequency response – M and N contours, Nichols chart; Compensation Techniques: Compensation techniques: lag, lead and lag-lead compensation, PD, PI and PID controllers, Cascade compensation based on root locus method, Introduction to feedback compensation; State Space Analysis: Concepts of state, state variables, and state model, State models for linear continuous-time systems, Diagonalization, Solution of state equations, Concepts of Controllability and Observability. Nonlinear Systems: Common physical nonlinearities, Phase plane method, Singular points, Stability of nonlinear systems, Phase trajectories, Describing function method and stability analysis, Lyapunov's stability criterion.

Text Books:

1. R. Stefani, B. Shahrian, C. Savant & G. Hostetter, "Design of Feedback Control Systems", Oxford University Press, 2002.
2. K. Ogata, "Modern Control Engineering", Prentice Hall, 1997.

Reference Books:

1. B. C. Kuo & F. Golnaraghi, "Automatic Control Systems", John Wiley, 2003.
2. M. Gopal, "Control Systems: Principles and Designs", 2nd Edition, McGraw Hill, 2002.
3. R. C. Dorf & R. H. Bishop, "Modern Control Systems", Prentice Hall, 2000.

Subject Code: EC3L009	Name: VLSI Design	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Semiconductor Devices, Digital Electronics

Introduction: Design hierarchy, layers of abstraction, integration density and Moore's law, VLSI design styles, packaging styles, design automation principles; Fabrication Technology: Basic steps of fabrication, bipolar, CMOS and Bi-CMOS fabrication processes, layout design rules; MOS and Bi-CMOS characteristics and circuits: MOS transistor characteristics, MOS switch and inverter, Bi-CMOS inverter, latch-up in CMOS inverter, super-buffers, propagation delay models, switching delay in logic circuits, CMOS analog amplifier; Logic Design: switch logic, gate restoring logic, various logic families and logic gates, PLA; Dynamic Circuits: Basic concept, noise considerations, charge sharing, cascading dynamic gates, domino logic, clocking schemes; Sequential Circuits: Basic regenerative circuits, bi-stable circuit elements, CMOS SR latch, clocked latch and flip-flops; Low-power Circuits: low-power design through voltage scaling, estimation and optimization of switching

activity, reduction of switched capacitance, adiabatic logic circuits; Subsystem Design: design of arithmetic building blocks like adders, multipliers, shifters, area-speed-power tradeoff; Semiconductor Memories: SRAM, DRAM, non-volatile memories; Bipolar ECL Inverter: Features of ECL gate, logic design in ECL, single-ended and differential ECL gates; Testability of VLSI: Fault models, scan-based techniques, BIST, test vector generation; Physical Design: Brief ideas on partitioning, placement, routing and compaction.

Text Books:

1. S. Kang and Y Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design," 3rd Ed., Tata McGraw Hill, New Delhi, 2003.
2. J. P. Uyemura, "Introduction to VLSI circuits and Systems," John Wiley, New Delhi, 2002.

Reference Books:

1. L Wang, C.Wu and X. wen, VLSI Test Principles and Architecture, Morgan Kaufmann, San Francisco, 2006.

Subject Code: EC4L005	**Name: Communication Networks and Switching**	**L-T-P: 3-0-0**	**Credits: 3**

Prerequisite: Analog and Digital Communications

Introduction to Communication Networks; Communication Switching: Circuit Switching, Message and Packet Switching, Connectionless and Connection oriented packet switching; Communication Process and Layered Architecture: Communication between computers and layering concept, OSI Layers, Protocols; Standards: Physical Layer, Data link layer- HDLC, Network layer – X. 25, Transport and Session layers, Application and Presentation layers; Local Area Networks: LAN topologies, access mechanisms and media, contention based LANS, Token passing LANS; Metropolitan Area Networks: Distributed Queue Dual Bus (DQDB), Fiber Distributed Data Interface (FDDI); Internet and Internet Protocol Suite: Internet, IPV4, IP addressing, ICMP, IPV6, Transport control protocol, UDP protocol suite; Routing: Concept, Techniques – Next-hop specific, Network-specific and Host-specific, routing algorithms, Protocols- RIP, OSPF, Link state routing, BGP; Flow-based routing, Hierarchial routing; Digital Switching: Space switching, Multistage switching, Time multiplexed space and time switching, time and space switches; Frame relay; ATM: Concepts and Header, virtual path, virtual channel, ATM adaptation layer (AAL); Narrowband and Broadband ISDN: Data rates, Access channel types, reference points, services and standards, B-ISDN; Synchronous Digital Hierarchy; Network Security.

Texts Books:

1. B. A Forouzan, "Data Communications and Networking," 4th Ed., McGraw Hill, 2012.
2. D. Bertsekas and R. Gallager, "Data Networks," 2nd Ed., PHI learning, 2011.

Reference Books:

1. A. S. Tanenbaum, "Computer Networks," 4th Ed., Prentice Hall, 2009.

Subject Code: EC4L006	Name: RF and Microwave Engineering	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Electromagnetic waves and Radiating Systems

Review of electromagnetics: Maxwell's equations, plane wave solutions; Transmission lines: coaxial lines, rectangular waveguides, Microstrip; Network analysis: scattering matrix, transmission matrix formulations; Matching networks: Lumped element designs and limitations, single and double-stub tuned designs, Quarter-wavelength transformers, multi-section matching transformers; Active microwave circuit design: characteristics of microwave transistors, mixers and detectors, Oscillators; Amplifier design: LNA and Power amplifiers, gain and stability, design for noise figure, Single-stage amplifier design; Antenna Analysis and Design: Dipole, Monopole, Loop, Antenna arrays and Pattern synthesis, Complex Wire Antennas (Helical, Spiral, LPDA, Turnstile), Aperture antennas, Broadband and Ultra-wideband Antennas; Noise in microwave circuits: dynamic range and noise sources, equivalent noise temperature, system noise figure considerations.

Text Books:

1. David M. Pozar, 'Microwave Engineering,' 3rd. ed., John Wiley & Sons, 2005.

Reference Books:

1. Guillermo Gonzalez, Microwave Transistor Amplifiers, 2nd. ed., Prentice-Hall, 1997.
2. Thomas H. Lee, Planar Microwave Engineering: A Practical Guide to Theory, Measurement, and Circuits, 1st Edition, Cambridge University Press, 2004.

Subject Code: EC6L012	Name: Optical Communication	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Analog and Digital Communications

Introduction: Fundamentals of Light, Optics, Optical Fibers, Dielectric waveguides: Attenuation, wavelength dispersion, modes, fields; Light sources and optical amplifiers: Semiconductor laser, light-emitting diode, rate equations, output power, modulation response, chirp, noise, optical amplifiers. Detectors: PIN-diode, avalanche diode, responsivity, bandwidth, noise. Transmission systems: Optical links, direct detection systems, soliton systems, coherent systems, multilevel signaling, dispersion limitations, attenuation limitations, additive noise, signal dependent noise, bit error rate, optical networks, Wavelength-Division-Multiplexing and challenges, Optical System Design and Performance analysis using software tools, Current issues & topics of optical fibre systems

Text Books:

1. G. Keiser, "Optical Fibre Communications", Tata McGraw-Hill Education, 4th Ed., 2008.
2. Govind Agrawal, "Fibre-Optic Communication Systems,' 4th Ed., Wiley, 2010.

References:

1. J. Senior, "Optical Fibre Communications: Principles and Practice," 3rd Ed., Prentice Hall, 2008.
2. R. Ramaswami, K. N. Sivarajan, "Optical Networks: A Practical Perspective," 3rd Ed., Morgan Kaufmann, 2009.
3. S. C. Gupta, "Textbook on Optical Fiber Communication and Its Applications," PHI Learning, 2004.
4. John A, "Buck Fundamental of Optical Fiber," Wiley-Interscience, 2004.

Subject Code: EC4L009	Name: Information Theory and Coding	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Digital Communication

Introduction: entropy and mutual information theory: joint entropy, conditional entropy, relationship between entropy and mutual information, chain rules for entropy, relative entropy, mutual information, jensen's inequality fano's inequality; An introduction to codes: coding: kraft inequality, optimal codes, bounds on optimal code length, kraft inequality for uniquely decodable codes, shannon and huffman codes, shannon, fano, elias codes, block codes, linear block codes, cyclic codes; Efficient encoding, information sources; average code word length; huffman encoding; noiseless coding: the noiseless coding theorem; Channel capacity: discrete memoryless channels and capacity, examples of channel capacity, symmetric channels, properties of channel capacity, channel coding theorem; Theory and practice of error-control coding: trellis diagram and the viterbi algorithm, convolution coding in mobile communications and modern graph-based codes (turbo-codes and ldpc codes), the main coding theory problem.

Text Books:

1. T. M. Cover and J. A. Thomas, "Elements of Information Theory," Wiley Student Ed, 2009.
2. S. Lin and D. J. Costello, "Error Control Coding," 2nd Ed., Pearson Prentice Hall, 2004.

Reference Books:

1. R. G. Gallager, "Information Theory and Reliable Communication," Wiley, 1968.
2. I. Csiszar and J. Korner, "Information Theory: Coding Theorems for Discrete Memoryless Systems," Akademiai Kiado, 1981.
3. T. S. Han, "Information-Spectrum Methods in Information Theory," Springer, 2002.
4. A. Neubauer, J. Freedenberg and V. Kuhn, "Coding theory Algorithm, Architectures and Applications," Willey India Editions, 2007.
5. R. Bose, "Information theory, Coding and Cryptography," TMH publication, 2008.

Lateral Courses

Lateral-1

Subject Code: EC2L006	Name: Introduction to Signals and Systems	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): None

Introduction and Basics: Signals and Systems; Classification of Signals, System Properties; Linear Algebra Basics-Vectors, Orthogonality, Eigenvalues and Eigenvectors; Probability and Random Signals: Random variables; probability density functions (PDFs); Moments and Cumulants; Multivariate distributions; Time averages, Ensemble averages, Autocorrelation functions, Crosscorrelation function; Estimation of parameters of random signals; Linear prediction; Auto-regressive model; Nonlinear models of signals; Analysis of Nonstationary signals; Continuous Signals and Systems: Laplace Transform, Transfer Functions, Causality and Stability, Poles/Zeros; Differential Equations, Steady State and Transient Responses, and Convolution Integral; Discrete-Time Signals and Systems: LTI Systems; Z-transform; Digital filters; Difference Equations; Causality and stability; Convolution and Correlation; Discrete Fourier Transform (DFT), FFT and Window Function; Frequency Analysis of Signals and Systems; Data Acquisition: Sampling theorem; Sampling of Bandpass Signals; Quantization; A/D conversion; D/A conversion; Sampling and Reconstruction; Interpolation and Decimation; Digital Filter Design: Butterworth, Elliptic, Chebyshev low-pass filters. Filter Realizations; Conversion to high-pass, band-pass, band-stop filters. Discrete-time filters: IIR and FIR. Linear phase filters. Frequency sampling filters.

