First Semester

Group A

S.NO.	COURSE CODE	COURSE TITLE	L	T	P	CREDITS	CONTACT HOURS
1.	MA-101	Mathematics-I	3	1	0	**4**	4
2.	PH-101	Physics	3	1	0	**4**	4
3.	IC/EC-101	Electrical Sciences	3	1	0	**4**	4
4.	CS-101	Computer Programming	2	0	0	**2**	2
5.	BT-101	Introduction to Bio Sciences	3	0	0	**3**	3
6.	HM-101	Psychology of Human Behaviour	2	0	0	**2**	2
7.	PH-102	Physics Lab	0	0	2	**1**	2
8.	ME-101	Engineering Graphics	1	0	4	**3**	5
9.	IC/EC-102	Electrical Science Lab	0	0	2	**1**	2
10.	CS-102	Computer Programming Lab	0	0	2	**1**	2
		TOTAL	**17**	**03**	**10**	**25**	**30**

Group B

S.NO.	COURSE CODE	COURSE TITLE	L	T	P	CREDITS	CONTACT HOURS
1.	MA-101	Mathematics-I	3	1	0	**4**	4
2.	CH-101	Chemistry	3	1	0	**4**	4
3.	ME-102	Elements of Mechanical Engineering	3	1	0	**4**	4
4.	HM-102	English Communication	3	0	0	**3**	3
5.	CE-101	Environmental Science and Technology	2	0	0	**2**	2
6.	HM-103	Introduction to Management	2	0	0	**2**	2
7.	IN-101	Manufacturing Process	1	0	4	**3**	5
8.	ME-103	Mechanical Engineering Lab	0	0	2	**1**	2
9.	HM-104	English Communication Lab	0	0	2	**1**	2
10.	CH-102	Chemistry Lab	0	0	2	**1**	2
		TOTAL	**17**	**03**	**10**	**25**	**30**

Second Semester

Group A

S.NO.	COURSE CODE	COURSE TITLE	L	T	P	CREDITS	CONTACT HOURS
1.	MA-102	Mathematics-II	3	1	0	**4**	4
2.	CH-101	Chemistry	3	1	0	**4**	4
3.	ME-102	Elements of Mechanical Engineering	3	1	0	**4**	4
4.	HM-102	English Communication	3	0	0	**3**	3
5.	CE-101	Environmental Science and Technology	2	0	0	**2**	2
6.	HM-103	Introduction to Management	2	0	0	**2**	2
7.	IN-101	Manufacturing Process	1	0	4	**3**	5
8.	ME-103	Mechanical Engineering Lab	0	0	2	**1**	2
9.	HM-104	English Communication Lab	0	0	2	**1**	2
10.	CH-102	Chemistry Lab	0	0	2	**1**	2
		TOTAL	**17**	**03**	**10**	**25**	**30**

Group B

S.NO.	COURSE CODE	COURSE TITLE	L	T	P	CREDITS	CONTACT HOURS
1.	MA-102	Mathematics-II	3	1	0	**4**	4
2.	PH-101	Physics	3	1	0	**4**	4
3.	IC/EC-101	Electrical Sciences	3	1	0	**4**	4
4.	CS-101	Computer Programming	2	0	0	**2**	2
5.	BT-101	Introduction to Bio Sciences	3	0	0	**3**	3
6.	HM-101	Psychology of Human Behaviour	2	0	0	**2**	2
7.	PH-102	Physics Lab	0	0	2	**1**	2
8.	ME-101	Engineering Graphics	1	0	4	**3**	5
9.	IC/EC-102	Electrical Science Lab	0	0	2	**1**	2
10.	CS-102	Computer Programming Lab	0	0	2	**1**	2
		TOTAL	**17**	**03**	**10**	**25**	**30**

Third Semester

Sr No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Pre-requisite	Category
1.	EC-201	Analysis and Synthesis of Networks	3	1	0	**4**	4	-	DC
2.	EC-203	Electronic Devices and Circuits	3	1	0	**4**	4	EC/IC-101 Electrical Science	DC
3.	EC-205	Digital Electronics	3	1	0	**4**	4	EC/IC-101 Electrical Science	DC
4.	EC-207	Communication Signals and Systems	3	1	0	**4**	4		DC
5.	CS-207	Object Oriented Programming	3	0	0	**3**	3		ID/ESA
6.	PH-206	Material Science (Nano Science)	3	0	0	**3**	3		ID/BS
7.	EC-211	Analysis and Synthesis of Networks Lab	0	0	2	**1**	2		DC-Lab
8.	EC-213	Electronic Devices and Circuits Lab	0	0	2	**1**	2		DC-Lab
9.	EC-215	Digital Electronics Lab	0	0	2	**1**	2		DC-Lab
10.	CS-217	Object Oriented Programming Lab	0	0	2	**1**	2		ID-Lab/ESA
		TOTAL	**18**	**04**	**8**	**26**	**30**		

Fourth Semester

Sr No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Pre-requisite	Category
1.	EC-202	Analog Communication Systems	3	1	0	**4**	4	-	DC
2.	EC-204	Analog Integrated Circuits	3	1	0	**4**	4	EC-203	DC
3.	CS-206	Data Structure and Algorithms	2	0	0	**2**	2		ID/ESA
4.	IC-232	Electronic Measurements and Instrumentation	3	0	0	**3**	3		ID/ESA
5.	MA-202	Numerical Methods	3	1	0	**4**	4		ID/BS
6.	PH-207	Electromagnetic Field Theory	3	1	0	**4**	4		ID/BS
7.	EC-212	Analog Communication Systems Lab	0	0	2	**1**	2		DC-Lab
8.	EC-214	Analog Integrated Circuits Lab	0	0	2	**1**	2		DC-Lab
9.	CS-216	Data Structures and Algorithms Lab	0	0	2	**1**	2		ID/ESA
10.	IC-252	Electronic Measurements and Instrumentation Lab	0	0	2	**1**	2		ID-Lab/ESA
		TOTAL	**17**	**04**	**8**	**25**	**29**		

Fifth Semester

Sr No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Pre-requisite	Category
1.	EC-301	Microprocessor and Its Applications	3	1	0	**4**	4	EC-205	DC
2.	EC-303	VLSI Circuit Design	3	1	0	**4**	4	EC-203	DC
3.	EC-3XX	Departmental Elective-I	3	0	0	**3**	3		DE
4.	ID-3XX	Open Elective-I	3	0	0	**3**	3		OE
5.	IC-305	Control Engineering	3	0	0	**3**	3		ID
6.	CS-305	Operating Systems	3	0	0	**3**	3		ID
7.	EC-311	Microprocessor and Its Applications Lab	0	0	2	**1**	2		DC-Lab
8.	EC-313	VLSI Circuit Design Lab	0	0	2	**1**	2		DC-Lab
		TOTAL	**18**	**02**	**04**	**22**	**24**		

Sixth Semester

Sr No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Pre-requisite	Category
1.	EC-304	Digital Communication Systems	3	1	0	**4**	4	EC-202	DC
2.	EC-306	Digital Signal Processing	3	1	0	**4**	4		DC
3.	EC-3XX	Departmental Elective-II	3	0	0	**3**	3		DE
4.	EC-3XX	Departmental Elective-III	3	0	0	**3**	3		DE
5.	EC-3XX	Departmental Elective-IV	3	0	0	**3**	3		DE
6.	*ID/ HM-3XX	Open Elective-II	3	0	0	**3**	3		ID
7.	EC-314	Digital Communication Systems Lab	0	0	2	**1**	2		DC-Lab
8.	EC-316	Digital Signal Processing Lab *(Audit Course)*	0	0	2	**0**	2		DC-Lab
		TOTAL	**18**	**02**	**02**	**21**	**22**		

**This elective is to be chosen from the list of ID courses offered by Department of Humanities and Management*

Seventh Semester

Sr No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Pre-requisite	Category
1.	EC-401	Microwave Engineering	3	1	0	**4**	4	EC-203	DC
2.	EC-403	Microelectronics	3	1	0	**4**	4	EC-203	DC
3.	EC-4XX	Departmental Elective-V	3	0	0	**3**	3		DE
4.	EC-4XX	Departmental Elective-VI	3	0	0	**3**	3		DE
5.	EC-4XX	Departmental Elective-VII	3	0	0	**3**	3		DE
6.	ID-4XX	Open Elective-III	3	0	0	**3**	3		ID
7.	EC-411	Microwave Engineering Lab	0	0	2	**1**	2		DC-Lab
8.	EC-300	Industrial Practical Training	-	-	-	**4**			
9.	EC-400	Project (Phase-I)	-	-	-	**2**	4		
		TOTAL	**18**	**02**	**6**	**27**	**26**		

Eighth Semester

Sr No.	Course Code	Course Title	L	T	P	Credits	Contact Hours	Pre-requisite	Category
1.	EC-4XX	Departmental Elective-VIII	3	0	0	**3**	3		DE
2.	EC-4XX	Departmental Elective-IX	3	0	0	**3**	3		DE
3.	EC-4XX	Departmental Elective-X	3	0	0	**3**	3		DE
4.	EC-4XX	Departmental Elective-XI	3	0	0	**3**	3		DE
5.	ID-4XX	Open Elective-IV	3	0	0	**3**	3		ID
6.	EC-400	Project (Phase-II)	-	-	-	**4**	4		
		TOTAL	**15**	**02**	**04**	**19**	**19**		

List of Departmental Electives (for Batch 2007 onwards)

Sr No.	Course Code	Course Title	L-T-P-C
Fifth (5th) Semester			
1.	EC-351	Fiber Optics	3-0-0-3
2.	EC-353	Pulse and Switching waveforms	3-0-0-3
3.	EC-355	Biomedical Instrumentation	3-0-0-3
4.	EC-357	Reliability Engineering	3-0-0-3
5.	EC-359	Power Electronics	3-0-0-3
6.	EC-361	Digital Systems Design	3-0-0-3
Sixth (6th) Semester			
7.	EC-352	Information Theory & Coding	3-0-0-3
8.	EC-354	Embedded Systems	3-0-0-3
9.	EC-356	Microcontrollers	2-0-2-3
10.	EC-358	Computer Organisation and Architecture	3-0-0-3
11.	EC-360	ASIC and FPGA	3-0-0-3
12.	EC-362	Radar & TV Engineering	3-0-0-3
13.	EC-364	Optoelectronic Devices	3-0-0-3
Seventh (7th)Semester			
14.	EC-451	Biomedical Signal Processing	3-0-0-3
15.	EC-453	Image Processing	3-0-0-3
16.	EC-455	Satellite Communication	3-0-0-3
17.	EC-457	Genetic Algorithms and Applications	3-0-0-3
18.	EC-459	Wireless Communication	3-0-0-3
19.	EC-461	Computer Communication Networks	3-0-0-3
20.	EC-463	Digital Signal Processors	3-0-0-3
21.	EC-465	Digital Integrated Circuits	3-0-0-3
22.	EC-467	VLSI Testing	3-0-0-3
Eighth (8th)Semester			
23.	EC-452	Antenna and Wave Propagation	3-0-0-3
24.	EC-454	Neural Networks & Fuzzy Logic	3-0-0-3
25.	EC-456	Wavelet Theory and Applications	3-0-0-3
26.	EC-458	Photonic Systems and Networks	3-0-0-3
27.	EC-460	Wireless Sensor Networks	3-0-0-3
28.	EC-462	Advanced Communication Systems	3-0-0-3
29.	EC-464	Mobile Computing	3-0-0-3
30.	EC-466	Optical Communication Systems and Networks	3-0-0-3
31.	EC-468	Telecommunication-Switching and Networks	3-0-0-3
32.	EC-470	Mixed Signal IC Design	3-0-0-3
33.	EC-472	Low Power Design	3-0-0-3
34.	EC-474	Digital IC Design	3-0-0-3
35.	EC-476	Analog IC Design	3-0-0-3
36.	EC-478	MEMS	3-0-0-3
37.	EC-480	RF Circuit Design	3-0-0-3
38.	EC-482	DSP applied to VLSI Design	3-0-0-3
39.	EC-484	Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC)	3-0-0-3
40.	EC-486	Sensor Technology	3-0-0-3