Text Books:

1. A. Papoulis and S. U. Pillai, “Probability, Random Variables, and Stochastic Processes,” McGraw Hill, 2001.
2. A. V. Oppenheim, A. S. Willsky and H. Nawab, “Signals and Systems,” 2nd Ed., Prentice-Hall, 1996.

Reference Books:

1. A. V. Oppenheim, Ronald W. Schafer and John R. Buck, “Discrete-Time Signal Processing,” 2nd Ed., Prentice Hall, 1999.
2. J. G. Proakis, and D. K. Manolakis, “Digital Signal Processing,” 4th Ed., Prentice Hall, 2006.

Subject Code:EC2L007	Name: Communication Systems	L-T-P: 3-0-0	Credits: 3
Pre-requisite(s): None			

Introduction, Communication process, Communication Signals, Fourier Transform and Properties Modulation techniques: Amplitude Modulation: Principle, DSB-FC, DSB-SC, SSB and VSB, AM Receiver; Frequency Modulation: Principle, Wideband FM, Narrowband FM, FM Receiver; Superheterodyne Receiver, Time-Division Modulation (TDM), PCM, PCM-TDM, PAM, PPM, PWM and Shift Keying: Amplitude Shift Keying (ASK) and Frequency Shift Keying (FSK); Random variables and Processes: Introduction, Random variables, statistical averages, random processes, mean correlation and covariance functions, PSD, Gaussian Process; Analog and Digital Receiver performance in AWGN.

Text Books:

1. Simon Haykin and Michel Moher, Communication Systems, 5th Ed., John Wiley, 2009.
2. Leon W. Couch, Digital and Analog Communication Systems, 4th Ed., Macmillan Coll Div., 1993.

Reference Books:

1. R, E. Ziemer and W. H. Tranter, "Principles of Communications, Systems, Modulation, and Noise," 5th Ed., Wiley, 2001.
2. P. L. Meyer, "Introductory Probability and Statistical Applications," 2nd Ed., Addison Wesley, 1970.
3. M. H. DeGroot, "Probability and Statistics," 4th Ed, Pearson, 2011.
4. B. P. Lathi, "Modern Digital and Analog Communication Systems," 4th Ed., Oxford, 2011.

Lateral-2

Subject Code: EC3L004	Name: Biomedical Systems	L-T-P: 3-0-0	Credits: 3
Pre-requisite(s): None			

Introduction to Signals and Systems: Classification of signals, Systems and properties; Signal Processing Techniques: Convolution and Correlation, Interpolations, DFT, STFT, DCT, KLT, Wavelet Transform, Hilbert Transform, Singular Value Decomposition, Principal component Analysis (PCA), Independent Component Analysis (ICA), Random Signal Modeling, Spectral Estimation, Information-theoretic, Nonnegative Matrix Factorization, Total Variation, Sparse Representation, Empirical Mode Decomposition, and Variational Mode Decomposition; Anatomy and Physiology: Structure and function of the human biology including cells, tissues and organs of the following systems: Nervous, Cardiovascular, Respiratory, Muscular, Skeletal, Digestion and Endocrine and special Senses, Membrane Potentials and Action Potentials; Biomedical Signals: The nature of biomedical signals, introduction to the biosignals (ECG, PPG, EEG, EEG, ERG, EOG, EEG, EGG, VMG, VMG and internal body sounds (heart, lung and bowel); Analog Signal Processing: Biosensors, Instrumentation Amplifier, Analog Filter design, Sampling and Quantization, A/D Conversion, D/A Conversion, compressive sensing and Key Challenges in Wearable Medical Devices; Biosignal Signal Analysis: Removal of Artifacts-Time-domain Filters, Frequency-domain Filters, Adaptive Filters and Homomorphic Filtering; Event Detection and

Classification, Modeling Biomedical Systems, Biosignal Watermarking and Compression; Biomedical Applications: Brain Computer Interface, Physical Rehabilitation, Emotional and Biometric Recognition Systems

Text Books:

1. A. C. Guyton and J. E. Hall, "Textbook of Medical Physiology," 11th Ed., 2006.
2. S. J. Cooper, and D. K. Vaughan, "Human Physiology Course Handbook" UW-Oshkosh, 2015
3. Martini and Welch, "Fundamentals of Anatomy and Physiology Applications Manual," 10th Ed., Pearson Education, Benjamin Cummings, San Francisco, CA 2015.

Reference Books:

1. R. M. Rangayyan, "Biomedical Signal Analysis: A Case-Study Approach," Wiley India, 2009.
2. E. N. Bruce, "Biomedical Signal Processing and Signal Modeling," 1st Ed., Wiley-Interscience, 2000.
3. J. L. Semmlow, "Biosignal and biomedical image processing: MATLAB-based applications," 1st Ed., CRC, 2004.
4. M. Akay, "Time Frequency and Wavelets in Biomedical Signal Processing," 1st Ed., Wiley-IEEE Press, 1997.

Lateral-3

Subject Code: EC3L008	**Name: Satellite Communication Engineering**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite: None

Overview of Principles of communication, modulation and receiver; Introduction to Satellite Communication: Principle, types of satellite communications systems, historical developments, Link budgets: antennas, propagation, noise, Carrier to noise ratio calculation, transmitters, propagation and rain, receivers, lnas, figure of merit, total system performance; Orbital mechanics: Basic equations, special orbits (LEO, MEO, GEO), geometry and movement , constellations, real world effects; Rf and licensing issues: spectrum allocations, modulation, multiplexing, multiple access; Current and future trends; Spectrum sharing, additional noise issues, interference and coordination, telemetry and tracking, power limitations, reliability.

Text Books:

1. T. Pratt, C. Bostian and J. Allnutt, "Satellite Communications," 2nd Ed., Wiley India, 2006.
2. W. L. Pritchart, H. G. Suyderhoud and R. A. Nelson, "Satellite Communication Systems Engineering," 2nd Ed., Pearson Education, 2012.

Reference Books:

1. G. D. Gordon and W. L. Morgan, "Communications Satellite Handbook," Wiley India, 2010.
2. D. Roddy, "Satellite Communications," 4th Ed., Tata McGraw-Hill Education, 2006.

Vertical Theory (Core):

Subject Code: EC2L002	Name: Signals and Systems	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Mathematics –1

Objective and overview, signal and system types and classifications, LTI system: Causality, stability, step response, impulse response and convolution integral; Periodic signal analysis: Fourier series and properties; Aperiodic signal analysis : Fourier Transform - its properties and sinusoidal steady state analysis of systems; Discrete-time Fourier transform; Fourier transform for periodic signals; Time and frequency characterization of signals and systems: magnitude-phase representation of Fourier transforms; Unilateral and Bilateral Laplace Transforms and properties: Analysis and characterization of LTI systems using Laplace transform; System function and block diagram representation, Bode plot; Discrete signals: Sampling, digitization and reconstruction of analog signals; Fourier transform of discrete signals: DFT, z-transforms; Discrete systems, transfer functions and convolution; Analog filter design: Butterworth, Sallen Key, frequency transformation and scaling.

Text Books:

1. A. Papoulis and S. U. Pillai, "Probability, Random Variables, and Stochastic Processes," McGraw Hill, 2001.
2. A. V. Oppenheim, A. S. Willsky and H. Nawab, "Signals and Systems," 2nd Ed., Prentice-Hall, 1996.

Reference Books:

1. A. V. Oppenheim, Ronald W. Schafer and John R. Buck, "Discrete-Time Signal Processing," 2nd Ed., Prentice Hall, 1999.
2. J. G. Proakis, and D. K. Manolakis, "Digital Signal Processing," 4th Ed., Prentice Hall, 2006.

Subject Code: EE2L001	Name: Network Theory	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Electrical Technology

Nodal and Loop Analysis: Review, modified nodal analysis; Network Theorems: Substitution theorem, Compensation theorem, Reciprocity theorem, Maximum power transfer theorem, Millman's theorem, Tellegen's theorem; Transient analysis of RLC circuit and higher order circuits; Frequency domain analysis of dynamic circuits using Fourier series, Fourier transforms and Laplace transforms; Network functions: poles and zeros, driving point and transfer functions, restrictions on poles and zeros for network functions, time domain behaviour, frequency response plots; Two-port networks and passive filters: z-parameters, y-parameters, h-parameters, and ABCD parameters; reciprocity and symmetry in two-port networks; Introduction to network topology: Graph theory: Tree, Co-tree, fundamental cut-set, fundamental loop analysis of network; State variable analysis of networks.

Text Books:

1. M. E. Valkenburg, "Network Analysis," 3rd Ed., Pearson Prentice Hall, 2006.
2. F. F. Kuo, "Network Analysis and Synthesis," 2nd Ed., Wiley India, 2007.

Reference Books:

1. W. H. Hyat, J. E. Kemmerly and S. M. Durbin, "Engineering Circuit Analysis," 6th Edition, Tata McGraw Hill, 2007.
2. R. A. DeCarlo and P-M Lin, "Linear Circuit Analysis," 2nd Ed., Oxford University Press, 2007.

Subject Code: EC2L006	Name: Digital Electronics and Microprocessor	L-T-P: 3-1-0	Credits: 4

Prerequisite: Introduction to Electronics

Introduction to Boolean algebra and Switching Function, Boolean minimization; Combinational Logic Design using MSI circuits : Full Adder/Subtractor, BCD Adder, LAC Adder, Decoder, MUX/DEMUX three structure, Combinational logic design using ROM array, Applications of MSI designs; Integrated Circuits: Difference between combinational and sequential circuits, Flip Flops, Counters, Shift Registers and PLA; Analysis and Synthesis of Sequential Circuits: Basic models of sequential M/C, Analysis of Asynchronous and Synchronous circuits, Synthesis of completely and incompletely specified synchronous sequential M/Cs; Introduction to Microprocessor: Overview of architecture of Intel 8085 Microprocessor (Register, Stack, Interrupt) Instruction set and programming; Introduction to 16 Bit Microprocessor : Architecture of 8086 CPU architecture, Internal operations, Machine Language instructions, Addressing mode, Instruction Format, Instruction executions, Addressing mode, Instruction Format, Instruction execution timing, comparison of 8088 with 8086; Assembly language programming and Instructions: Assembler instruction format, Data Transfer, Arithmetic, Branch, Flag manipulation, Logical, Shift and Rotate. String Manipulation Stack Manipulation, all and return instructions, REP Prefix, segment override prefix, and simple assembler directives such as real, variable, DB, DW, DD, EQU, END, Assume, pointer (byte, word, double word, Near, Short, and Far).

Text Books:

1. S. Lee, "Digital Circuits and Logic Design" Prentice Hall India, 2008.
2. D. P. Leach, A. P. Malvino and G. Saha, "Digital Principles and Applications," Tata McGraw Hill, 2006.

Reference Books:

1. M. Morris Mano, "Digital Logic and Computer Design," Prentice Hall, 2013.
2. B. N Jain and R. P. Jain, Modern Digital Electronics, Tata McGraw Hill, 2006.
3. B. B. Bray, The Intel Microprocessors- 8086/8088, 80186, 80286, 80386, and 80486-Architecture, Programming and Interfacing, Prentice Hall, 2000.
4. D. V. Hall, Microprocessor and Interfacing programming & Hardware, TMH, 2001.
5. A. K. Ray and K. M. Bhurchandi, Advanced Microprocessors & Peripherals: Architecture, Programming & Interfacing, TMH, 2008.

Vertical Theory (Elective-1, 2):

Subject Code: EC4L001	Name: Semiconductor Devices	L-T-P: 3-0-0	Credits: 3

Prerequisite: Introduction to Electronics

Semiconductor Fundamentals, Crystal Structure, Energy bands, Intrinsic and extrinsic semiconductors, Fermi Level, Carrier concentrations at thermal equilibrium, Carrier transport phenomenon: drift and diffusion, Scattering, Excess carriers in semiconductors: generation, recombination and injection of carriers, transient and steady state response, Basic governing equations in semiconductors; Physical description of p-n junctions, Transport equations, current-voltage characteristics, deviations from simple theory, small-signal ac analysis, metal-semiconductor junctions, hetero junctions; BJT fundamentals, operation regions, BJT equivalent circuits and modelling frequency response of transistors, pnpn diodes, SCR; MOS structure, flat-band threshold voltages, MOS static characteristics, small signal parameters and equivalent circuit, charge sheet model, strong, moderate and weak inversion, short channel effects, scaling laws of MOS transistors, LDD MOSFET, NMOS and CMOS IC technology, CMOS latch-up phenomenon; optical absorption in a semiconductors, photovoltaic effect, solar cell, photoconductors, PIN photodiode, avalanche photodiode, LED, semiconductor lasers; Negative conductance in semiconductors, transit time devices, IMPATT, Gunn device, BiCMOS devices.

Text Books/Reference Books:

1. Ben G Streetman, S K Banarjee, Solid State Electronic Devices, 6th edition, PHI India, New Delhi, 2007.
2. R S Muller, T.I.Kamins, Device Electronics for Integrated Circuits, 3rd edition, Wiley-India, New Delhi, 2012.
3. S M Sze, K K Ng, Physics of Semiconductor Devices, 3rd edition, John Wiley, New Jersey, 2007.
4. P Bhattacharya, Semiconductor Optoelectronics, 2nd edition, Pearson, New Jersey, 1997.

Subject Code: EC6L005	Name: Statistical Signal Processing	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Digital Signal Processing

Review of Probability and Stochastic Process; Estimation Theory: Minimum-variance unbiased estimator (MVUE), Cramer-Rao Lower bound, Best Linear Unbiased Estimator, Maximum likelihood Estimator, General Bayesian Estimator**,** Detection Theory: Neyman Pearson Theorem, Receiver Operating Characteristics, Matched Filters, Composite Hypothesis Testing; Nonparametric Spectral Estimation: Estimation of power spectrum of stationary random signal using periodogram-various methods, Joint signal analysis and estimation of cross power spectrum; Linear Signal Model: Synthesis of coloring filter and Analysis of whitening filter, Rational power spectra (AR, MA, ARMA), Relationship between filter parameters and autocorrelation sequences, Lattice-Ladder filter realization; Parametric Spectral Estimation: Order selection criterion of AR model , Minimum-variance, Maximum

entropy and Maximum likelihood spectrum estimation Harmonic models and frequency estimation techniques Harmonic Decomposition, MUSIC algorithm, ESPRIT algorithm; Linear Optimum Filter: Optimum FIR Filter, PCA of optimum linear estimator and its frequency domain interpretation, Forward and Backward Linear prediction and optimum reflection coefficients Optimum causal and non-causal IIR Filters, De-convolution and Signal restoration Algorithms and Structure of Optimum Linear Filters Levinson Recursion for optimum estimate, Order-recursive algorithms for optimum FIR filters and its lattice structures.

Text Books/Reference Books:

1. S. M. Kay, Fundamentals of Statistical Signal Processing, Vol I: EstimationTheory, Vol II: Detection Theory, Prentice Hall, 1993/1998.
2. Harry L. Van Trees, Detection, Estimation, and Modulation Theory, Part I, Wiley-Inter science, 2001
3. Monson H. Hayes, Statistical Digital Signal Processing and Modeling, John Wiley, 1996.

Subject Code: CS6L001	**Name: Computational Intelligence**	**L-T-P: 3-0-0**	**Credits: 3**

Prerequisite: Introduction to Programing and Data Structures

Soft Computing: Artificial Neural Network: Artificial neuron, single layer and multilayer architecture, nonlinear function like sigmoid function, back propagation learning algorithm. Functional link artificial neural network, trigonometric, Chebyshev and Legendre polynomial. Readial basis function neural network, its learning algorithm, recurrent neural network and its learning algorithm; Fuzzy Logic: Types of fuzzy logic, membership functions, fuzzification and defuzzification, rule-based fuzzy inference engine, Type-1 and Type-2 fuzzy logic, typical applications; Evolutionary Computing and Swarm Intelligence: Derivative based and derivative free optimization, multivariable and multiconstraint optimization. Genetic algorithm and its variants, Differential evolution and its variants, particle swarm optimization and its variants, Cat swarm optimization, bacterial foraging optimization, Artificial immune system, multiobjective optimization like NSGA-II.

Text Books/References:

1. S. Haykin, 'Neural Networks and Learning Machines', Prentice Hall, 2009.
2. Y.H. Pao, 'Adaptive pattern recognition and neural networks', Addison-Wesley, 1989.
3. Jang, J.S.R., Sun, C.T. and Mizutani, E., 'Neuro-fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence', Prentice Hall, 2009.
4. Hagan, M., 'Neural Network Design', Nelson Candad, 2008.
5. K.A.D. Jong, 'Evolutionary Computation – A Unified Approach', PHI Learning, 2009.

Subject Code: EC6L001	Name: Advanced Communication Engineering	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Analog and Digital Communication

Noise in amplitude modulation, frequency modulation, pulse code, delta modulation, MPSK, MQAM and MFSK, CPFSK, OQPSK, CPM; Information theory and coding; Optimum reception of digital signals, Performance analysis of digital communication systems; Multi carrier communications, Multi-channel communications and Multi-user communications; Introduction to software defined radios, Spectrum sensing, Dynamic spectrum access and management, Distributed learning; Introduction to sensor networks, Deployment and configuration, Protocols routing and application;

Text Books:

1. J. G. Proakis and Masoud Salehi, "Fundamentals of Communication Systems," 1st Edition, Prearson Education, 2006.
2. Simon Haykin, "Communication Systems," John Wiley & Sons, 5th Ed., 2009.

Reference Books:

1. B. P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems," Oxford University Press, 4th Ed., 2009.
2. U. Madhow, "Fundamentals of Digital Communication," Cambridge Univ. Press, 2008.
3. Cauligi S Raghavendra, Krishna M Sivalingam, Taieb Znati, "Wireless Sensor Network", Springer, 2006.
4. Hüseyin Arslan, "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", Springer, 2007.
5. Kwang-Cheng Chen, Ramjee Prasad,"Cognitive Radio Networks", John Wiley & Sons, 2009.

Subject Code: EE6L011	Name: Energy Storage Systems	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Introduction to Electronics

Energy Storage Need of energy storage; Different modes of Energy Storage. Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energy storage. Solar Ponds for energy storage. Electrochemical Energy Storage Systems Batteries: Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Lead Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon nano-tubes in electrodes. Magnetic and Electric Energy Storage Systems Superconducting Magnet Energy Storage(SMES) systems; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application, role of activated carbon and carbon nano-tube.

Text Books/Reference Books:

1. R. Huggins, Robert 'Energy Storage', Springer, 2010.
2. Ter-Gazarian 'Energy Storage for Power Systems', Institution of Engineering and Technology, 1994.

Subject Code: CS2L002	Name: Computer Organization and Architecture	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Digital Electronic Circuits

Overview of computer organization – components and system buses; Concepts of assembly and machine language programs. Machine language program execution – instruction cycles, machine cycles and bus cycles. Overview of memory and I/O addressing; CPU organization – components and subsystems, register banks, internal bus structure, information flow; Instruction set – characteristics and functions, types of operation and operands. Addressing modes – various ways of addressing memory and input-output devices and their timing characteristics; CISC and RISC architectures – examples; ALU – flags, logical operations, fixed point number representations and arithmetic, floating point number representations and arithmetic, exceptions. Control Unit – how it operates, hardwired control unit, concepts of microprograms and microprogrammed control unit; Memory hierarchy – main memory – types and interfacing; Cache memory – its organizations and operations, levels of caches; Memory management module – paging and segmentation, virtual memory; Disk memory, RAIDs. Back-up memory. Interrupts and interrupt structures – interrupt cycles, handling multiple simultaneous interrupts, programmable interrupt controllers; I/O interfacing and modes of I/O data transfer. Direct memory access – DMA controller; Instruction level parallelism – instruction pipelining, pipeline hazards; Concepts of multiprocessor systems; Examples will be drawn from real life RISC and CISC processors.