Detailed Syllabus

Third Semester

EC-201 Analysis and Synthesis of Networks [3 1 0 4]

Circuit Concepts: Review of circuit concepts, DC Resistive Circuits and Network Theorems: Kirchoff's voltage law, Kirchoff's current law, Voltage division and current division, Series parallel Network reduction, Loop and Mesh currents, Matrices and Mesh currents, Determinants and mesh current Input résistance, Node voltage method. (9)

Network Theorms: Superposition theorem and its application, Thevenin's and Norton's theorem and its application, Maximum power transfer theorem, Tellegen's theorem, Millman's theorem, Substitution theorem, Compensation theorem. (8)

Network Graph Theory: Concept of a network graph terminology used in network graph relation between twigs and links, Properties of a tree in a graph, Formation of incidence matrix, No. of trees in a graph, Cut set matrix and tie set matrix. (5)

Laplace Transformation: Introduction, The Laplace transformation, Some basic theorems for the Laplace transformation, Partial fraction expansions, Initial and final value theorem, Heaviside's expansion theorem. (3)

Network Synthesis: Network functions, Impedance & Admittance function, Transfer functions, Relationship between transfer and impulse response, poles and zeros and restrictions, Network function for two terminal pair network. Sinusoidal network in terms of poles & zeros. Real liability condition for impedance synthesis of RL & RC circuits. Network synthesis techniques for 2-terminal network, Foster and Cauer forms. (10)

Filters Synthesis: Classification of filters, characteristics impedance and propagation constant of pure reactive network, Ladder network, T section, IT section, terminating half section. Pass bands and stop bands. Design of constant-K, m-derived filters. Composite filters. (5)

Books Recommended

1. Van-Valkenberg M E "*Network Analysis*", PHI, New Delhi, Third Edition (1999)
2. Van-Valkenberg M E, "*Introduction to Modern Network Synthesis*", John Wiley & Sons (1999)
3. Nahvi M, Edminister J, "*Scaum's Outline of Electric Circuits (Theory and Problems)*", TMH Publication, Fourth Edition, (2002)
4. Balabanian N, Bickert Theodare A, "*Linear Network Theory: Analysis, Properties, Design and Synthesis*", Matrix Publishers, First edition (1985)
5. DeCalro R A, Lin P M, "*Linear Circuit Analysis*", 2nd Ed. Oxford University Press, Indian Edition (2004).

EC-203 Electronic Devices and Circuits [3 1 0 4]

Semiconductor Diodes: PN junction Diode - VI characteristics, qualitative and quantitative analysis of its behavior, Diode resiatance, Transition capacitance and Diffusion capacitance, diode applications: Rectifiers-half wave and full wave, clippers, clampers, clamping circuit theorem, Voltage multipliers, Special purpose diodes - Zener diode, Tunnel diode, Varactor diode, p-i-n diode, Schottky barrier diode. (7)

Bipolar Junction Transistor: Transistor current components, Transistor as an amplifier, Amplifier types-CE, CB, CC and their characteristics, small signal low frequency transistor model: Hybrid model of BJT, Analysis of amplifier using Hybrid model of BJT, Transistor at high frequency and hybrid pi-model, introduction to HBT. (7)

Transistor Biasing and Stabilization: DC operating point, DC Biasing circuits-fixed bias, emitter bias, voltage divider bias, voltage feedback, Bias stability, Stabilization against variation in I_{co}, V_{BE} and β, Bias compensation. (7)

Field-Effect Transistor: The junction FET - construction, operation, characteristics, parameters, Biasing of JFET, Small signal analysis of JFET as an amplifier- common source and common drain amplifiers, MOSFET- construction, operation, characteristics, parameters, MOSFET as an amplifier, equivalent circuits, Biasing, Introduction to MESFET and CMOS devices. (7)

Power Amplifiers: Analysis of Class A, B, C, AB amplifiers, harmonic distortion, Push-pull amplifiers, Power BJTs. (5)

Multistage and Feedback Amplifiers: Amplifier frequency response-low frequency range and high frequency, Frequency response of multistage amplifiers, various coupling methods for multistage amplifiers, Feedback concept, Analysis of various configurations of feedback in amplifiers, Oscillators (7)

Books Recommended

1. Millman, Jacob, Halkias Christos C and Satyabrata jit, "*Electronic Devices and Circuits*" Tata McGraw- Hill, New Delhi.
2. Boylestad Nashelsky, "*Electronic Devices and Circuit Theory*", 8th Ed., Pearson Education, 7th Indian Reprint (2004)
3. Floyd, Thomas L, "*Electronic Devices*", Pearson Education Inc., Delhi, Sixth Edition, (2002)
4. Sedra, Adel S and Smith, Kenneth C, "*Microelectronic Circuits*", Oxford University Press, New York, Fourth Edition, (1997)
5. Streetman Ben J, Sanjay Banerjee, "*Solid State Electronic Devices*", 5th Ed. PHI (2004)

EC-205 Digital Electronics [3 1 0 4]

Number Systems And Boolean Algebra: Review of Number systems, Radix conversion, Complements 9's &10's, Subtraction using 1's & 2's complements, Binary codes, Error detecting and Correcting codes, Theorems of Boolean algebra, Canonical forms, Logic gates. (6)

Digital Logic Families: Introduction to bipolar Logic families: RTL, DCTL, DTL, TTL, ECL and MOS Logic families: NMOS, PMOS, CMOS, Details of TTL logic family - Totem pole, open collector outputs, TTL subfamilies, Comparison of different logic families. (7)

Combinational Logic: Representation of logic functions, Simplification using Karnaugh map, Tabulation method, Implementation of combinational logic using standard logic gates, Multiplexers and Demultiplexers, Encoders and Decoders, Code Converters, Adders, Subtractors, Parity Checker and Magnitude Comparator. (7)

Sequential Logic Concepts And Components: Flip flops - SR, JK, D and T flip flops - Level triggering and edge triggering, Excitation tables - Counters - Asynchronous and synchronous type Modulo counters, design with state equation state diagram, Shift registers, type of registers, circuit diagrams. (7)

D/A And A/D Converters: Weighted resistor type D/A Converter, Binary ladder D/A converter, Steady state accuracy test, D/A accuracy and resolution, Parallel A/D Converter, counter type A/D converter, Successive approximation A/D converter, Single and Dual slope A/D converter, A/D accuracy and resolution. (6)

Semiconductor Memories: Memory organization, Classification, and characteristics of memories, Sequential memories, ROMs, R/W memories, Content Addressable memories, Charged-Coupled Device memory, PLA, PAL and Gate Array. (7)

Books Recommended

1. Malvino and Leach "*Digital principles and Applications*" Tata McGraw Hill.
2. Jain R P "*Modern Digital Electronics*", Tata McGraw-Hill, Third Edition, (2003)
3. Mano M Morris, "*Digital Design*" Pearson Education, Third Edition, (2006)
4. James W. Bignell and Robert Donovan, " Digital Electronics", 5th Edition (2007)
5. Flecther "*An Engineering Approach to Digital Design*", Prentice Hall of India, New Delhi.
6. Tocci Ronald J "*Digital Systems-Principles and Applications*" Prentice Hall of India, New Delhi

EC-207 Communication Signals and Systems [3 1 0 4]

Systems And Signal Analysis: Classification of Signals and Systems, Signal Representation using Fourier Series, Complex Exponential Fourier Series, Fourier Series Representation of Periodic Signals (7)

Aperiodic Signal Representation using Fourier Transforms, Fourier Transforms of Periodic Power Signals, Power Spectral Density (PSD) (3)

System Response - Impulse, Step and Time Domain Response Analysis, Transfer Function and Frequency Domain Analysis, Effects of Transfer Function on spectral densities. (3)

Random Signal Theory: Introduction to Probability Theory, Definition of Probability of Random Events. Joint and Conditional Probability, Probability Mass Function,. (5)
Statistical Averages. Probability Density Functions (PDF) and Statistical Averages. Examples of PDF, Transformation of Random Variables. (6)
Random Processes, Stationarity and Ergodicity. (2)
Signal Transmission Through Linear Networks: Convolution Theorem and its graphical interpretation. The Sampling Theorem, Low Pass and Band Pass Networks, Matched Filter, Envelope detector. (4)
Introduction To Noise: Thermal Noise, Shot noise, Partition noise, Flicker noise, Gaussion Noise, Noise in Bipolar Junction Transistors (BJTs), FET noise. (4)
Equivalent input noise,,Signal to Noise Ratio (SNR), Noise Temperature, Noise equivalent Bandwidth, Noise Figure. (4)
Experimental determination of Noise Figure, Pulse Response and Digital Noise and its elimination (2)

Books Recommended

1. Lathi B P, "*Digital and Analog Communication Systems*", Oxford University Press, Fourth Addition, (2000)
2. Armugam K Sam, "*Digital and Analog Communication Systems*", John Wiley and Sons, (1994)
3. Simon Haykins, "*Communication Systems*", John Wiley and Sons, Third Edition, (1999)
4. Roberts M J, "*Signals and Systems*", TMH Edition, (2003)
5. Ghosh Smarajit, "Signals and Systems", Pearson Education, (2006)

CS-207 Object Oriented Programming [3 0 0 3]

Principles of Object Oriented Programming: A Look at Procedure-Oriented Programming, Object Oriented Programming Paradigm, Basic Concepts of Object Oriented Programming, Benefits of OOP, Object Oriented Languages
Tokens, Expressions and Control Structures: Tokens, Keywords, Identifiers and Constants, Basic Data Types, User-Defined and Derived Data Types, Type Compatibility, Reference, Variables, Scope Resolution Operator, Type Casting, Implicit Conversion, Operator Overloading, Operator Precedence, Control Structures
Classes and Objects: Specifying a Class, Arrays within a Class, Memory Allocation for Objects, Static Data Members, Arrays of Objects, Friend and Virtual Functions, Function Overloading**,** Pointers to Members
Constructors and Destructors: Parameterized Constructors, Multiple Constructors in a Class, Constructors with Default Arguments, Dynamic Initialization of Objects, Copy Constructor, Dynamic Constructor, and Destructors.
Operator Overloading and Type Conversion: Defining Operator Overloading, Overloading Unary Operators, Overloading Binary Operators, Overloading Binary Operators Using Friends, Manipulation of Strings Using Operators, Rules for Overloading Operators, Type Conversions
Inheritance: Extending Classes: Deriving Derived Classes, Single, Multilevel, Multiple, Hierarchical, Hybrid Inheritance, Virtual Base Classes, Abstract Classes
Pointers, Virtual Functions and Polymorphism: Pointers to Objects, this Pointer, Pointers to Derived Classes, Virtual Functions, Pure Virtual Functions.
Working with Files: Classes for File Stream Operations, Opening and Closing a File, File Pointers and their Manipulations, Sequential Input and Output Operations, Error Handling During File Operations, Command Line Arguments
Templates: Class Templates with multiple parameters, Function Templates, Overloading of Template Functions, Member Function Templates
Windows Programming Foundations: Windows concepts, Windows programming concept, Visual C++, Windows tools, Procedure-Oriented Windows Applications, Microsoft Foundation Class Library concepts, Windows application with MFC.
Wizards: Application class wizards, Introduction to OLE, ActiveX controls with the MFC library.

Books Recommended:

1. Chair H Pappas & William H Murray III "The Complete Reference Visual C++5", Tata McGraw Hill Company Ltd
2. Chair H Pappas & William Murray "The Visual C++ Hand book"

PH-206 Material Science [3 0 0 3]

Crystal Structure: Fundamental concepts, Closed packed structures, Crystal systems,Crystallographic planes and directions, Miller indices, Point defects.

Electrical Properties: Classical free electron theory of metals, Quantum theory – Particle in a box, Wave function and energy states, Finite potential barrier, Tunneling, Fermi-Dirac distribution law, Density of energy states, Kronig-Penney model, Classification of solids into conductors, Semiconductors and insulators, Zone schemes, Effective mass, Hall effect and applications.

Dielectric Properties: Dielectric materials, Polarization mechanisms, Dipole moment, Dielectric strength, Methods for producing polarization, Application of dielectric materials.

Magnetic Properties: Basic concepts, Soft and hard magnetic materials, Ferrites, Selection techniques for applications, Magnetic recording, Magnetic memories.

Optical Properties: Index of refraction, Damping constant, Characteristic penetration depth and absorbance, Reflectivity and transmissivity, Atomic theory of the optical properties, Optical storage devices.

Superconductivity: Properties of superconductors, London equations, Quantum explanation of superconductivity, Applications of superconductors.

Ceramics: Basic structures and properties, Processing of ceramic materials, Conduction in ionic materials, Ceramic dielectric.

Semiconductor Materials: Intrinsic and extrinsic materials, Electron and hole concentrations at equilibrium, Temperature dependence of carrier concentrations, Conductivity and mobility, Effect of temperature and doping on mobility, Direct and indirect recombination of electron and holes, Diffusion and drift of carriers, Diffusion length, Contact potential.

Books Recommended:

1. Hummel R E "Electronic Properties of Materials", Narosa Publishing House, New Delhi, (1997)
2. William D Callister, Jr "Materials Science and Engineering", John Wiley and Sons, Inc. New York, (2002)
3. Dekker A J "Solid State Physics", MacMillan, India Limited, Madras, (2000)
4. Pillai S O " Solid State Physics", New Age International Publishers, New Delhi, (1999)
5. Van Vlack L H "Elements of Material Science and Engineering", Addison Wesley Publishers
6. Streetman B G and Banerjee S "Solid State Electron Devices", Prentice Hall of India, New Delhi, (2001)

EC-221 Analysis and Synthesis of Networks Laboratory [0 0 2 1]

1. Verification of Thevenin's theorem, Norton's theorem.
2. Verification of Maximum power transfer theorem, Superposition theorem.
3. Verification of Reciprocity theorem.
4. Design and implementation of T and Π passive filters.
5. Determination of h-parameters of a network.
6. Study of sinusoidal steady state response of a network.
7. Study of transient response of a network.
8. Study of passive integrator and differentiator.
9. Synthesis of RC-network for a given network function.
10. Verification of equivalence of star and delta transformation.

Experimentation to be supported by computer simulations on SPICE simulator.

EC-223 Electronic Devices and Circuits Laboratory [0 0 2 1]

1. To study bipolar transistor as a switch.
2. To plot a load line for a CE amplifier and show effect of input signal on Q-point.
3. To demonstrate use of a BJT in a CE amplifier circuit configuration and study its frequency response.
4. To demonstrate use of a BJT in a CC amplifier circuit configuration and study its frequency response.
5. To demonstrate use of a power BJT as an amplifier.
6. To study frequency response of a tuned amplifier.
7. To demonstrate and study a two stage RC coupled amplifier.
8. To demonstrate and study a Transformer coupled amplifier.
9. To demonstrate working of a JFET and study its V-I characteristics.
10. To experimentally study working of a CS JFET amplifier.
11. To demonstrate working of a LED and calculate appropriate value of series resistance R_S for it.
12. To design and assemble a public address system.

Experimentation to be supported by computer simulations on SPICE simulator.

EC-223 Electronic Devices and Circuits Laboratory [0 0 2 1]

1. Verification of the truth tables of TTL gates, e.g., 7400, 7402, 7404, 7408, 7432, 7486.
2. Verify the NAND and NOR gates as universal logic gates.
3. Verification of the truth table of the Multiplexer 74150.
4. Verification of the truth table of the De-Multiplexer 74154.
5. Design and verification of the truth tables of Half and Full adder circuits.
6. Design and verification of the truth tables of Half and Full subtractor circuits.
7. Design and test of an S-R flip-flop using NOR/NAND gates.
8. Verify the truth table of a J-K flip-flop (7476)
9. Verify the truth table of a D flip-flop (7474)
10. Operate the counters 7490, 7493. Verify the frequency division at each stage and with a low frequency clock (say 1 Hz) display the count on LEDs.
11. Operate the universal shift register 74194.
12. Verify the truth table of decoder driver 7447/7448. Hence operate a 7 segment LED display through a counter using a low frequency clock.
13. Design and test D/A converter using R-2R Ladder Network

Experimentation to be supported by computer simulations on SPICE simulator.

CS-217 Object Oriented Programming [0 0 2 1]

1. Program to break a number into it's factors
2. Program to find the prime numbers from the list
3. Program to overload <= and + operator
4. Program to get tomorrow's date
5. Program to add two complex numbers using add as member function of class complex
6. Program to add 2 complex numbers using friend function
7. Program to overload unary operator
8. Program to demonstrate multiple inheritance
9. Program to demonstrate multilevel inheritance
10. Program to demonstrate containership
11. Program to demonstrate hybrid inheritance
12. Program to overloading member functions
13. Program to illustrate virtual base class
14. Program to find sum of array passing pointers to functions

15. Program to convert polar to rectangular coordinates using constructor in destination class
16. Program to concatenate 2 strings using inheritance
17. Program to perform operation on strings

Fourth Semester

EC-202 Analog Communication Systems [3 1 0 4]

Analog Modulation Techniques: Introduction, Theory of Amplitude Modulation; AM Power Calculations, AM Modulation with a Complex wave, Theory of Frequency Modulation (FM); Spectra of FM Signals, Narrow Band and Wide Band FM, Theory of Phase Modulation, Comparison of AM and FM, Comparison of PM and FM, Noise and Frequency Modulation, Pre-emphasis and De-emphasis. (10)

AM Transmission/AM Reception: Introduction, Generation of Amplitude Modulation, Basic Principles of AM Generation; Square law Diode Modulation, Vander Bijl Modulation, Suppressed Carrier AM Generation, Ring Modulator, Balanced Modulator.Tuned Radio Frequency (TRF) Receiver, Basic Elements of AM Super-heterodyne receiver; RF Amplifiers Characteristics-Sensitivity,Selectivity, Image Frequency Rejection, MixersTracking and Alignment, Local Oscillator, IF Amplifier, AM Detectors; Envelope or Diode Detector, AGC, AM Receiver using Transistors Communication Receiver. (10)

FM Transmission/FM Reception: Generation of FM by Direct Methods.Indirect Generation of FM; The Armstrong Method, FM Stereo Transmission.FM Receiver Direct Methods of Frequency Demodulation; Slope Detector, Travis Detector Foster Seely or Phase Discriminator, Indirect methods of FM Demodulation; FM Detector using PLL and Stereo FM Multiplex Reception. (10)

SSB Transmission/SSB Reception: Advantages of SSB transmission, Generation of SSB; Independent Side-Band Systems (ISB), Vestigial Side-Band Modulation (VSB).SSB Product Demodulator, Balanced Modulator as SSB Demodulator, ISB/Suppressed Carrier Receiver. (5)

Pulse Modulation Transmission and Reception: Introduction, Pulse Amplitude Modulation (PAM), PAM Modulator Circuit, Demodulation of PAM Signals, Pulse Time Modulation (PTM); Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), PPM Demodulator.FSK ,PSK. (5)

Books Recommended

1. George Kennedy, *"Electronic Communication System"*, 4th edition, McGraw- Hill (2000).
2. Gary M. Miller and Jeffery S. Beasley, "*Modern Electronic Communications* ", 7/e PHI.
3. Simon Haykin, " Communication Systems", 8th edition, Wiley Pubclishers.
4. Wayne Tomasi, " Electronics Communication systems", 4th edition, Pearson Publishers.
5. Proakis,'Communication Systems", 4th Edition, McGraw-Hill Publications.

EC-204 Analog Integrated Circuits [3 1 0 4]

Differential amplifiers: Introduction, Differential Amplifier configurations –Dual Input-Balanced output, Dual Input-Unbalanced output, Single Input-Balanced output, Single Input-Unbalanced output Differential amplifier with their DC and AC analysis, Differential amplifier using FET, Differential amplifier with swamping resistors, Constant current bias, Current mirror, Cascaded differential amplifier Stages, Level Translator, Cascode amplifier. (8)

Introduction to Op-amps: Block diagram of a typical Op-Amp, Schematic symbol, Characteristics and performance parameters of ideal Op-Amp, Open loop configurations: Differential, Inverting & Non Inverting. Practical Op-Amp: offset voltage analysis and compensation, input bias and offset current analysis and compensation, Change in Input offset voltage and Input offset current with time, Temperature and supply voltage, Common mode configuration and Common mode rejection Ratio, Frequency response, slew rate. (8)

Op-amp with Negative Feedback: Block diagram representation of feedback configurations, Voltage-series and Voltage–shunt feedback amplifier, Differential amplifiers-using one op-amp, two op-amps, three op-amps. (5)

Op-amp Applications: DC and AC amplifiers, Peaking amplifiers, Summing, Scaling and Averaging amplifiers, Differential amplifier, Instrumentation amplifiers, V to I and I to V converters, Differentiator and integrator, A to D and D to A converters, Log and antilog amplifiers, Sample and hold circuits, Schmitt

trigger. (6)

Active Filters and Oscillators: Active filters- Low-Pass, High-Pass, Band-Pass, Band-Reject Butterworth filters, State variable filters, All pass filters, Sallen and Key structures, Introduction to Chebyshev and Cauer Filters, phase-shift & Wein bridge Oscillators, Square wave, triangular wave and saw-tooth wave generators, Voltage controlled oscillator. (7)

Specialised Ics: Phase Locked Loop- Operating principles and applications, Voltage Regulators - Fixed, adjustable and switching regulators, 555 Timer- its applications as Monostable and Astable multivibrators (6)

Books Recommended

1. Gayakwad Ramakant A, "*Op-amps and Linear Integrated Circuits*" Pearson Education.Inc, Delhi, (2000)
2. Botkar K B, "*Integrated Electronics*", Khanna Publishers
3. Sedra, Adel S and Smith, Kenneth C, "*Microelectronic Circuits*", Oxford University Press, New York, Third edition, (1997)
4. Roy Choudhary D and Jain Shail, "*Linear Integrated Circuits*", 2nd Ed., New Age Publishers
5. David Bell, "*Operation Amplifiers and Linear Integrated Circuits*", 4th Ed., PHI

CS-206 Data Structures and Algorithms [2 0 0 2]

Introduction: Basic Terminology, Elementary Data Organization, Structure operations, Algorithm Complexity and Time-Space trade-off

Arrays: Array Definition, Representation and Analysis, Single and Multidimensional Arrays, address calculation, application of arrays, Character String in C++, Character string operation, Array as Parameters, Ordered List, Sparse Matrices and Vectors.

Stacks: Array Representation and Implementation of stack, Operations on Stacks: Push & Pop, Array Representation of Stack, Linked Representation of Stack, Operations Associated with Stacks, Application of stack: Conversion of Infix to Prefix and Postfix Expressions, Evaluation of postfix expression using stack.

Queues: Array and linked representation and implementation of queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, D-queues and Priority Queues**.**

Linked list: Representation and Implementation of Singly Linked Lists, Two-way Header List, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and deletion to/from Linked Lists, Insertion and deletion Algorithms, Doubly linked list, Linked List in Array, Polynomial representation and addition, Generalized linked list, Garbage Collection and Compaction.

Trees: Basic terminology, Binary Trees, Binary tree representation, Algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees, Threaded Binary trees, Traversing Threaded Binary trees, Huffman algorithm**.**

Graphs: Terminology & Representations, Graphs & Multi-graphs, Directed Graphs, Sequential Representations of Graphs, Adjacency Matrices, Traversal, Connected Component and Spanning Trees, Minimum Cost Spanning Trees.