Text Books:

1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization,” McGraw-Hill, 2011.
2. D A Patterson and J L Hennessy, “Computer Architecture – A Quantitative Approach,” Morgan Kaufmann, 2011.
3. W Stallings, “Computer Organization and Architecture – Designing for Performance,” Pearson, 2013.

Reference Books:

1. J. P. Hayes, “Computer Architecture and Organization,” McGraw-Hill, 1998.
2. D A Patterson and J L Hennessy, “Computer Organization and Design – The Hardware/Software Interface,” ARM Edition, Morgan Kaufmann, 2012.
3. A. S. Tannenbaum, “Structured Computer Organization,” EEE Ed., Prentice Hall, 2013

Subject Code: EC4L002	Name: Opto-Electronics	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Introduction to Electronics

Review of basic principles from physics, optical wave representation, interferometers, optical resonators, planar mirror resonators, modes of resonators, spherical mirror resonators, confinement, Gaussian beams, photons and matter, energy levels; Photon optics: interactions of photons and atoms, population inversion, spontaneous and stimulated emission; Lasers: gain mechanism, rate equations, pumping, gain and gain coefficient, laser oscillation theory, laser types, power and spectral distribution , polarization, mode selection, light emitting diodes, fabry-perot lasers, erbium-doped fiber amplifiers (EDFA); Photo detectors: properties of photo detectors, photoconductors, photodiodes. Avalanche photodiodes, phototransistors and noise mechanisms, signal-to-noise analysis, and modulation of optical signals, formats, and receivers; Noise and detection: types of noise and distortion which affects optical signals, methods of reducing effects of noise and distortion, optimal detection methods and devices; Overview of opto-electronic networks: FDDI, Fiber channel, sonnet.

Text Books:

1. Saleh and Teich, "Fundamentals of Photonics," Wiley Interscience, 2nd edition, 2007.
2. J. Senior, "Optical Fiber Communications. Principle and Practice," Prentice Hall, 2011.

Reference Books:

1. Wilson and Hawkes, "Optoelectronics: An Introduction, 3rd. Ed., Prentice Hall, 1997.

Subject Code: EC6L002	Name: Image and Video Processing	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): Digital Signal Processing

Introduction to digital image processing, intensity transformation, spatial filtering, frequency domain filtering, point and line detection, edge detection, Hough Transform, image restoration, color processing, thresholding, image segmentation, affine transformation, image transforms, multi-resolution image analysis, shape and texture representation and description, introduction to object recognition, image compression, JPEG, introduction to digital video, video compression standards, motion estimation.

Text Books/Reference Books:

1. Gonzalez and Woods, "Digital Image processing," 3rd Ed., Pearson and Prentice Hall, 2009.
2. W.K. Pratt, "Digital image processing," 4th Ed., Wiley India, 2007.
3. K.R. Castleman, "Digital image processing," 2nd Ed., Pearson, 2012.
4. A.K. Jain, "Fundamentals of digital image processing," Prentice Hall, 1989.

Subject Code: EE6L007	Name: Industrial Instrumentation	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Measurement and Electronic Instruments

Introduction to Instrumentation system; Static and Dynamic characteristics of Instrument; Pressure measurement: Elastic transducers (Bourdon Gauge, Bellow and Diaphragm Gauge); Temperature measurement: Thermocouple, Resistance Temperature Detector (RTD), Thermistor, Radiation Pyrometer; Flow and pressure measurements: Differential Pressure flow meter, Variable area flow meter, Variable reluctance transducer, Turbine flow meter, Ultrasonic flow meter (Both transit time and Doppler Shift), Electromagnetic flow meter and Mass flow meter; Measurement of level: Capacitance based and Float based method; Measurement of strain: Strain Gauge; Position sensor: Linear Variable Differential Transformer (LVDT), Synchro; Load and torque cell; pH probe and viscosity measurement; Piezoelectric sensors; Ultrasonic sensors; Pollution measurement; Smart sensors; Actuators and Control valves; Signal conditioning; Pneumatic and Hydraulic Instrumentation system.

Text Books/References:

1. D. Patranabis, 'Principles of Industrial Instrumentation', Tata Mcgraw-Hill, 2001.
2. W. C. Dunn, 'Fundamentals of Industrial Instrumentation and Process Control', Mcgraw-Hill, 2005.
3. N. A. Anderson, 'Instrumentation for process measurement and control', CRC press, 1998.
4. E. Doebelin 'Measurement Systems: Application and Design', Mcgraw-Hill, 2003.

Subject Code: CS4L003	Name: Artificial Intelligence	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Introduction to Programing and Data Structures

Introduction to AI, Brief history. Different agent architectures, Problem formulation and search, Heuristic search, A*, local search and optimization, Constraint satisfaction problems, Game playing and adversarial search, Knowledge representation. Logical reasoning. Propositional logic. Planning, Production system, Semantic network and Frame, Propositional logic, First order predicate logic, Other methods for reasoning, An Introduction to Pattern Recognition, Supervised learning methods, Decision trees. Reinforcement learning, Game theory, Robotics.

Text Books/Reference Books:

1. S. Russell and P. Norvig. "Artificial Intelligence: A Modern Approach," 3rd Ed., Prentice Hall, 2009.
2. G. F. Luger, "Artificial Intelligence: Structures and Strategies for Complex Problem Solving", 4/e, Addison-Wesley, 2002.
3. J. Finlay and A. Dix, "An Introduction to Artificial Intelligence", UCL Press, 1996.

Vertical Theory (Elective-3, 4, 5):

Subject Code: EC6L015	Name: Biomedical Signal Processing	L-T-P: 3-0-0	Credits: 3
Prerequisite: Digital Signal Processing			
Nature of biomedical signals, Artifacts removal, Event detection, Wave shape analysis, Frequency-domain characterization, Biomedical system modeling, Non-stationary signal analysis, Detection of region of interests in biomedical images, Shape and texture analysis, oriented pattern analysis, Image reconstruction of projections, Pattern classification and diagnostic decision, presentation of different case studies. **Text Books/Reference Books:** 1. R. M. Rangayyan, "Biomedical signal analysis," Wiley, 2011. 2. R. M. Rangayyan, "Biomedical image analysis," CRC press, 2005. 3. D. C. Reddy, Biomedical signal processing: principles and techniques, Tata McGraw Hill, 2012. 4. Tompkins, Biomedical digital signal processing, Prentice Hall India, 1995.			
Subject Code: EC6L019	**Name: Fibre Optic Sensors**	**L-T-P: 3-0-0**	**Credits: 3**
Prerequisite: None			
Classification of sensors, modulation and demodulation mechanism of sensors, interferometric sensors, optical fibres Doppler systems, polarization modulation sensors, fibre optic sensors for the measurement of temperature, pressure, displacement, turbidity, pollution, etc., multiplexed sensor systems, other sensor applications. **Text Books/References Books:** 1. R. Kasyap, 'Fiber Bragg Gratings', Academic Press, 2009. 2. B. Glisic, D. Inaudi, 'Fibre Optic Methods for Structural Health Monitoring', Wiley, 2008.			
Subject Code: EC6L030	**Name: Embedded Systems**	**L-T-P: 3-0-0**	**Credits: 3**
Prerequisite: Digital Electronics and Microprocessor			
Embedded Processing Systems: Introduction, Components of Embedded Systems – Embedded Processor, Microcontrollers (PIC and ARM architectures), DSP and ASICs and SoC, Memory Devices: ROM and RAM family, Interfacing Memory, Simple I/O programming, Interrupts and their servicing, Timing Devices and Interfacing, Analog I/O Techniques, Introduction to HDL, Design of Embedded Processors and Components, Design Case Studies, Embedded Communication: Parallel Bus Standards, Serial Bus Standards, Networking Standards and Wireless Standards, Real Time Operating Systems (RTOS): Introduction, Memory Management, I/O Management and Device Drivers, Scheduling, Introduction to Software Design: Embedded System Life Cycle, Multicore and Heterogeneous Embedded Systems.			

Text Books:

1. W. Wolf, Computers as Components: Principles of Embedded Computing System Design, 2nd Ed., Burlington, 2008.
2. T Noergaard, Embedded Systems Architecture: A comprehensive Guide for Engineers and Prgrammers, Elsevier,Oxford, 2005.

Reference Books:

1. Steve Heath, Embedded System Design, 2nd Edition, Newnes, Burlington, 2003.

Subject Code: EC6L027	**Name: Pattern Recognition**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Digital signal processing, Probability and stochastic processes

Introduction to pattern recognition; Bayesian decision theory : Classifiers, Discriminant functions, Decision surface, Normal density and discriminant functions, Parameter estimation methods: Maximum-Likelihood estimation, Gaussian mixture models, Expectation-maximization method, Bayesian estimation, Hidden Markov models: Discrete hidden Markov models, Continuous density hidden Markov models; Dimensionality reduction methods: Fisher discriminant analysis, Principal component analysis; Non-parametric techniques for density estimation: Parzen-window method, K-Nearest Neighbour method, Linear discriminant function based classifiers: Perceptron , Support vector machines, Non-metric methods for pattern classification: Non-numeric data or nominal data Decision trees, Unsupervised learning and clustering: Criterion functions for clustering Algorithms for clustering: K-means, Hierarchical and other methods, Cluster validation.

Text Books/References:

1. R.O.Duda, P.E.Hart and D.G.Stork, “Pattern Classification,” John Wiley, 2001.
2. S.Theodoridis and K.Koutroumbas, “Pattern Recognition,” 4th Ed., Academic Press, 2009.
3. C.M.Bishop, “Pattern Recognition and Machine Learning,” Springer, 2006.