Books Recommended

1. Horowitz and Sahani, "Fundamentals of data Structures", Galgotia Publication Pvt. Ltd., New Delhi.
2. R. Kruse etal, "Data Structures and Program Design in C", Pearson Education Asia, Delhi-2002
3. A. M. Tenenbaum, "Data Structures using C & C++", Prentice-Hall of India Pvt. Ltd., New Delhi.
4. Bruno R Preiss, "Data Structures and Algorithms with Object Oriented Design Pattern in C++", Jhon Wiley & Sons, Inc.
5. Gilberg Forozan , "Data Structure – A pseudo code approach with C++", Cengage Learning, New Delhi.

IC-232 Electronic Measurements and Instrumentation [3 1 0 4]

Measurement Systems and Characteristics Of Instruments: Introduction- Measurements, Significance of

measurements, Methods of measurements, Instruments and measurement system, Electronic instruments, Classification of instruments, Deflection and Null type instruments, Comparison Analog and Digital Modes of operation, Application of measurement system, Errors in measurements, Types of errors, Accuracy and Precision, Noise, Resolution or discrimination, loading effects, Units, Absolute units, Fundamental and Derived units.

Electromechanical Indicating Instruments: D'Arsonaval Galvanometer- Construction of D'Arsonaval Galvanometer, Torque equation, Dynamic behavior of Galvanometer, Ballistic galvanometer- Construction and theory, Introduction to PMMC Instruments and Moving iron instruments, Instrument transformers.

Bridge Circuits for RLC Measurements: Measurement of R, L and C, Wheatstone, Kelvin, Maxwell, Anderson, Schering and Wien bridges Measurement of Inductance, Capacitance, Effective resistance at high frequency, Q-Meter.

Electronic Instruments: Introduction-Electronic Voltmeter, Electronic multimeter, Logic Analyzer, Network Analyzer, Function generator, Wave analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer.

Cathode Ray Oscilloscope: Introduction- CRO, Cathode ray tube, Block diagram of CRO, Measurement of voltage, phase and frequency using CRO, Special purpose oscilloscopes.

Transducers: Principles of operation, Classification of transducers based upon principle of transduction, Summary of factors influencing the choice of transducer, Qualitative treatment of Strain Gauge, LVDT, Thermocouple, Piezo-electric crystal and Photoelectric transducers.

Data Acquisition System and Telemetry: Introduction- Analog and digital data acquisition system, Methods of data transmission, General telemetry system, Types of telemetry systems.

Virtual Instrumentation

Books Recommended

1. Sawhney A K, "*Electrical and Electronic Measurements and Instrumentation*", Dhanpat Rai and Sons
2. Kalsi H S "*Electronic Instrumentation* "
3. Gupta JB "*Measurements and Instrumentation*", S K Kataria & Sons, Delhi, First Edition (2003)
4. Cooper W D, Helfrick A D "*Modern Electronic Instrumentation and Measurement Techniques*", PHI,
5. Murthy D V S "*Transducers and Instrumentation*", Prentice Hall of India, New Delhi, Tenth Edition (2003).

MA-202 Numerical Methods [3 1 0 4]

Approximation and Errors: Accuracy of numbers, Errors in approximations, Order of approximation and Propagation of errors.

Roots of Algebraic and Transcendental Equations: Bisection method, Regula-falsi method, Iteration method, Newton-Raphson method, Bairstow's method and Graeffe's root squaring method.

Solution of Simultaneous Algebraic Equations, Matrix Inversion and Eigen-value Problems: Triangularisation method, Jacobi's and Gauss-Siedel iteration methods, Newton-Raphson method for nonlinear simultaneous equations, Triangularisation method for matrix inversion, Partition method for matrix inversion, Power method for largest eigen-values and Jacobi's method for finding all eigen-values.

Finite Differences Interpolations and Numerical Differentiations: Forward, Backward, Central differences and relations between them, Newton's forward, backward and divided difference interpolation formulas, Lagrange's interpolation formula, Stirling's and Bessel's central difference interpolation formulas, Numerical differentiations using Newton's forward and backward difference formulas and Numerical differentiations using Stirling's and Bessel's central difference interpolation formulas.

Numerical Integrations: Trapezoidal rule, Simpson's one-third rule and Numerical double integrations using Trapezoidal rule and Simpson's one-third rule.

Numerical Solution of Differential Equations

Ordinary Differential Equations: Taylor's series method, Euler's and modified Euler's methods, Runge-Kutta fourth order methods, methods for solving simultaneous first order differential equations and methods for solving second order differential equations.

Boundary Value Problems: Finite difference methods for Boundary Value Problems

Partial Differential Equations: Finite difference methods for Elliptic, Parabolic and Hyperbolic equations

Books Recommended

1. Ames, W F., *Numerical Methods for Partial Differential Equations*, 3rd edition, Academic Press, New York (1992).
2. Dahlquist, G. and Björck, A., "*Numerical Methods*", Prentice-Hall, NJ (1974).
3. Jain, M K., Iyengar, S R.K and Jain, R K., "*Numerical Methods for Scientific and Engineeing Computations"*, 4th edition New Age International (P) Limited, Publishers, New Delhi, (2003).
4. Shampine, L F, "*Numerical Solution of Ordinary Differential Equations",* Chapman and Hall, New York, (1994).
5. Shampine,L F et al., "*Fundamentals of Numerical Computing* ", Wiley, New York, (1996).
6. Stewart, G W, "Introduction to Matrix Computations", Academic Press, New York, (1973).

PH-207 Electromagnetic Field Theory [3 1 0 4]

Electrostatic Fields: Divergence Theorem, Poisson's and Laplace's equation in various co-ordinate systems, solution of single dimensional Laplaces equation, Conditions at a boundary between dielectrics, Electrostatic uniqueness theorem, capacitance, Calculation of capacitance for simple rectangular, Cylindrical and spherical geometries. Effect of multi-layer dielectrics, Energy and Mechanical forces in electric fields, Method of Electrical images for a point charge in the neighborhood of infinite conducting plane, Application of image method for transmission line capacitance calculations.

Magnetic Fields: Ampere's work law in differential vector form, Ampere's law for a current element. Magnetic vector Potential, Magnetic scaler Potential, Magnetic dipole, Energy and Mechanical forces in magnetic fields, Image of current carrying conductor in the neighborhood of a magnetic plane.

Maxwell's Equations: Equation of continuity for time varying fields. Inconsistency of Amperes law, Maxwell's equations and their physical interpretation, Conditions at a boundary surface.

Electromagnetic Waves: TEM**,** Derivation of the wave equation and their general solution. Plane waves in unbounded media, Reflection and refraction of plane waves at surface interface, surface impedance, Penetration of Flux and Current in a conductor, Transmission line analogy.

Poynting Vector and Flow of Power: Poynting's theorem, Interpretation of (E x H) - vector, Instantaneous, Average and complex Poynting Vector, Power Loss in a plane conductor.

Guided Waves and Wave Guides: Characteristics of TE and TM waves, wave impedance, transmission line theory, impedance matching by means of stab lines, TE and TM waves in circular guides, Introduction to wave guides, Circuits, line and guides - a comparison, Rectangular and circular wave guides, TE and TM waves in rectangular wave guides, Impossibility of TEM waves in wave guides, Wave impedances and characteristics impedances, Transmission line analogy for wave guides, Attenuation and Q-factor of wave guides, Dielectric slab wave guides.

Antenna Fundamentals: Directional properties of Dipole antennas, SW-antennas, Antenna gain, effective area, antenna terminal impedance, transmission loss between antennas, antenna temperature and S to N – ratio, concept of space communication.

Books Recommended

1. Jordon E C and Balmain K G, "*Electromagnetic waves and Radiating System"*, second edition, Prentice Hall New Delhi (1993).
2. Carter G W, "*The Electromagnetic Fields in its Engineering aspects"*, Longmans, Green and Co. London, (1954)
3. Hayt W H, "*Engineering Electromagnetics*", McGraw Hill Book Co, second Edition, NY (1967)
4. Wazed Miah M A, "*Fundamentals of Electromagnetics*", Tata McGraw-Hill, New Delhi, (1982).

EC-222 Analog Communication Systems Lab [0 0 2 1]

1. To study Amplitude Modulation using a transistor and determine depth of modulation.
2. To study envelope detector for demodulation of AM signal and observe diagonal peak clipping effect.
3. Frequency Modulation using Voltage Controlled Oscillator.
4. Generation of DSB-SC signal using Balanced Modulator.

5. Generation of Single Side Band (SSB) signal.
6. Study of Phase Lock Loop (PLL) and detection of FM Signal using PLL.
7. Measurement of Noise Figure using a noise generator.
8. Study functioning of Super heterodyne AM Receiver.
9. Familiarization of PLL, measurement of lock/captures range, frequency demodulation, and frequency multiplier using PLL.
10. Measurement of Sensitivity, Selectivity and Fidelity of radio receivers.

EC-224 Analog Integrated Circuits Laboratory [0 0 2 1]

1. To experimentally study the performance of inverting amplifier-using op-amp.
2. To experimentally study the performance of non-inverting amplifier using op-amp.
3. To experimentally study the performance of differential amplifier using op-amp
4. To experimentally study the performance of op-amp as summing, scaling and averaging amplifier.
5. To demonstrate working of an op-amp as a voltage level detector.
6. To demonstrate working of an op-amp as a square wave generator.
7. To demonstrate working of an op-amp as a triangular and saw-tooth wave generator.
8. To demonstrate working of an op-amp as a low pass filter.
9. To demonstrate working of an op-amp as a high pass filter.
10. To demonstrate the operation of a 555 timer as monostable multivibrator.
11. To demonstrate the operation of a 555 timer as astable multivibrator.
12. To demonstrate the operation of a 555 timer as missing pulse detector.

Experimentation to be supported by computer simulations

CS-216 Data Structures and Algorithms Lab [0 0 2 1]

1. Liner Search for an array of values.
2. Binary Search for an array of values.
3. Bubble Sort for an array of values.
4. Push. Pop and Display operations of a Stack.
5. To convert an expression in infix notation into postfix notation.
6. To evaluate an expression in postfix notation.
7. Insert, Delete and Display operation on a simple queue.
8. Insert, Delete and Display operation on a circular queue.
9. Insertion, Deletion and Display of Linked List.
10. Construction of Binary Search Tree (BST).
11. Pre-order traversed of a BST.
12. Inorder traversed of a BST.
13. Postorder traversed of a BST.

This is only the suggested list of practicals. Instructor may frame additional practicals relevant to the course contents

IC-252 Electronic Measurements and Instrumentation Laboratory [0 0 2 1]

1. To study the waveform on a storage Oscilloscope.
2. To study the dynamic recording of different signals on oscillographic recorders.
3. Measurement of Inductance by Maxwell's bridge.
4. Measurement of small resistance by the Kelvin's Bridge.
5. Measurement of Capacitance of the Schering Bridge.
6. Measurement of medium resistance with the help of Wheat stone bridge.
7. To find Q of a coil by a series resonance method and verify it by using Q-meter.
8. To study the recording of different signals from sensors on magnetic tape recorder.
9. To study the acquisition of data from strain gauge based transducer on data acquisition system.

10. Displacement measurement using LVDT, Inductive pick up and capacitive pick up.
To measuring the temperature of soldering by using thermocouple. Plot the variation of temperature with respect of voltage.

Fifth Semester

EC-301 Microprocessor and Its Applications [3 1 0 4]

Unit-I

Introduction to Microcomputers & Microprocessor: Digital computing, Computer languages, From large chip computers to single chip Microcomputers, Microcomputers organization, and 4- bit Microprocessors.

Introduction to 8-bit Microprocessor Architecture: Microprocessor architecture & its operations, Memory, Input/Output, Interfacing devices MPU, 8085 based Microcomputer, Instruction classification, Instruction format, Instruction timings, 8080 A MPU, and Overview of 8085/8080A instruction set.

Introduction to 8085/8080A Basic Instructions: Data transfer instructions, Arithmetic operations, Logic operations, Branch operations, Programming techniques using looping counting & indexing, Dynamic debugging, Time delays, Counters, Stock, Subroutines, Conditional call, and return instructions, Advanced subroutine concepts.

Unit-II

Interrupts: The 8080A interrupts 8085 interrupts, Restart instructions, Additional I/O concepts & processes

Parallel Input/Output And Interfacing Applications: Basic interfacing concepts, Interfacing output displays, Interfacing input keyboards, Memory mapped I/O, Interfacing memory, Interfacing D/A & A/D converters

Unit-III

General Purpose Programmable Peripheral Devices: Introduction to 8255, 8253 programmable interval timer, 8259 A programmable interrupt controller, SID & SOD lines, 8251 USART.

Introduction to 8086 architecture, programming & Interrupts

Books Recommended

1. Ramesh S Gaonkar, "Microprocessor Architecture- Programming & Applications with 8085/8080A", 5th Ed., Penram International Publishing (India) Pvt. Ltd.
2. Ram B, "Introduction of Microprocessors & Microcomputers", 4th Ed., Dhanpat Rai Publisher (P) Ltd.
3. Rodnay Zaks and Austin Lesea, "Microprocessor Interfacing Technique", 1st Indian Edition, BPB Publication (1988)
4. James L Antonakes, "An introduction to Intel family of Microprocessors", 3rd Ed., Pearson Education.
5. Charles M Gilmore, "Microprocessor; Principles and Applications", 2nd Ed., McGraw Hill

EC-303 VLSI Circuit Design [3 1 0 4]

Unit-I

Introduction to CMOS, CMOS Capabilities and Limitations and CMOS Transistors and Logic .Overview of the VLSI technologies and ASIC Design Flow, VLSI Circuits and Analog IC Design Fundamentals. Detailed Design flow .

Unit-II

VLSI Circuits Design Theory. Process overview. Transistor device model, Circuit characterization. Technology libraries Overview. Pre-layout parasitics estimation. Post layout simulation techniques. VLSI Circuit Schematics and Simulation EDA Tool Flow

Unit-III

Building basic combinatorial cells & Building basic sequential cells.

Analog IC Design Theory. Analog IC (CMOS) Detailed Design Flow. Active and Passive devices for analog VLSI design. Analog Sub building blocks: MOS switches, diodes, capacitors and resistors, Analysis and Simulation techniques Analog IC Schematics and Simulation EDA Tools.

Books Recommended

1. Allen, Phillip E. & Holberg, Douglas R. "CMOS Analog Circuit Design" Oxford University Press (2002).
2. Michael J S Smith "Application-Specific Integrated Circuits" Addison-Wesley Professional,(1997).
3. J. Baker "CMOS: Circuit Design, Layout, and Simulation" 2nd Edition,Wiley IEEE Press (2007)
4. B. Razavi, "Design of Analog CMOS Integrated Circuits " McGraw Hill (2004).
5. Neil H. E. Weste, Kamran Eshraghian " Principles of CMOS VLSI Design "2nd edition , Pearson Education India, (1999).
6. Kang S.M, Leblebici Y,"CMOS Digital Integrated Circuits : Analysis and Design" Tata McGraw Hill, 3rd ed. 2006.

IC-351 Control Engineering [3 0 0 3]

Introductory Concepts: Plant, Systems, Servomechanism, regulating systems, disturbances, open loop control systems, closed loop control systems, linear and non-linear systems, time variant and invariant, continuous and sampled-data control systems, block diagrams, some illustrative examples.

Modeling: Formulation of equation of linear electrical, mechanical, thermal, pneumatic and hydraulic systems, electrical, mechanical analogies. Use of Laplace transforms, signal flow graphs and associated algebra, characteristics equation.

Time Domain Analysis: Typical test-input, Transient response of the first and second order systems. Time domain specification, Dominant closed loop poles of higher order systems. Steady state error and coefficients, pole-zero location and stability, Routh-Hurwitz criterion.

Root Locus Technique: The extreme points of the root loci for positive gain. Asympotes to the loci, Breakway Points, intersection with imaginary axis, location of roots with given gain and sketch of the root locus plot.

Frequency Domain Analysis: Closed loop frequency response ,Bode Plots,stability and loop transfer function. Frequency response specification, relative stability,relation between time and frequency response for second order systems. Log. Magnitude versus Phase angle plot, Nyquist criterion for stability.

Compensation: Necessity of compensation, series and parallel compensation, compensating networks, application of lag and lead-compensation.

Control Components: Error detectors-potentiometers and Synchros, Servo motors, a.c. and d.c techno generators, Magnetic amplifiers

Books Recommended

1. Ogata K, "Modern Control Engineering", Prentice Hall,4th Ed.,N. Delhi(2002)
2. Kuo BC, "Automatic Control Systems", Prentice Hall,3rd ED.(1978)
3. nagrath I J and Gopal M,Modern Control Systems Engineering", Wiley Eastern Ltd N. Delhi(1998)
4. Dorf Richard C and Bishop Robert H, "Modern Control Systems", Addison-Wesley, Pearson New Delhi (1998).
5. Stephanopoulos G, " Chemical Process Control-An Introduction to Theory and Practice", 1st Ed., Prentice Hall of India Pvt. Ltd, New Delhi(1998)

CS-305 Operating Systems [3 0 0 3]

Operating systems objectives, services and functions: Characteristics of Modern Operating Systems, Characteristics of Batch and multiprogramming operating systems. Comparisons between real time systems and time-sharing systems, Operating system services and kernel features.

I/O management, I/O devices: Introduction to I/O management, I/O devices, Concepts of threading, Organization of I/O functions, polling, various modes of data transfer, Hardware/Software interface, I/O buffering.

Disk scheduling policies and processes: Motivation for disk scheduling policies, Introduction to processes management, operating system views of processes, various process transition states, Introduction to Processor scheduling, Introduction to various types of schedulers, Performance criteria in scheduling

algorithms, Concept of FCFS scheduling algorithm, Concept of priority scheduling algorithm like SJF, Concept of non-preemptive and preemptive algorithms, Concept of round-robin scheduling algorithm, Concept of multi-level queues, feedback queues.

Concurrency control schemes: Various approaches to concurrency control schemes, Concept of prouder/consumer problem, Mutual Exclusion, Concept of mutual exclusion first and second algorithm, Concept of mutual exclusion third algorithm including introduction and characteristics of semaphores, Introduction to Mutual exclusion with semaphores, Introduction to Interprocess Communication and Synchronization, Critical regions and Conditional critical regions in a Semaphore. Introduction to monitors, various modes of monitors, Issues in message implementation, Concept of mutual exclusion with messages.

Dead Locks: Concept of Deadlocks, issues related to its prevention, avoidance and detection/recovery, Concept of deadlock prevention and its avoidance, Concept of deadlock detection and recovery.

Memory Management: Need of Memory management and its requirements, paging, segmentation, concept of fragmentation. Characteristics of contiguous & non-contiguous allocation techniques, Detail study of fragmentation, Virtual memory management, introduction to page-replacement, Need of various page-replacement policies, Concept of FIFO and optimal page-replacement algorithms, Concept of LRU approximation and its page-replacement algorithm, Concept of allocation algorithms.

File management System: Need of file management, its requirements, User's and operating system's view of file system, Concept of file directories and file sharing, Motivation for disk space management, Characteristics of file related system services, Generalization of file services**.**

Books Recommended

1. Peterson and Silberschatz, "Operating System Concepts", Addison-Wesley 4th Edition 1994.
2. Milenkoviac, "Operating Systems Concepts and Design", Tata McGraw-Hill 1992.
3. Charles Crowley, "Operating Systems a Design Oriented Approach", Tata McGraw-Hill 1996.
4. Andrews S. Tanenbaum, "Modern Operating Systems", Pearson Education, 2nd edition 2001.
5. W Richard Stevens, "Linux Network Programming", PHI, 1st Edition 2003

EC-311 Microprocessor and Its Applications Lab [0 0 2 1]

1. Simple programs for sorting a list of numbers in ascending and descending order.
2. Sorting a list without destroying the original list.
3. Code conversion - Binary to Gray/Gray to Binary.
4. Program for addition of BCD numbers.
5. Program for multiplication of 8-bit numbers using Booth's algorithm.
6. Interface an LED array and 7-segment display through 8255 and display a specified bit pattern/character sequence at an interval of 2 seconds.
7. Program for interfacing between two 8085 kits by using 8255.
8. Interface an ADC chip with microprocessor kit and verify its operation.
9. Interface an external 8253 to the microprocessor kit at the address given. Hence,
   i) generate a pulse train of specified duty cycle at the given output line,
   ii) operate as a: N counter,
   iii) Count a train of pulses for a given duration.
10. Interface the given microprocessor kit to a personal computer through R.S-232C. The band rate is specified. Verify data transfer in both directions (P - PC and PC - P)
11. Interface an external keyboard to a microprocessor kit through on board 8255.

EC-313 VLSI Circuit Design Lab [0 0 2 1]

1. Introduction to Digital Design flow and EDA tools used at various levels.
2. To Design & simulate the Basic Gates , Flip Flops using VHDL/Verilog
3. To Design a Designing BCD Up/Down Counter.
4. To Design a finite state machine for the given specifications.
5. To Study FPGA kit
6. To implement counter and other sequential circuits on FPGA.
7. Introduction to SPICE simulation and coding.

8. Design & Simulation of MOS inverter using various technology
9. Design & Simulation of CMOS inverter.
10. Design & Simulation an Differential amplifier using with spice simulator.
11. Design & Simulation an operational amplifier of the given specifications with spice simulator.

Sixth Semester

EC-304 Digital Communication Systems [3 1 0 4]

Unit-I

Introduction: Block Diagram of Digital Communication System, Advantages of Digital communication system over analog communication systems, Sampling theorem, Signal reconstruction in time domain, Practical and Flat Top Sampling, Sampling of Bandpass Signal, Aliasing Problem.

Waveform Coding Techniques: Discretization in time and amplitude, Linear quantizer, Quantization noise power calculation, Signal to Quantization noise ratio, Non-uniform quantizer, A-law & μ- law, companding; encoding and Pulse Code Modulation, Bandwidth of PCM, Differential pulse code modulation, Multiplexing PCM signals, Delta modulation, Idling noise and slope overload, Adaptive delta modulation, Adaptive DPCM, Comparison of PCM and DM.

Unit-II

Digital Base Band Transmission: Line Coding & its properties. NRZ & RZ types, signaling format for unipolar, Polar, bipolar (AMI) & Manchester coding and their power spectra (No derivation), HDB and B8ZS signaling, ISI, Nyquist criterion for zero ISI & raised cosine spectrum, Matched filter receiver, Derivation of its impulse response and peak pulse signal to noise ratio, Correlation detector decision threshold and error probability for binary unipolar (on-off) signaling.

Digital Modulation Techniques: Types of digital modulation, Wave forms for Amplitude, Frequency and Phase Shift Keying, Method of generation and detection of coherent & non-coherent binary ASK, FSK & PSK, Differential phase shift keying, Quadrature modulation techniques, M-ary FSK, Minimum Shift Keying (MSK), Probability of error and comparison of various digital modulation techniques.

A base band signal receiver, Probability of error, The Optimum filter, Matched Filter, Probability of error in Matched filter, Coherent reception, Coherent reception of ASK, PSK and FSK, Non-Coherent reception of ASK, FSK, PSK and QPSK, Calculation of error probability of BPSK and BFSK, Error probability for QPSK.

Unit-III

Multiple Access Techniques: Time division multiplexing, Frequency division multiplexing, code division multiplexing, Introduction to Wireless and Mobile Communication Systems

Books Recommended

1. Haykin Simon, "Communication Systems", 4th Edition, Wiley publication.
2. Sklar, "Digital Communication- Fundamentals and Applications", 2nd Edition, Pearson Education India.
3. Miller Gary M, *"Modern Electronic Communication"*, 6th edition, Prentice-Hall, (1999).
4. Nicolaos S Tzannes, *"Communication and Radar Systems"*, Prentice-Hall Inc, (1985).
5. Proakis J J, *"Digital Communications"*, 2nd Edition, Mc Graw –Hill
6. Wayne Tomsi, "*Electronic Communication Systems, Fundamentals Through Advanced*", Fourth Edition, Pearsons Edition.