Subject Code: EC6L024	**Name: Array Signal Processing**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Digital Signal Processing, Probability and Statistics Processes

Introduction: Array Processing and Applications, Arrays and Spatial Filters: Uniform Linear Array, Array Steering, Array Performance, Linear Aperture, Synthesis of Linear Arrays and Apertures: Spectral Weighting, Array Polynomials, Minimum Beamwidth, Null Steering, Spatially Non-uniform Linear Arrays, Broadband Arrays, Planar Arrays and Apertures: Rectangular Arrays, Circular Arrays, Circular Apertures, Non-planar Arrays, Characterization of Space-time Processes: Snapshot Models, Space-time Random Process, Optimum Waveform Estimation: Optimum Beamformers, MVDR and MPDR Beamformers, LCMV and LCMP Beamformers, Eigenspace Beamformer, Beamspace Beamformer, Broadband Beamformer, Adaptive Beamformers: Parametric Estimation, RLS, LMS, Gradient Algorithms, Parameter Estimation and Direction of Arrival Estimation: Cramer-Rao Bounds, Maximum Likelihood Estimation, Capon methods, Subspace methods - MUSIC, Minimum-Norm and ESPRIT techniques.

Text Books:

1. Harry L. Van Trees, Optimum Array Processing (Part IV of Detection, Estimation, and Modulation Theory), Wiley-Interscience, 2002.

Reference Books:

1. D. E. Dugeon and D. H. Johnson, "Array Signal Processing: Concepts and Techniques," Prentice Hall, 1993.
2. P. Stoica and R. L. Moses, "Spectral Analysis of Signals," Prentice Hall, 2005.

Subject Code: EC6L016	**Name: Computational Electromagnetics**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Electromagnetic Engineering, Introduction to Programming and Data Structure

Applications of electromagnetics in the 21st century. Numerical Methods: ODE solvers, Euler, Runge-Kutta. Review of Basic Electromagnetics: Electrostatics, Magnetostatics, Wave Equations. Numerical Techniques: Method of Moements, Finite Difference Method, Finite Element method, Charge Simulation Method, Monte carlo method. Time Varying Electromagnetic Fiels: Eddy currents & skin depth, introduction to wavelets, families of wavelets. Microwaves, Optics, Micromagnetics, Bio-electromagnetics. Tutorials and demonstration on PC, programming assignments.

Text/ Reference Books:

1. M.N.O. Sadiku, "Numerical Techniques in Electromagnetic," 2nd Ed., CRC Press.
2. E. Weber, "Electromagnetic Fields," Dover, 1951.
3. P. P. Silvester, and R. L. Ferrari, "Finite Elements for Electrical Engineers," Cambridge University Press 1996.
4. J. Kiusalaas, "Numerical Methods in Engineering with Python," Cambridge.

Subject Code: EC6L023	**Name: Adaptive Signal Processing**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Digital Signal Processing

Introduction to adaptive filters, optimal estimation, linear estimation: normal equation, orthogonality principle, linear models. Constrained linear estimation: minimum variance unbiased estimation, steepest descent algorithms, stochastic gradient algorithms: LMS algorithm, normalized LMS algorithm, RLS algorithm. Steady-state performance of adaptive filters, transient performance of adaptive filters, block adaptive filters, the least-squares criterion, recursive least-squares, lattice filters

Texts/Reference Books:

1. A. H. Sayed, "Fundamentals of Adaptive Filtering," Wiley, 2003.
2. S. Haykin, "Adaptive filter theory," Fourth edition, Pearson, 2012.
3. Widrow and Stearns, "Adaptive Signal Processing," Pearson, 2007.

Subject Code: EE6L014	Name: Smart Grid Technology	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): None

Review of basic elements of electrical power systems, desirable traits of a modern grid, principal characteristics of the smart grid, key technology areas; Smart grid communication: Two way digital communication paradigm, network architectures, IP-based systems, Power line communications, advanced metering infrastructure; Renewable Generation: Renewable Resources: Wind and Solar, Microgrid Architecture, Tackling Intermittency, Distributed Storage and Reserves; Wide Area Measurement: Sensor Networks, Phasor Measurement Units, Communications Infrastructure, Fault Detection and Self-Healing Systems, Application and Challenges; Security and Privacy: Cyber Security Challenges in Smart Grid, Defense Mechanism, Privacy Challenges.

Texts/Reference Books:

1. J. Momoh 'Smart Grid: Fundamentals of Design and Analysis' Wiley-IEEE Press, 2012.
2. P. F. Schewe 'The Grid: A Journey through the Heart of our Electrified World' Joseph Henry Press, 2006.

Subject Code: EC6L031	Name: Computer Vision	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Image & Video Processing

Introduction to computer vision, geometric camera models, light and shading, local image features: SIFT, HOG, texture and shape descriptors, active contour, segmentation, deformable models, RANSAC, image registration, learning and classification strategies, image classification, object detection and recognition, stereopsis, tracking, applications

Text Books/References:

1. Forsyth and Ponce, "Computer vision: a modern approach," 2nd Ed., Pearson, 2012.
2. Sonka, Hlavac and Boyle, "Digital image processing and computer vision," Cengage learning, 2008.
3. Rick Szeliski, "Computer Vision: Algorithms and Applications," Springer,2011.

Subject Code: EC6L004	Name: Advanced Digital Signal Processing	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Digital Signal Processing

Multi-rate digital signal processing: decimation, interpolation, sampling rate conversion, digital filter banks, two-channel quadrature mirror filter bank, M-channel QMF bank, Linear prediction and optimum linear filters: forward and backward linear prediction, normal equations, AR lattice and ARMA lattice-ladder filters, Wiener filters, Power spectrum estimation: nonparametric and parametric methods, filter bank methods, Eigen analysis algorithms, Time-frequency analysis: uncertainty principle, Short-time Fourier transform, Wigner distribution, Kernel design, Gabor wavelets, multi-resolution analysis.

Texts/Reference Books:

1. Proakis and Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications," 4th Ed., Pearson, 2012.
2. Cohen, "Time-frequency Analysis," Prentice-Hall, 1995.

3. Vaseghi, “Advanced digital signal processing,” 4th Ed., Wiley, 2008.
4. Vaidyanathan, “Multi-rate systems and filter banks,” Pearson, 1992.

Subject Code: EC6L017	Name: Semiconductor Device Modelling	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Semiconductor Devices

Review of semiconductor physics: Quantum foundation, Carrier scattering, high field effects; P- N junction diode modeling: Static model, Large signal model and SPICE models; BJT modeling: Ebers - Moll, Static, large-signal, small- signal models. Gummel - Poon model. Temperature and area effects. Power BJT model, SPICE models, Limitations of GP model; Advanced Bipolar models: VBIC, HICUM and MEXTARM;MOS Transistors: LEVEL 1, LEVEL 2 ,LEVEL 3, BSIM, HISIMVEKV Models, Threshold voltage modeling, Punchthrough, Carrier velocity modeling, Short channel effects, Channel-length modulation, Barrier lowering, Hot carrier effects, Mobility modeling, Model parameters; Analytical and Numerical modeling of BJT and MOS transistors; Types of models for Heterojunction Bipolar Transistors, Compact modeling concepts, Modeling of HBTs, HBT noise models, Measurement and parameter extraction.

Text Books:

1. G. Massobrio, P. Antognetti, Semiconductor Device Modeling with SPICE, 2nd edition, McGraw-Hill, New York,1993.
2. M. Rudolph, Introduction to Modeling HBTs, Artech House, Boston, 2006.

Reference Books:

1. S. M. Sze, K. K. Ng, Physics of Semiconductor Devices, 3rd edition, John Wiley, New Jersey, 2007.
2. G. A. Armstrong, C. K. Maiti, Technology Computer Aided Design for Si, SiGe and GaAs Integrated Circuits, IET Series, London, 2007.

Subject Code: CS3L005	Name: Operating Systems	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Introduction to Programming and Data Structure

Operating systems – overview and objectives; Process concept – process control block, process life cycle; multi-processing and process management, multi-threaded programming; Process scheduling – long and short time scheduling, pre-emptive and non-pre-emptive scheduling, dispatching, scheduling criteria and algorithms; Concurrent cooperating sequential processes – process synchronization, critical section, synchronization hardware, semaphores, monitors; Deadlocks – conditions for deadlock, deadlock prevention, avoidance, detection and recovery, classic problems; Memory management – partitioning, paging, segmentation, segmentation with paging; Virtual memory – demand paging, page replacement policies; I/O systems – I/O interfaces and busses, interrupt structures and interrupt handlers, Direct memory access; File systems – disk structures and disk accesses, blocking and buffering, directories and file allocation strategies, protection. RAID structures; Overview of Security and protection; Concepts of distributed and real time systems;

Examples will be drawn from existing operating systems.

Text Books

1. A. Silberschatz, P. B. Galvin and G. Gagne, “Operating System Principles,” John Wiley & Sons, 2009.
2. W. Stallings, “Operating Systems– Internals & Design Principles,” Pearson Education, 2013.

Reference Books:

1. A. S. Tenenbaum, “Modern Operating Systems,” Prentice Hall, 2009.

Subject Code: EC6L011	Name: Remote Sensing Systems	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): None

Electromagnetics basis: Electromagnetic waves, Polarization, Spectra and Fourier transform, Doppler effect, Angular distribution of radiation, Thermal radiation, diffraction, Interactions of electromagnetic radiation: Propagation through homogeneous materials, Reflection and emission from real materials, Propagation through the atmosphere Molecular absorption and scattering, Radiative transfer equation Electro optical remote sensing system: Spectral Imagery, VIR imaging systems, Thermal infrared imagers, Passive Microwave Systems: Antenna Theory, Microwave Radiometry, Ranging Systems: Laser profiling, Radar altimetry, Scattering Systems: Lidar, Microwave Scatterometry, Synthetic Aperture Radar, Data Processing: Image Processing, Classification and Segmentation, Applications of Remote Sensing Systems.

Text Books:

1. W. G. Rees, Physical Principles of Remote Sensing, Cambridge University Press; 3rd edition, 2013.

Reference Books:

1. Remote Sensing from Air And Space by R. C. Olsen, SPIE Press, 2007.
2. James B. Campbell, Randolph H. Wynne, Introduction to Remote Sensing, 5th Edition, Guilford Press, 2011.

Subject Code: EC6L013	Name: Antenna Theory	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Electromagnetic Engineering or equivalent

Introduction, Definitions, EM radiation, Friis and Radar Equations, Basic antenna elements (Dipole, Monopole, Loop), Antenna arrays (Linear and End-fire arrays) and Pattern synthesis
Complex Wire Antennas (Helical, Spiral, LPDA, Turnstile), Aperture antennas, Broadband and Ultra-wideband Antennas, Antennas in Communication Link Budgets, Introduction to Computational Methods (including Integral Equations, Method of Moments), Novel Antenna Concepts and Emerging Trends (e.g. Metamaterial Antennas, Fractal Antennas, Reconfigurable Antennas, Nano antennas).