EC-306 Digital Signal Processing [3 1 0 4]

Unit-I

Introduction: Limitations of analog signal processing, Advantages of digital signal processing and its applications; Some elementary discrete time sequences and systems;

Basic elements of digital signal processing such as convolution, correlation and autocorrelation, Concepts of stability, causality, linearity, difference equations

Frequency Domain Representation of Discrete Time Signal and Systems: Complex exponentials as

Eigen functions of LTI systems; Fourier Transform of sequences. Fourier Transform theorems and symmetry properties of Fourier Transform.

Sampling of Continuous Time Signals: Sampling and aliasing problem, Reconstruction of a continuous time signal from its samples; Discrete Time Processing of Continuous time signals and vice-versa. Decimation & Interpolation; changing the sampling rate by integer and non-integer factors using discrete time processing.

Unit-II

The Z Transform: Z-Transform, Region of convergence; Properties of the Z-transform; convolution theorem; Parseval's relation; Unilateral Z-transform and its application to difference equations with non-zero initial condition.

Discrete Fourier Transform: DFT and its properties; Linear Periodic and Circular convolution; Linear Filtering Methods based on DFT; Filtering of long data sequences; Fast Fourier Transform algorithm using decimation in time and decimation frequency techniques; Linear filtering approaches to computation of DFT.

Unit-III

Design of Digital Filters: Linear Phase FIR filters; Design methods for FIR filters; IIR filter design by Impulse Invariance, Bilinear Transformation, Matched Z-Transformation, Frequency Transformation in the Analog and Digital Domain.

Finite Precision Effects: Fixed point and Floating point representations, Effects of coefficient unitization, Effect of round off noise in digital filters, Limit cycles.

Books Recommended

1. Oppenheim A V & Sehafer R W, *"Discrete Time Signal Processing"*, Prentice Hall (1989).
2. Proakis J G & Manolakis D G, "*Digital Signal Processing*", Pearson Education India.
3. Oppenheim A V, Willsky A S & Young I T, *"Signal & Systems"*, Prentice Hall, (1983).
4. Ifeachor and Jervis, "*Digital Signal Processing*", Pearson Education India.
5. D.J. DeFatta, J.G.Lucas and W. S. Hodgkiss, Digital Signal Processing, J Wiley and Sons, Singapore, 1988
6. Andrias Antonion, "*Digital Filters, Analysis, Design and Applications*", Second Edition, Tata Mcgraw Hills, 1998.

EC-314 Digital Communication Systems Laboratory [0 0 2 1]

1. Study of analog time division multiplexer.
2. Study of pulse code modulation and demodulation.
3. Study of delta modulation and demodulation and observe effect of slope overload.
4. Study pulse data coding techniques for NRZ formats.
5. Data decoding techniques for NRZ formats.
6. Study of amplitude shift keying modulator and demodulator.
7. Study of frequency shift keying modulator and demodulator.
8. Study of phase shift keying modulator and demodulator.

EC-316 Digital Signal Processing Lab [0 0 2 1]

1. Write a program in Matlab to generate standard sequences.
2. Write a program in Matlab to compute power density spectrum of a sequence.
3. To write a Matlab program for noise reduction using correlation and autocorrelation methods.
4. Write a program in Matlab to verify linear convolution.
5. Write a program in Matlab to verify the circular convolution.
6. To write a Matlab programs for pole-zero plot, amplitude, phase response and impulse response from the given transfer function of a discrete-time causal system.
7. Write a program in Matlab to find frequency response of different types of analog filters.
8. Write a program in Matlab to design FIR filter (LP/HP) through Window technique
    a. Using rectangular window
    b. Using triangular window

c. Using Kaiser window

9. Write a program in Matlab to find the FFT of given 1-D signal and plot.
10. To study the architecture of DSP chips – TMS 320C 5X/6X Instructions.
11. To study TMS320C6713 hardware and software tools by outputting sinusoidal signals from the C6713 board
12. To implement different digital filters on TMS320C6713 based kit.
13. To Implement IIR filter (LP/HP) on DSP Processor.
14. Implementation of low-pass, high pass and band-pass filter on some chosen signal.

Seventh Semester

EC-401 Microwave Engineering [3 1 0 4]

Unit-I

Microwave Tubes: UHF limitations in conventional tubes, Analysis and operation of multicavity and reflex, Klystron, Admittance diagram of Klystron. Analysis and Operation of a traveling wave magnetron, Performance Charts of magnetron tubes; principle of operation of Traveling Wave Tube.

Microwave Components: Coupling-probes and loops Apertures, Attenuators, Phase shifters. Waveguide cornors,bends and twists. Matched Terminators, short circuit plunger, waveguide tees-E, Hybrid. Hybrid rings. Directional Coupler, two-hole directional coupler. Isolator, Circulator.

Unit-II

Microwave Semiconductor Devices: Classification of Microwave Devices, Point Contact diode; Tunnel Diode; Gunn Diode, two valley structures, mode of operation, circuit realization. IMPATT Diode, read Diode, circuit realization. PIN diode, basic principles of operation equivalent circuit , and application as switch, modulator and Phase shifter. Microwave Bi-polar and Field effect Transistors-Characteristics and performance. Parametric amplifiers.

Unit-III

Microwave Network Theory: Symmetrical Z and Y Matrics for reciprocal network. Scattering ma-matriz representation of multiport network-properties of S-parameters. Relation of Z,Y and ABCD parameter with S-parameters.

Microwave measurements: Tunable detector, slotted line carriage. Measurement of VSWR and Reflection coefficient, impedance using slotted line. Use of smith chart. Impedance matching, Double and triple stub tuners, Quarter wave Transformer. Measurement of Frequency and Wavelenght. Measurement of Frequency and wavelength. Measurement of Microwave power-low-high, use of bolometer, thermisters, calotimetery.

Books Recommended

1. Reich A J, “Microwave principles”, Van Nostrand, Affilated East-West press Pvt. Ltd., New Delhi.
2. Collin R E, “Fundamentals of Microwave Engg”, McGraw-Hill.
3. Liao S Y, “Microwave Devices and Circuits”, Prentice hall of India, (1995)
4. Das A and Das S K, “Microwave Engineering” Tata McGraw-Hill Publishing Companty Limited, New Delhi,(2001).
5. K C Gupta, “Microwave”, New Age International, New Delhi,(1983)

EC-403 Microelectronics [3 1 0 4]

Unit-I

Electronic-Grade Silicon: Crystal growth-Czochralski, LCE, Zone-refining and floating zone. Wafer preparation. Epitaxy, VPE, LPE, MBE, MOCVD.

An Overview Of IC Technology, And Its Requirements: Unit steps used in IC Technology: Wafer cleaning, , oxidation, characterization of oxide films, diffusion, ion implantation, annealing-RTA. Photo-lithography, E-beam lithography and newer lithography techniques for VLSI/ULSI; mask generation, wet and dry etching.

Unit-II

CVD and LPCVD techniques for deposition of poly silicon, silicon nitride and silicon dioxide. Metallisation and passivation.

Special Techniques For Modern Processes: self-aligned silicides, shallow junction formation, nitride oxides etc. process flows for CMOS and bipolar IC processes.

Plasma And Rapid Thermal-Processing: Plasma etching, RIE techniques, RTP for annealing, growth and deposition of films testing, bonding, packaging. Evaluation and measurement techniques.

Unit-III

Thin Film And Thick Film Technology, hybrid circuits,circuit elements: Diodes, resistors, capacitors, inductors, contacts and interconnections.

Sub Micron Device Physics and Technology: Review of basic device physics, MOS capacitor and transistor theory, Moore law on technology scaling, Short channel effects, sub threshold leakage, Punch through, DIBL, High field mobility, Velocity saturation and overshoot

Books Recommended

1. May G S and Sze S M, *"Fundamentals of Semiconductor Fabrication"*, John Wiley & Sons, India.(2004)
2. Sze S M, "*VLSI Technology*", 2nd Ed., McGraw Hill International Edition (1988)
3. Ghandhi S K, *"VLSI fabrication Principles"*, John Wiley Inc., New York (1983).
4. Streetman BG, *"Solid State Electronics Devices"*, Prentice Hall of India, New Delhi, (1995).
5. Chang C Y and Sze S (Ed),*"ULSI Technology"*, McGraw-Hill Companies Inc. (1996).

EC-411 Microwave Engineering Lab [0 0 2 1]

1. Study of Microwave components and Instruments
2. To study the characteristics of reflex Klystron
3. Tuning of Klystron Mechanical and Electronics Methods
4. To study the Characteristics of Crystal Detector.
5. To measure the Frequency using direct reading frequency meter and compare it with indirect frequency meter.
6. To measure VSWR, Insertion loss and attention of fixed and variable attenuator
7. Measurement of Directivity and Coupling coefficient of an directional coupler
8. To plot and study the V-I characteristics of a Gunn diode
9. To match impedance for maximum power transfer using a slide screw tuner
10. calibration of the attenuation constant of an attenuator
11. Determination of a radiation Characteristics and gain of an antenna
12. Measurement of Q of a cavity by slotted line method.

Departmental Electives (5th Semester)

EC-351 Fiber Optics [3 0 0 3]

Unit I

Introduction: The Electromagnetic Spectrum, Properties of Light, Dual Nature of Light, Concept of a photon, Wave Model, Characteristics of light waves, concepts of information, general communication systems, evolution of Basic Fiber Optic Communication System, Benefits and disadvantages of Fiber Optics, Transmission Windows, Transmission Through Optical Fiber, The Laws of Reflection and Refraction, Light rays and light waves, Reflection of light from optical surfaces, Refraction of light from optical interfaces, The Numerical Aperture (NA), The Optical Fiber, Types of Fiber.

Unit II

Degradation in Optics Fibers: Different Losses & Issues in Fiber Optics, Attenuation in Optical Fibers, Fiber Optic Loss Calculations, Dispersion, connectors & splices, bending loses, Absorption, scattering, very low loss materials, plastic & polymer-clad-silica fibers. Dispersion in single mode and multimode fibers, dispersion shifted and dispersion flattened fibers, attenuation and dispersion limits in fibers, Kerr nonlinearity, self phase modulation, combined effect of dispersion and self phase modulation.

Unit III

Wave Propagation in Fibers: wave propagation in step index & graded index fiber, fiber dispersion, single mode fibers, multimode fibers, dispersion shifted fiber, dispersion flattened fiber, polarization, cut-off condition and V-parameter.

Fibre Material and Fabrication Methods: Outside CVD, Modified CVD and VAD methods - losses in fibres - attenuation absorption, scattering and radiation losses - signal distortions - intra model and inter model distortions: Group delay, material and wave guide distortions - fiber optic cables.

Books Recommended

1. Mynbaev and Djafer, *"Optical fiber Communication Technology"*, 2nd edition, Pearson Pub.
2. Keiser G, *"Optical fiber communications"*, McGraw-Hill.
3. G P Agrawal, *"Nonlinear Fiber Optics",* Second edition, Academic Press, (2000).
4. Dutton J R, "*Understanding Optical communication"' online book by IBM.*
5. Senior J. Optical Fiber Communications, Principles & Practice, PHI.

EC-353 Pulse and Switching Waveforms [3 0 0 3]

Unit-I

Introduction to Pulse waveforms: Functions, signals and waveforms, classification and analysis of pulse waveforms, passive and active pulse circuits, periodic waveforms, Fourier series, Fourier transform, Laplace transform, Laplace transform pair, use of Laplace transform, transfer function, frequency function of pulse waveforms.

Unit-II

Linear Wave Shaping: Low pass & high pass circuits & their response to different input waveforms viz. step, pulse, ramp, exponential etc. Low pass circuit on differentiator, high pass circuit as integrator. Compensated attenuator, Pulse transformer

Unit-III

Non-Linear Wave Shaping: Clipping circuits: series diode clipper, shunt diode clipper, transistor clipper. Two level clipping. Comparators, Clamping circuit, Clamping Theorem.