Text Books:

1. C.A. Balanis, "*Antenna Theory Analysis and Design*," 3rd Ed., John Willey & Sons, 2005.

Reference Books:

1. R. S. Elliott, "*Antenna Theory and Design*," revised Ed., Willey-Interstice & IEEE Press, 2003.
2. W. L. Stuzman and G. A. Thiele, "*Antenna Theory and Design*," 2nd Ed., John Wiley, 1997.
3. S. Silver, "*Microwave Antenna Theory and Design*," M.I.T. Radiation Laboratory Series, 1986.

Subject Code: EC6L014	Name: Photonic Network	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Optical Communication

Introduction to photonics networks, bandwidth management, internet growth, topology, osi reference model, photonic system technologies and issues, tdm and wdm multiplexing and demultiplexing. Routing. Wavelength blocking and conversion, Photonic network topologies and architectures, modulation and demodulation techniques, modulation related effects & nonlinear optical effects, photonic components, signal amplification and regeneration, link budget, network technologies and issues, Photonic network components: multiplexer/demultiplexer, switches/routers, cross connectors-converter, Network protocols: ip, g-ethernet, sdh/sonet, fddi, atm, etc., System performance and management, dispersion management, ber & sources of noise, power budgets; optical switching & routing, network safety, regulations & standards, current issues of photonic systems.

Text / Reference Books:

1. G. Prati “Photonic Networks: Advances in Optical Communications” Springer Verlag, 1997.
2. R. Ramaswami and K.N.Sivarajan, “Optical networks: A practical perspective,” 2nd Ed., Morgan Kaufman, 2000.
3. U. Black, “Optical Networks: Third Generation Transport Systems,” Prentice Hall, 2008.
4. R. Sabella and P. Lugli, “High speed optical communications,” Kluwer, 1997.

Subject Code : EC6L028	Name: Speech Signal Processing	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Digital Signal Processing

Introduction, Physiological and Mathematical Models, Categorization of Speech Sounds; Discrete time speech signals, Fourier transform and Z-transform, convolution, filter banks. Spectral estimation, Pole-zero modeling and linear prediction (LP) analysis. Homomorphic deconvolution, cepstral analysis; Feature extraction, Static and dynamic features, robustness, feature selection. Mel frequency cepstral coefficients (MFCC), linear prediction cepstral coefficients (LPCC), Perceptual LPCC; Distance measures: Log spectral distance, cepstral distances, weighted cepstral distances, distances for linear and warped scales, Dynamic Time Warping for Isolated Word Recognition; Statistical models for speech recognition: Vector quantization model, Gaussian mixture model, Discrete and Continuous Hidden Markov modeling.

Texts/References Books:

1. Thomas F. Quatieri, "Discrete-Time Speech Signal Processing: Principles and Practice," Prentice-Hall, 2001.
2. L. Rabiner and B. Juang, "Fundamentals of Speech Recognition," Prentice-Hall, 1993.
3. B. Gold and B. Morgan, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music," Wiley 2000.

Subject Code: CS4L001	Name: Compiler Design	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Introduction to Programing and Data Structures, Formal Languages & Automat Theory

Introduction: Overview and phases of compilation; Lexical Analysis: Non-deterministic and deterministic finite automata (NFA & DFA), regular grammar, regular expressions and regular languages, design of a lexical analyser as a DFA, lexical analyser generator; Syntax Analysis: Role of a parser, context free grammars and context free languages, parse trees and derivations, ambiguous grammar; *Top Down Parsing:* Recursive descent parsing, LL(1) grammars, non-recursive predictive parsing, error reporting and recovery; *Bottom Up Parsing*: Handle pruning and shift reduces parsing, SLR parsers and construction of SLR parsing tables, LR(1) parsers and construction of LR(1) parsing tables, LALR parsers and construction of efficient LALR parsing tables, parsing using ambiguous grammars, error reporting and recovery, parser generator; Syntax Directed Translation: Syntax directed definitions (SDD), inherited and synthesized attributes, dependency graphs, evaluation orders for SDD, semantic rules, application of syntax directed translation; Symbol Table: Structure and features of symbol tables, symbol attributes and scopes; Intermediate Code Generation: DAG for expressions, three address codes - quadruples and triples, types and declarations, translation of expressions, array references, type checking and conversions, translation of Boolean expressions and control flow statements, back patching, intermediate code generation for procedures; Run Time Environment: storage organizations, static and dynamic storage allocations, stack allocation, handlings of activation records for calling sequences; Code Generations: Factors involved, registers allocation, simple code generation using stack allocation, basic blocks and flow graphs, simple code generation using flow graphs; Elements of Code Optimization: Objective, peephole optimization, elimination of local common sub-expressions, redundant and un-reachable codes, flow of control optimization.

Text Books:

1. K. D. Cooper and L. Torczon, "Engineering a Compiler," Morgan Kaufman.
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, "Compilers: Principles, Techniques and Tools," Pearson Education.

Reference Book:

1. Compiler Design in C by Holub – PHI.
2. Modern Compiler Design by Dick Grune et al – Wiley India.

Subject Code: EE6L006	**Name: Renewable and Distributed Energy Sources**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Electrical Technology or equivalent

Brief idea on renewable and distributed sources, their usefulness and advantages, Wind Energy: Estimates of wind energy potential, wind maps, instrumentation for wind velocity measurements, aerodynamic and mechanical aspects of wind machine design, conversion to electrical energy, aspects of location of wind farms, Solar Energy: Present and new technological developments in photovoltaic, estimation of solar irradiance, components of solar energy systems, solar-thermal system applications to power generation, heating, Hydel Power: Water power estimates, use of hydrographs, hydraulic turbine, characteristics and part load performance, design of wheels, draft tubes and penstocks, plant layouts, Brief idea of other sources viz., tidal, geothermal, gas-based, etc, Requirements of hybrid/combined use of different renewable and distributed sources, need of energy storage.

Texts/References Books:

1. M. J. Bollen and Fainan Hassan, "Integration of Distributed Generation in the Power System," IEEE Press, 2011.
2. L. L. Lai and T. F. Chan, "Distributed Generation: Induction and Permanent Magnet Generators," Wiley-IEEE Press, 2007.
3. C. Anderson and R. I. Howard, "Wind and Hydropower Integration: Concepts, Considerations and Case," Nova Publisher, 2012.
4. A. E. Niemi and C. M. Fincher, "Hydropower from Small and Low-Head Hydro Technologies," Nova Publisher, 2011.
5. D. Y. Goswami, F. Kreith and J. F. Kreider, "Principles of Solar Engineering." Taylor & Francis 2000.
6. G. N. Tiwari, "Solar Energy Technology," Nova Science Publishers, 2005.

Subject Code:CS6L002	**Name: Networks and Systems Security**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite(s): Introduction to Programing and Data Structures

Introduction: computer security concepts, the OSI security architecture, security attacks, security services, security mechanisms, a model for network security: Basic cryptography: historical background, transposition/substitution, caesar cipher, introduction to symmetric crypto primitives, asymmetric crypto primitives, and hash functions, block ciphers, message authentication,

symmetric-key encryption, public-key encryption, digital signatures; Secret key cryptography: applications, data encryption standard (des), encrypting large messages (ecb, cbc, ofb, cfb, ctr), multiple encryption des (ede), Public key cryptography applications, theory: Euclidean algorithm, Euler theorem, Fermat theorem, multiplicative and additive inverse, RSA, selection of public and private keys. Authentication: security handshake pitfalls, online vs. Offline password guessing, reflection attacks, per-session keys and authentication tickets, key distribution centers and certificate authorities. Real-time communication security: introduction to TCP/IP protocol stack, implementation layers for security protocols and implications, Network security applications: key distribution and user authentication , symmetric key distribution using symmetric encryption, key distribution using asymmetric encryption, certificates, public-key infrastructure, federated identity management, transport-level security, web security considerations, secure socket layer and transport layer security, transport layer security, https, secure shell (SSH), wireless network security, IEEE 802.11 wireless LAN overview, IEEE 802.11i wireless LAN security, wireless application protocol overview, wireless transport layer security, WAP end-to-end security, Electronic mail security: distribution lists, establishing keys, privacy, source authentication, message integrity, non-repudiation, proof of submission, proof of delivery, message flow confidentiality, anonymity, pretty good privacy (PGP), Firewalls and web security: packet filters, application level gateways, encrypted tunnels, cookies, web security problems.

Text Books:

1. William Stallings, "Network Security Essentials Applications and Standards" 5th Ed., Prentice Hall, 1997.
2. Kaufman, Perlman and Speciner, "Network Security: Private Communication in a Public World," 2nd Ed., Prentice Hall, 2002.

Reference Books:

1. W. Richard Stevens,"TCP/IP Illustrated, Vol. 1: The Protocols," US Edition,Addison-Wesley Professional Computing Series, 1993.
2. ERIC Cole, "Network Security Bible," Willey, 2013.
3. J. M. Kizza "Computer Network Security", 1998.

Subject Code: EC6L029	**Name: Natural Language Processing**	**L-T-P: 3-0-0**	**Credits:3**

Pre-requisite(s): Introduction to Programing and Data Structures, Formal Languages & Automat Theory

Introduction to Natural Language Processing, Finite-state automata and transducers Computational morphology, N-gram language models; smoothing; interpolation; backoff Part-of-speech tagging, Syntactic parsing: rule-based parsing; CYK algorithm; Earley's algorithm, Computational semantics and lexical semantics, Computational lexicons: WordNet Word Sense Disambiguation and Induction, Roles and frames: FrameNet, Semantic Role Labeling, Discourse and dialogue, Statistical Machine Translation.

Text Books:

1. Jurafsky and Martin, "Speech and Language Processing", Prentice Hall, 2009.

2. Manning and Schűtze, “Foundations of Statistical Natural Language Processing,” MIT Press, 1999.
3. Larry Wall, Tom Christiansen and Jon Orwant, “Programming Perl,” O'Reilly, 1996.

Subject Code: EC6L022	Name: Modern Radar Systems	L-T-P: 3-0-0	Credits:3

Pre-requisite(s): Communication Engineering

Introduction, Radar Basics, Radar Equation including its search and track forms, Displays, Receivers, Transmitters, Radar Antennas including Reflectors and Phased Array Antennas, Radar Cross Section, Statistical Models for Noise and Target RCS, General Characteristics of Clutter and Clutter Modeling, Clutter Reduction Techniques of Doppler and MTI, Pulse compression, Radar Measurements, Radar Tracking, Radar Detection and Target Classification, Constant False Alarm Rate Detectors, DPCA and STAP, Types of Radar and Emerging Trends.

Text Books:

1. M.A. Richards et al, Principles of Modern Radar, Basic Principles Vol. 1, 1st Ed.,, SciTech 2010.

Reference Books:

1. Skolnik, “Introduction to Radar Systems,” 3rd Ed., Tata McGraw Hill, 2008.
2. H. Meikle, “Modern Radar Systems,” 2nd Ed., ARTECH House, 2005.

Subject Code: EC6L026	Name: Computer Network	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Introduction to Programing and Data Structures, Communication Engineering

Overview of OSI reference model. Topology design, Media Access Control Level, Services, Problems and protocols, Practical local area network design and implementation. IEEE LAN Standards, Logical Link Control protocols, HDLC, ALOHA, SLOTTED ALOHA, FDDI, Client Server model and related softwares, Network Layer level services, problems and protocols. AN, MAN, interconnection networks related softwares, TCP/IP, Novel NetWare, Routers, Bridges and Gateways their Practical implementation aspects. X.25, Internet and related softwares NETSCAPE and MOSAIC. Transport layer, services, problems and their protocol, Brief functioning of upper layers, E-mail and other application.

Texts/ Reference Books:

1. B. A. Forouzan, “Data Communications and Networking,” 4th Ed., Tata McGraw-Hill Education.
2. A. S. Tanenbaum, “Computer Networks,” 4th Ed., Pearson education.

Subject Code: EC6L018	Name: Satellite Communication	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Electromagnetic Engineering, Communication Engineering

Introduction, general overview, types of satellite communications systems, historical developments, Link budgets: antennas, propagation, noise, c0/n0, c/n calculation, transmitters, propagation and rain, receivers, lnas, figure of merit, total system performance; Orbital mechanics: basic equations, special orbits, geometry and movement , constellations, real world effects; Rf and licensing issues : spectrum allocations, modulation, multiplexing, multiple access
Current and future trends; Spectrum sharing, additional noise issues, interference and coordination, telemetry and tracking, power limitations, reliability.

Text/Reference Books:

1. T. Pratt, C. Bostian and J. Allnutt, "*Satellite Communications," 2nd Edition*, Wiley India, 2006.
2. W. L. Pritchart, H. G. Suyderhoud and R. A. Nelson, "*Satellite Communication Systems Engineering," 2nd Edition*, Pearson Education, 2012.
3. G. Gordon and W. Morgan, "*Principles of Communications Satellites*,"
4. D. I. Dalgleish "*An Introduction to Satellite Communications*," IET Publisher, ISBN: 0863411320, 9780863411328
5. D. Roddy, " *Satellite Communication*," Tata McGraw-Hill Education.

Subject Code: EC6L025	Name: Multimedia Network	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Digital Communication or equivalent

Introduction: multimedia information representation – text, images, audio, video, digital coding techniques and standards, audio coding, image coding, video coding; Multimedia compression and resiliency, codecs, adaptive coding, error handling techniques, multimedia network services and applications; Wireless broadband, broadcast TV and video streaming, QOS, media transport protocols, session initiation protocol (sip), real-time streaming protocol (RTSP), real-time transport protocol (RTP), session description protocol (SDP), media transport - security issues/techniques and compression; Firewalls, NATS, IPSEC and secure RTP, header compression, next-generation multimedia network architecture standards: multiservice switching forum architecture.

Text/Reference Books:

1. Perkins, "RTP: Audio and Video for the Internet," Addison-Wesley, 2003.
2. Hwang, "Multimedia Networking: From Theory to Practice," Cambridge, 2005.
3. F. Halsall, Multimedia Communications Applications, Networks, Protocols and Standards, Addison Wesley, 2001.
4. K.R. Rao and Z.S. Bojkovic, "Packet Video Communications over ATM Networks," Prentice Hall, 2000.
5. C. -H. Wu and J.D. Irwin, "Emerging Multimedia Computer Communication Technologies," Prentice Hall, 1998.

Subject Code: EC6L020	Name: Wireless and Mobile Communication	L-T-P: 3-0-0	Credits: 3

Pre-requisite(s): Digital Communication or equivalent

Review of Digital Communication: Block diagram of digital communication, Modulation Schemes (BPSK, M-PSK, M-QAM, M-FSK), Pulse Shaping, Bandwidth efficiency, MAP-Receivers, AWGN Channel and Performance analysis; Wireless Channels: Fading Wireless Channel Modeling , Rayleigh/Ricean Fading Channels ,BER Performance in Fading Channels , Diversity modeling for Wireless Communications, BER Performance Improvement with diversity, RMS Delay Spread , Doppler Fading, Jakes Model, Jakes Spectrum , Impact of Doppler Fading, Types of Diversity – Frequency, Time, Space; Cellular Communications: Introduction to Cellular Communications, Frequency reuse, Multiple Access Technologies, Cellular Processes - Call Setup, Handover, Introduction to CDMA ,Walsh codes, PN Sequences , Multipath diversity, RAKE Receiver; MIMO/OFDM: Introduction to MIMO, MIMO Channel Capacity, SVD and Eigenmodes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity – Alamouti, OSTBC, Introduction to OFDM , Multicarrier Modulation and Cyclic Prefix, OFDM Issues; Wireless Standards: GSM, GPRS, WCDMA, LTE, WiMAX.

Texts/References Books:

1. D. Tse and P. Viswanath, “Fundamentals of Wireless Communications,” Cambridge University Press, 2005.
2. A. Goldsmith, “Wireless Communications,” Cambridge University Press, 2005.
3. T. S. Rappaport, “Wireless Communications: *Principles and Practice*,” 2nd Ed., Prentice Hall.

Subject Code: EC3L007	Name: Microprocessor and Microcontrollers	L-T-P: 3-1-0	Credits: 4

Pre-requisite(s): None

Historical background; organization and architectural features of microprocessor and microcontrollers; the instruction set: instruction format, addressing modes; assembly language programming of 8085 and 8051; interfacing of memory devices; data transfer techniques and I/O ports; interfacing of keyboard and display devices; programmable interrupt and DMA controllers; interfacing of sensors, transducers, actuators, A/D and D/A Converters, analog signal conditioning circuits, data acquisition systems; standard interfaces - RS232, USB; development aids and troubleshooting techniques; Microprocessor Programming: Modular programming; Structured programming. Embedded C programming; Exception handling and programming: types of exception; exception vector table; stacks and its role in exception processing; Interrupts and Interrupt service routines; Interrupt priority. Basic I/O and I/O Programming: I/O organization and structure, I/O ports and their configuration; serial interface; Polling techniques; interrupt-driven I/O; ARM Processor Fundamentals: Basic features and comparison of ARM, PIC, AVR, Arduino, Raspberry Pie microcontrollers, ARM architecture, I/O pins, Ports, timers, interrupts, memory organization, pipelining and Hazards, ARM processor families, ARM instruction set, addressing modes, assembly language programming of ARM; Advanced Microprocessor Features: protected mode, real address mode, system management mode, memory models and management, paging and virtual memories, support for multitasking operating systems: privilege levels and protection, input-output architecture.

Text Books:

1. R. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, 6th Edition, Penram Intl. Publishing (India) Pvt. Ltd., 2013
2. K. J. Ayala, The 8051 Microcontroller Architecture, Programming and Applications, Penram Intl. Publishing (India) Pvt.Ltd., 2007.

Reference Books:

1. M. A. Mazidi, Microcontroller and Embedded Systems, Pearson Education, 2008.
2. R. Kapadia, "8051 Microcontroller and Embedded Systems," Jaico Publishing House, 1st Ed., 2004.
3. Steve Furber, "ARM System –On –Chip architecture," Addision Wesley, 2000.
4. Daniel Tabak, "Advanced Microprocessors," Mc Graw Hill. Inc., 1995
5. James L. Antonakos, "The Pentium Microprocessor," Pearson Education, 1997.
6. John .B. Peatman, "Design with PIC Microcontroller," Prentice Hall, 1997.

Subject Code: EC4L009	**Name: Information Theory and Coding**	**L-T-P: 3-0-0**	**Credits: 3**

Pre-requisite: Digital Communication

Introduction: Entropy and mutual information theory: joint entropy, conditional entropy, relationship between entropy and mutual information, chain rules for entropy, relative entropy, mutual information, jensen's inequality fano's inequality; An introduction to codes: coding: kraft inequality, optimal codes, bounds on optimal code length, kraft inequality for uniquely decodable codes, shannon and huffman codes, shannon, fano, elias codes, block codes, linear block codes, cyclic codes; Efficient encoding, information sources; average code word length; huffman encoding; noiseless coding: the noiseless coding theorem; Channel capacity: discrete memoryless channels and capacity, examples of channel capacity, symmetric channels, properties of channel capacity, channel coding theorem; Theory and practice of error-control coding: trellis diagram and the viterbi algorithm, convolution coding in mobile communications and modern graph-based codes (turbo-codes and ldpc codes), the main coding theory problem.

Text Books:

1. T. M. Cover and J. A. Thomas, "Elements of Information Theory," 2nd Ed., Wiley-Inter Science, 2006.
2. S. Lin and D. J. Costello, "Error Control Coding," 2nd Ed., Pearson Prentice Hall, 2004.

Reference Books:

1. R. G. Gallager, "Information Theory and Reliable Communication," Wiley, 1968.
2. I Csiszar and J. Korner, "Information Theory: Coding Theorems for Discrete Memoryless Systems," Akademiai Kiado, December 1981.
3. T. S. Han, "Information-Spectrum Methods in Information Theory," Springer, 2002.
4. Andre Neubauer, Jurgen Freedenberg, Volker Kuhn, "Coding theory Algorithm, Architectures and Applications," Willey India Editions, 2007.
5. Ranjan Bose, "Information theory, Coding and Cryptography," TMH publication, 2008.
6. Roman, Steven, "Introduction to Coding and Information Theory", Springer, 2000.