Multivibrators: Bistable multivibrator, fixed bias, self-bias transistor binary circuits concept of speed-up capacitor. Triggering of binary, Schmitt Trigger.

Monostable Multivibrator: circuit explanation & waveforms, rigging of monostable multivibrator – circuit explanation & waveform, timing considerations

Books Recommended

1. Millman and Taub, *"Pulse, Digital and Switching Waveforms",* Tata McGraw-Hill Edition, (1991).
2. Aggarwal K K and Rai, *"Wave Shaping and Digital Circuits"*, Khanna Publishers, Reprint (1992).
3. Straus, "*Wave Generation and Shaping",* McGraw Hill.

4. Bakshi U A and Godse A P, "*Waveshaping Techniques,"* 1st edition, Technical Publications, Pune, (2003).
5. Boylestad Nashelsky, "*Electronic Devices and Circuit Theory*," 8th edition, Pearson education, 7th Indian reprint, (2004).

EC-355 Biomedical Instrumentation [3 0 0 3]

Unit-I

Physiological Systems of The Body: Brief description of neuronal, cardiovascular and respiratory systems; their electrical, mechanical and chemical activities.

Electrodes, Sensors and Transducers: Bioelectric signals, Electrodes for biophysical sensing; surface electrodes; microelectrodes; review of transducers and other sensors for bio-medical applications.

The Heart System and Measurements: The heart; electro conduction system of the heart; the heart as a potential source; the ECG waveform; the standard lead system; the ECG preamplifier; ECG machines.

Unit-II

Physiological Pressure and Other Cardiovascular Measurements and Devices: Physiological pressures; blood pressure measurements; sphygmo manometers; oscillometric and ultrasonic methods; direct methods: manometers; pressure transducers; pressure amplifiers; typical calibration methods; systolic, diastolic and mean pressure detector circuits; pressure differentiation (dp/dt) circuits; automatic zero circuits; practical problems in pressure monitoring; cardiac output measurement; plethysmography; blood flow measurements; phonocardiography; vectorcardiography; defibrillators circuits; pacemakers; heartlung machines.

The Human Respiratory System and Its Measurement: Internal (cellular) and external (lung) respiration; organs of respiration; mechanics of breathing; parameters of respiration; regulation of respiration; unbalanced and diseased states; environmental threats to the respiratory system; respiratory system measurements; respiratory transducers and instruments; spirometers; Respirator.

Unit-III

Measurement of Electrical Activity in Neuromuscular System and Brain: Neuron potential; muscle potential; electromyography (EMG); electroencephalography (EEG); EEG electrodes and the 10-20 system; EEG amplitude and frequency bands; the EEG system – simplified block diagram; preamplifiers and EEG system specifications; EEG diagnostic uses and sleep patterns; visual and auditory evoked potential recordings; EEG system artifacts.

Advances In Bio-Medical Instrumentation: Computer Tomography; Magnetic Resonance imaging; X-ray; Nuclear medicine; Ultrasound; lasers; Electromagnetic interference; Electrical safety; Bedside monitor.

Books Recommended

1. Joseph J. Carr and John M. Brown, *"Introduction to Biomedical Equipment Technology"*, 4th ed., Singapore: Pearson Education, Inc., (2001). (ISBN 81-7808- 327-2)
2. Cromwell L., Weibell F. J. and Pfeiffer E. A., *"Biomedical Instrumentation and Measurements"*, 2nd ed. Singapore: Pearson Education, Inc., (2003). (ISBN 812970028X)
3. Webster J. G. (ed.), *"Encyclopedia of Medical Devices and Instrumentation"*, Vols. 1-4, New York: Wiley (1988).
4. Bronzino J. D. (ed.), *"The Biomedical Engineering Handbook"*, FL: CRC Press (1995).
5. Khandpur R S, "*Handbook on Biomedical Instrumentation*", TMGH, (1998), 13th reprint.

EC-357 Reliability Engineering [3 0 0 3]

Unit-I

Introduction: Definition for Reliability, Static and Dynamic Reliability Need for reliability Engineering, success and failure models, Causes of failures, catastrophic failures and degradation failures Characteristic types of failures, useful life of components, Exponential case of chance failure, Reliability Measures; MTBF, MTTR, hazard rate, probability distribution function, Derivation for exponential distribution function, other kinds of distributions, Binomial, Poisson uniform, Raleigh, Weibull, Gamma distribution, marks, Chains, failures data analysis.

Series Parallel Systems: Reliability Block Diagrams, series systems, parallel systems, K-out of-M systems, open and short circuits failures, standby systems.

Reliability Analysis of Non-Series Parallel System: Boolean algebra Method, Outset approach, delta star method, logical signal relation method, Bay's Theorem Method.

Unit-II

Reliability Prediction: objective of reliability prediction, classification, information sources for failure rate data, prediction methodologies, general requirements, Role and limitations of Reliability prediction.

Reliability Allocation: subsystems reliability improvement, allocation for new units, criticality.

Redundancy Techniques for Reliability: Optimization; signal redundancy, Time redundancy, software redundancy, hardware redundancy.

Unit-III

Maintainability and Availability: forms of maintenance, measures of Maintainability and availability, maintainability function, availability function, two unit parallel system with repair, Markov Model for two unit systems, preventive maintenance, provisioning of spares.

Reliability Testing: kinds of testing, component reliability measurements, parametric methods, confidence limits, accelerated testing, equipment acceptance testing, standard life testing plans, accelerated life testing, system safety analysis-FMECA, risk priority number and its allocation

Economics of Reliability Engineering: Reliability cost, Life Cycle Costing, effect of reliability on cost, reliability achievement cost models, reliability Utility cost models, Replacement policies.

Books Recommended

1. Agarwal K K, "*Reliability Engineering*", 1st Ed., Kluwer Academic Press, USA (1993).
2. Balagurusamy E,"Reliability Engineering", Fourth Reprint, Tata McGraw Hill (2003)
3. Srinath L S, "*Reliability Engineering*", 3rd Ed., East West Press Pvt. Ltd. (1991)
4. Dr Brijendra Singh, "*Quality Control and Reliability Analysis*", Khanna Publishers (1998)
5. Lewis E E, "*Introduction to Reliability Engineering*", John Wiley and Sons (1987)

EC-359 Power Electronics [3 0 0 3]

Unit-I

Semiconductor Switching Devices: Review of Thyristor, two transistor Model of SCR, classification and V-I characteristics, junction temperature, gate circuit ratings, triggering process, UJT and characteristics, UJT as a relaxation oscillator, triggering UJT using SCR, turn off methods, fast recovery diodes, schottky diodes, Series and parallel connections of SCR, DIAC, TRIAC, Power MOSFETS, application of SCR

Power Rectification: Classification of rectifiers, half, full, three-phase rectifier, semi converters, full converters, free wheeling diodes, circuits using SCR, voltage multiplying rectifier circuits, transformer utility factor.

Regulated Power Supplies: Classification of voltage regulators, short period and long period accuracy of voltage regulator, D.C. voltage regulators, complete series voltage regulator circuit with ICs, SMPS basic principles, step up and step down circuits, UPS.

Unit-II

Inverters: Introduction, simple Inverters and Power Inverter using SCR, output voltage control in inverter waveform control, PWM inverters, reduction of harmonies with the help of PWM inverters.

Industrial Timing Circuits:, Thermal timers, Electronic timers, SCR delay timer, I.C. electronic timers, 555 timer as astable, bistable and monostable multivibrator, timer applications.

Induction And Dielectric Heating: Induction heating effect of frequency power requirements, merits and application of induction heating, Dielectric heating, dielectric properties of a few typical materials, thermal losses, application of dielectric heating, skin effect, high frequency sources for induction and dielectric heaters.

Unit-III

Electronic Control of D.C. Motors: Introduction, control of D.C. shunt motor, full wave D.C. shunt motor control overload projection, universal motor control, electronic control for reversing motor control using SCR, choppers, their classifications and applications.

Electronic Control of A.C. Motros: Instability of D.C. motors, variable speed induction motor drives, T.N. characteristics of I.M. invertors for driving the motor, speed control of I.M. using various methods, cyclo-converters, their classifications and applications.

Books Recommended

1. Rashid M H, *"Power electronics"*, 2nd Ed., PHI, N.Delhi (1998).
2. Mithal G K, *"Industrial electronics"*, 18th Ed., Khanna Publishers, Delhi (1998).
3. Biswas S N, *"Industrial electronics"*, 3rd Ed., Dhanpat Rai and Company, Delhi (2000).
4. Bhimbra P S, *"Power electronics"*, 3rd Ed., Khanna Publishers, Delhi (2002).
5. Singh M D, Khanchandani K B, *"Power electronics"*, 6th reprint TMH, New Delhi (2001).

EC-361 Digital Systems Design [3 0 0 3]

Unit-I

Introduction to Digital Design Concepts: Review of digital design fundamentals, minimization and design of combinational circuits, sequential machine fundamentals.

Clocked Sequential Finite State machines: State diagram, analysis of synchronous circuits, derivation of state graphs and tables, reduction of state tables, state assignment, design of sequence detectors, serial data code conversion, design of synchronous sequential state machine, design and applications of counters and shift registers.

Unit-II

Multiinput System Controllers Design: System controller, controller design principles, timing and frequency considerations, DFD development, controller architecture design, asynchronous input handling, state assignment concepts, flip-flop level implementation using VEM's.

Sequential Design using LSI & MSI circuits: Using decoders, multiplexers in sequential circuits, sequential network design using ROMs, PLAs and PALs, Programmable gate Arrays (FPGAs).

Unit-III

Asynchronous Sequential Finite State Machines: Introduction, analysis of asynchronous networks, races and cycles, derivation of primitive flow tables, reduction of primitive flow tables, state assignments, hazards, asynchronous sequential network design.

VHDL: Why VHDL? Basic Language Elements, Data objects, classes and data types, operators, overloading, logical operators, VHDL representation of Digital design entity and architectural declarations, introduction to behavioral, dataflow and structural models.

Books Recommended

1. Fletcher William I, *"An Engineering Approach to Digital Design"*, Third Indian reprint, PHI, (1994).
2. Morris Mano M, "*Digital Design"*, 3rd Edition, Pearson Education (2002).
3. Navabi Z, *"VHDL-analysis and modeling of digital systems"*, McGraw Hill.
4. Skahill Kevin, "*VHDL for Programmable Logic"*, First Indian Reprint, Pearson Education (2004).
5. Charles H. Roth Jr., *"Fundamentals of Logic Design"*, 4th Edition, Jaico Publishers (2002).

Departmental Electives (6th Semester)

EC-352 Information Theory and Coding [3 0 0 3]

Unit-I

Information Theory: Definition of Information, Entropy, Mutual Information, Properties of Mutual Information, Fundamental Inequality, I.T. Inequality, Divergence, Properties of Divergence, Divergence Inequality, Relationship between entropy and mutual information, Chain Rules for entropy, relative entropy and mutual information.

Channel Capacity: Uniform Dispersive Channel, Uniform Focusing Channel, Strongly Symmetric Channel, Binary Symmetric Channel, Binary Erasure Channel. Channel Capacity of the all these channels, Channel Coding Theorem, Shannon-Hartley Theorem

Data Compression: Kraft inequality, Huffman codes, Shannon-Fano coding, Arithmetic Coding

Unit-II

Linear Block Codes

Systematic linear codes and optimum decoding for the binary symmetric channel;Generator and Parity Check matrices, Syndrome decoding on symmetric channels;Hamming codes; Weight enumerators and the

MacWilliams identities; Perfect codes. Cyclic Codes,BCH codes; Reed-Solomon codes, Justeen codes, MDS codes, Alterant, Goppa and generalized BCH codes; Spectral properties of cyclic codes

Unit-III

Decoding of BCH codes: Berlekamp's decoding algorithm, Massey's minimum shift register synthesis technique and its relation to Berlekamp's algorithm. A fast Berlekamp - Massey algorithm.