Laboratory Courses

Subject Code: EC2P001	Name: Introduction to Electronics Lab	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Introduction to Electronics

Familiarization with electronic components; Familiarization and usage with oscilloscope, signal generator, multimeter; Frequency-response of R-C, C-R and R-L networks; Square-wave testing, V-I characteristics of PN junction diode and zener diode; Voltage Rectifiers; Common-Emitter amplifiers; Analog circuits using OP-AMP; logic gates.

Text Books:

- S. Sedra, K. C. Smith, "Microelectronic Circuits," Oxford University Press, India, 2005.
- A Malvino, D J Bates; "Electronic Principles," Tata McGraw Hill, India, 2007.

Reference Books:

- R C Jaeger, T N Blalock, "Microelectronic Circuit Design," Tata McGraw Hill, India, 2006.

Subject Code: EC2P002	Subject Name: Signals and Systems Laboratory	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Signals and Systems

Basic MATLAB Programming: Manipulation of Vectors, Arrays and Matrices, Arithmetic Operations, Logical Operations, Loops, M-files & Functions, Mathematical Functions; Graphics and 3-D Visualization: Plotting of One-dimensional and Two-dimensional Signals, Plotting Symbolic Functions, 3-D Plotting; Mathematical Functions: Finding Roots of Polynomials, Computing Integration and Differentiation, Solving Differential and Difference Equations, Polynomial Curve Fitting, Recording, Storing, Reading, and M-File; Functions: Recording and Playing Signals, Storing and Reading Data in Different Formats, Creating M-Functions for Generating Different Elementary Signals, Creating M-Functions for Computing Different Statistical Parameters; Analysis of Systems: Finding Convolution, Finding Laplace and Inverse Laplace Transforms, Finding Z-and Inverse-Z Transforms, Zero-Pole Analysis; Analysis of Signals and Systems: Sampling of Signals, Fourier Series of Signals, Finding Magnitude and Phase Spectrum of Signals, Frequency Response of System; Convolution and Filtering, Creating GUI in MATLAB, MATLAB Simulink Modelling.

Texts/References:

- A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and Systems," 2nd Ed., Pearson Prentice Hall, 2008.
- S. Haykin and B. V. Veen, "Signals and Systems," 2nd Ed., Wiley India, 2007.
- H. P. Hsu, "Signals and Systems – Schaum's Outline Series," McGraw Hill, 1995.

Subject Code: EC2P004	Name: Digital Electronics Circuits Laboratory	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Digital Electronic Circuit

Truth tables of Logic gates; Half Adder and Full Adder; Multiplexer and De-multiplexer; Comparators; Encoders; Schmitt Trigger; Multivibrators: Astable, Monostable and Bi-stable; Flip Flops: S-R, J-K and D; Asynchronous and Synchronous Counters: Up-Down, Ripple counter, Ring counter;

Text Books:

1. S. Lee, “Digital Circuits and Logic Design” Prentice Hall India, 2008.
2. D. P. Leach, A. P. Malvino and G. Saha, “Digital Principles and Applications,” Tata McGraw Hill, 2005.
3. M. Morris Mano, “Digital Logic and Computer Design,” Prentice Hall, 2006.

Reference Book:

1. Z. Kohavi and N. K. Jha, “Switching and Finite Automata Theory,” Tata McGraw Hill, 2004.

Subject: EC2P005	Name: Analog Communication Lab	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s):

Carrier modulation and Demodulation; AM: DSB, SSB, Envelope detector, mixer; FM: Modulation and demodulation; Superheterodyne receiver; Sampling, Pulse amplitude modulation, pulse width modulation, pulse position modulation.

Text Book:

1. S. Haykin, "Communication Systems", 4th Ed., John Wiley and Sons, 2006.

Subject: EC3P003	Name: Digital Communication Lab	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Digital Communication

Delta modulation and demodulations; PAM, PPM and PWM modulation and demodulation; Frequency division multiplexing (FDM) and Time division multiplexing (FSM), PSK, FSK modulations.

Text Books:

1. M. Salehi, J. G. Proakis, "Fundamentals of Communication Systems", 1st Ed., Prearson Education, 2006.
2. S. Haykin, "Communication Systems", 4th Ed., John Wiley and Sons, 2006.

Reference Books:

1. P. Lathi, Zhi Ding, "Modern Digital and Analog Communication Systems", 4th Ed., Oxford University Press, 2009.
2. Roddy, J. Coolen, "Electronic Communications", 4th Ed., Pearson Education, 2008.

Subject Code: EC3P004	Name: Microprocessor and Microcontrollers Lab	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Microprocessor and Microcontrollers

Familiarization with 8/16 bit microprocessors/microcontroller kits and interfaces; Experiments related to interfacing ADC, DAC, Motors, Timers, Serial and Parallel ports; Assembly and machine language programming, signal generators, interfacing basic I/O devices like keypad, LED display, usage of timers and USART peripherals, multi-port device access, stepper motor movement control, DC motor speed control, bootstrap programming and interfacing various peripherals for embedded applications; building a complete microcontroller-based system; ARM Processor Programming Experiments; Embedded C Language Programming Experiments.

Texts/ Reference Books:

1. R. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, 6th Edition, Penram Intl. Publishing (India) Pvt. Ltd., 2013
2. K. J. Ayala, The 8051 Microcontroller Architecture, Programming and Applications, Penram Intl. Publishing (India) Pvt.Ltd., 2007.

Subject Code: EC3P002	Name: Digital Signal Processing Laboratory	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Digital Signal Processing

Fourier transform; Z-transform; Discrete Fourier transform (DFT); Fast Fourier transform (FFT); Infinite impulse response (IIR) and Finite impulse response (FIR) filter designs.

Texts/Reference Books:

1. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications, 4th Ed., Pearson, 2012.
2. A. V. Oppenheim and R. W. Shafer, "Discrete-Time Signal Processing," Prentice Hall, 2009.
3. R. G. Lyons, "Understanding Digital Signal Processing," 3rd Ed., Prentice Hall, 2010.
4. V. K. Ingle and J. G. Proakis, "Digital Signal Processing using MATLAB," Thomson Learning, 2000.

Subject Code: EE3P003	Name: Control Systems Lab	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Control Systems

Transfer function evaluation of a DC motor; Study of an AC servomotor; Study of digital control systems; DC servo motor position control; Closed loop speed control of DC motor; Study of temperature control systems; Feedback control of magnetic levitation system; PID stabilization of an inverted cart-pendulum system; Study of coupled tank system; PID stabilization of a twin rotor MIMO system; PID control of two link flexible manipulator.

Texts/Reference Books:

1. B. C. Kuo, 'Automatic Control Systems', Wiley, 2003
2. K. Ogata, Modern Control Engineering, Prentice Hall, 1997

3. R. C. Dorf and R. H. Bishop, 'Modern Control Systems', Pearson Education, Inc, 2008.
4. W. A. Wolovich, 'Automatic Control Systems', Saunders College, 1994
5. R. T. Stefani, 'Design of Feedback Control Systems', Oxford University Press, 2002.

Subject Code: EC3P004	Name: VLSI Laboratory	L-T-P: 0-0-3	Credits:2

Pre-requisite(s): VLSI Design

Analog circuits simulation using SPICE; Simple analog and digital circuits, mixed signal simulation using mixed signal simulators; Layout extraction for analog & mixed signal circuits; Parasitic values estimation from Layout; Net list extraction; Design and simulate operational amplifier performance parameters; Design of various routing - local routing, area routing, channel routing and global routing; Design and simulation of gate-level modeling; Design and implement reducing power consumption in memories, Design of NMOS and CMOS inverters -DC and transient characteristics and switching times, Estimation of resistance, capacitance and inductance, Design of multiplexers, decoders and comparators, Design of designing digital filters using FPGA.

Text/Reference Books:

1. S. Kang and Y Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design," 3rd Ed., Tata McGraw Hill, New Delhi, 2003.
2. J. P. Uyemura, "Introduction to VLSI circuits and Systems," John Wiley, New Delhi, 2002.

Subject Code: EC4P001	Name: Electronic System Design Laboratory	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): Digital Electronic Circuits

The objective of the electronic system design (ESD) laboratory is to pursue industrially relevant research in innovative design of electrical and electronic system technologies and assembling in PCB for signal, image and video processing, communication and wireless sensors, power generation and distribution, energy and health monitoring applications. The design of electrical and electronic systems includes: audio amplifier, AC/DC voltage regulator, inverter, data acquisition system, process control timer, communication systems, wireless Transceiver, microcontroller based system, DSP based system, digital system, and PCB layout design.

Texts/Reference Book:

1. S. Sedra and K. C. Smith, "Microelectronic Circuits," Oxford University Press, India, 2005.
2. A. Malvino and D. J. Bates; "Electronic Principles," Tata McGraw Hill, India, 2007.

Subject Code: EC4P003	Name: RF and Microwave Laboratory	L-T-P: 0-0-3	Credits: 2

Pre-requisite(s): RF and Microwave Engineering

I:Basic microwave measurement techniques for power, frequency, wavelength, standing wave ratio, impedance, S parameters and noise

1. Measurement of frequency and wavelength using frequency meter
2. Measurement of SWR and impedance using slotted line
3. Measurement of S parameters using Vector Network Analyzer
4. Measurement of power using Gunn Diode
5. Measurement of noise

II. Characterization of some basic microwave components.

1. Stub Tuner - $\lambda/4$ transformer (impedance matching and tuning)
2. Klystron tube (microwave generation and tuning)

3. Cavity Resonators (resonant frequency)
4. Directional Couplers (insertion loss, directivity)
5. Dipole Antenna (radiation pattern and gain)

Text Books:

1. David M. Pozar, 'Microwave Engineering,' 3rd. Ed., John Wiley & Sons, 2005.

Reference Books:

1. Guillermo Gonzalez, Microwave Transistor Amplifiers, 2nd. ed., Prentice-Hall, 1997.

2. Thomas H. Lee, Planar Microwave Engineering: A Practical Guide to Theory, Measurement, and Circuits, 1st Edition, Cambridge University Press, 2004.