Convolution codes

Wozencraft's sequential decoding algorithm, Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm, Turbo Codes, Concatenated Codes.

Books Recommended

1. F.J. MacWilliams and N.J.A. Slone, The theory of error correcting codes,North Holland, 1977.
2. R.E. Balahut, Theory and practice of error control codes, Addison Wesley, 1983.
3. Thomas M. Cover, Joy A. Thomas, "Elements of Information Theory", Wiley Publishers.
4. Ranjan Bose," Information Theory Coding, Cryptography", TMH Publication.

EC-354 Embedded Systems [3 0 0 3]

Unit-I

Embedded Processing Systems – Introduction, Components of Embedded Systems

Embedded Processors: Microprocessors, Microcontrollers, DSP and ASICs, Comparative Assessment of Embedded Processors

Pipelining

Unit-II

Memory Devices: ROM family, RAM family, Interfacing memory

Embedded Programming - C and C++, Programming languages for embedded systems: desirable characteristics of programming languages for embedded systems, low-level versus high-level languages.

Input-output Ports and Interfacing, I/O Programming

Interrupts and their servicing, timing devices and interfacing, Analog I/O techniques

Embedded Communications: Serial Bus, Parallel Bus, Networking and Wireless Standards

Introduction to Real-Time Operating System (RTOS), RTOS: memory management

Unit-III

I/O Management and Device Drivers

Software Engineering Practices: Embedded Software development process

Hardware-Software Co-design in an embedded system

Tools and Trends in Embedded systems design

Recommended Books

1. Raj Kumar, *"Embedded Systems: Architecture, Programming and Design",* Tata McGraw Hill, Third Reprint, (2003).
2. John Catsoulis, O'Reilly, *"Designing Embedded Hardware"*, First Indian Reprint, (2003).
3. David E. Simon, *"An Embedded Software Primer"*, Pearson Education Asia, Fifth Indian Reprint, (2002).
4. Michael Barr, O'Reilly, *"Programming Embedded Systems in C and C ++"*, (1999).
6. J.W. Valvano, "Embedded Microcomputor System: Real Time Interfacing", Brooks/Cole, 2000.
7. Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 1999.
8. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.

EC-356 Microcontrollers [2 0 2 3]

Unit-I

Introduction: 8051 Micro controller: Comparison of Microprocessor and Micro controller, micro controller and embedded processors, overview of 8085 families.

8051 Assembly Language Programming: Introduction to 8051 Assembly programming, Assembling and running an 8051 program. Data Types and directives.8051 flag bits and PSW register. Register banks and stack.

Jump loop and call instructions, I/O Port programming: Addressing modes and accessing memory using various addressing modes. Arithmetic instructions and programs, Logic instructions and programs

Unit-II

Single Bit addressability: Single bit instructions and programming, Timer/counter programming in the 8051
Serial Communication: 8051 connection to RS 232, 8051 serial communication programming.
Interrupt Programming: 8051 Interrupts, Programming of Timer Interrupts, Interrupt Priority list.

Unit-III

Introduction to Interrupts Programming, Interfacing to External Memory, Interfacing with 8255.
Real World Interfacing: LCD, Stepper motor, keyboard, DAC & ADC.

List of Experiments

1. Introduction and Installation of Keil and Flash Magic Software for 8051 microcontroller
2.
    a. Write a Program to complement the contents of the accumulator 700 times.
    b. Write a Program to add a series of number stored at memory location 40 H to 45 H
    c. Write a Program to move contents from one memory location to Accumulator using indirect Addressing mode.
3. Write a Program to copy 55 H to 41H -45 H using following
    a. Direct Addressing Mode
    b. Indirect Addressing mode.
    c. Indirect Addressing mode with loop.
4.
    a. Write a Program to copy 10 bytes from memory location 50H to memory location 60 H.
    b. Write a Program to add values in RAM location 40 H -44H and to store carry.
5.
    a. Write a Program to find the greatest number among the given numbers.
    b. Write a Program to find the smallest number from the given set of numbers.
    c. Write a Program to display bytes on P1 and FFH when 00H is reached
    d. Write a Program to turn P0.0 ON and OFF using T0 as time delay .
6.
    a. Write a Program to use timer to introduce delay and output on LED.
    b. Write a Program for serial transmission.
    c. Write a Program for serial reception in mode 2 for timer 1 at 9600 baud rate to receive “YES ” entered in serial window. Store code in A.
7. Write a Program to display 0-9 on 7 segment display.
8. Write a Program to interface LCD with 8051 and to display “YES” on LCD.
9. Write a Program to display “NO ” on LCD and rotate it clockwise and anticlockwise by interfacing it with DIP switches.
10. Write a Program to interface stepper motor with 8051 and rotate it with clockwise or anticlock wise with push button switches.
11. Write a Program to interface stepper motor using 8051 relay.
12. Write a Program for the execution of external level triggered interrupt INT0.
13. Write a Program for the execution of external level triggered interrupt INT1.
14. Write a Program in which 805 reads data from P1 and writes it to P2 continously while giving a copy of it to the serial communication port to be transmitted serially using serial interrupt.
15. Write a Program Interfacing of 7-segment LED.
16. Interrupt programming of 8051
17. Study of 8051 timers
18. Write a Program for the Interfacing of DAC and ADC to 8051.
19. Write a Program Timer and Counter Technique using MC 8051-C: Stepper/ac/dc motor Control.
20. Write a Program for interfacing of buzzer with 8051 .

Books Recommended

1. Ali Mazidi, “The 8051 Microcontroller and embedded Systems” Pearson Education, 2005
2. David e Simon ,” An embedded software primer” Pearson Education ,2nd edition.

3. Kenneth J Ayala, "The 8051 Microcontroller", Cengage Learning (3rd edition)
4. I. Scott Mackenzie, " The 8051 Microcontroller", Pearson education (4th edition)
5. Thomas W. Schultz, " C and 8051", Woods Island prints (4th edition)

EC-358 Computer Organization and Architecture [3 0 0 3]

Unit-I

Digital Logic: Fundamental building blocks (logic gates, flip-flops, counters, registers, PLA); logic expressions, minimization, sum of product forms; register transfer notation; physical considerations (gate delays, fan-in, fan-out)

Data Representation: Bits, bytes, and words; numeric data representation and number bases; fixed- and floating-point systems; signed and twos-complement representations; representation of nonnumeric data (character codes, graphical data); representation of records and arrays.

Assembly Level Organization: Basic organization of the von Neumann machine; control unit; instruction fetch, decode, and execution; instruction sets and types (data manipulation, control, I/O); assembly/machine language programming; instruction formats; addressing modes; subroutine call and return mechanisms; I/O and interrupts.

Unit-II

Memory Systems: Storage systems and their technology; coding, data compression, and data integrity; memory hierarchy; main memory organization and operations; latency, cycle time, bandwidth, and interleaving; cache memories (address mapping, block size, replacement and store policy); virtual memory (page table, TLB); fault handling and reliability.

Interfacing and Communication: I/O fundamentals: handshaking, buffering, programmed I/O, interrupt-driven I/O; interrupt structures: vectored and prioritized, interrupt acknowledgment; external storage, physical organization, and drives; buses: bus protocols, arbitration, direct-memory access (DMA); introduction to networks; multimedia support; raid architectures

Functional Organization: Implementation of simple datapaths; control unit: hardwired realization vs. microprogrammed realization; instruction pipelining; introduction to instruction-level parallelism (ILP)

Unit-III

Multiprocessor And Alternative Architectures: Introduction to SIMD, MIMD, VLIW, EPIC; systolic architecture; interconnection networks; shared memory systems; cache coherence; memory models and memory consistency.

Performance Enhancements: RISC architecture; branch prediction; prefetching; scalability.

Contemporary Architectures: Hand-held devices; embedded systems; trends in processor architecture.

Books Recommended

1. William Stallings, *"Computer Organisation and Architecture"*, 5th ed. 0-13-081294-3 Prentice-Hall, (1999).
2. Morris Mano M, Charles R Kime, *"Logic and Computer Design Fundamentals"*, 0-13-016176-4 Prentice-Hall, (2000).
3. Andrew S Tanenbaum, *"Structured Computer Organisation"*, 4th ed. 0-13-020435-8 Prentice-Hall, (1999).
4. Linda Null, Julia Lobur, "*The Essentials of Computer Organization and Architecture*," Jones & Bartlett Publishers (2003)
5. Carpinelli John D., "*Computer Systems Organization and Architecture*," Addison Wesley (2000)

EC-360 ASICs and FPGAs [3 0 0 3]

Unit-I

Introduction: VLSI Design Flow, Structured Design Strategies, VLSI Design Styles, Chip Design Options. Role of FPGAs, FPGA Type, FPGA vs Custom VLSI, FPGA Based System Design. Type of ASIC, Full custom ASIC, Gate Array Based ASIC, Standard Cell Based ASIC, Different Types of Array, Design Flow, Case Study, Economics of ASIC.

ASIC Library Design: Transistor as Resistor, Transistor Parasitic Capacitance, Logical Effort, Predicting Delay, Logical Area, Logical paths, multistage cells, Optimum Delay, Library Cell Design, Library

Architecture

Unit-II

Programmable ASICs: Anti fuse**,** Static RAM, EPROM & EEPROM, Practical Issues, Specification and programmable

FPGA: FPGA Architectures, SRAM-Based FPGA, Permanently Programmed FPGAs, Chip I/O, Circuit Design of FPGA fabrics. ASIC I/O Cells

Unit-III

HDL: An overview of VHDL and verilog HDL, Basic concepts of hardware description languages. Structural, Data-flow and Behavioral styles, Delay modeling. Control statements, FSM modeling of hardware description. Architecture of event driven simulators.

Logic synthesis - physical design compilation, simulation, and implementation. Floor planning and placement, Commercial EDA tools for synthesis.

Books Recommended

1. 1.J. Bhaskar, "VHDL Primer", Pearson Education Asia 2001.
2. Z. Navabi, "VHDL", McGraw Hill International Ed. 1998.
3. S. Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Prentice Hall NJ, USA), 1996.
4. Michad John, Sebastian Smith "Application Specific Integrated Circuit",Pearson Education, LPE 2006.
5. Wayne Wolf, "FPGA- Based System Design"Pearson education,LPE 1st Indian Reprint, (2005)
6. John V. oldfield,Richard C. Dorf "Field Programmable Gate Arrays" John Wiley & Sons (1995)

EC-362 Radar and TV Engineering [3 0 0 3]

Unit-I

Radar Engineering

Introduction: Working Principle of Radar, Radar Frequencies, Radar Equation, Minimum Detectable signal, integration of radar pulses, Pulse repetition frequency and range ambiguities, Applications of Radar.

CW And Frequency Modulated (Fm) Radar: Doppler effect, CW Radar, FM-CW radar

MTI and Pulse Doppler Radar: Principle And Working, Delay-Line Cancellers

Unit-II

Tracking Radars: Angular Tracking Systems: Conical Scan and Monopulse, Range and Velocity Tracking Systems, Fundamentals Of Electronic Warfare, Instrument Landing Systems.

TV Engineering

Signal Transmission And Channel Bandwidth: Sound and Picture transmission, Signal Standards, Scanning process, Interlaced Scanning, Resolution, Video Bandwidth, Construction of Composite Video Signal, Vestigial Sideband transmission, Negative transmission, Complete Channel Bandwidth.

Unit-III

Monochrome TV Receivers*:* Block diagram of TV receiver, Antenna, Balun, R.F Tuner- Block Diagram of VHF and UHF tuners, Video I.F amplifier, Video Detector, Video Amplifier, A.G.C circuits, Sound I.F, Picture tube, Horizontal and Vertical deflection circuits

Colour Television: Colour fundamentals, Mixing of Colour, Chromaticity Diagram, Colour T.V Transmission and Reception.

Books Recommended

1. Skolnik, *"Introduction to Radar Systems"*, Tata McGraw Hill.
2. Peyton Z. Peebles, Jr, *"Radar Principles"*, John Wiley and Sons (2004).
3. Nagaraja, *"Electronic Navigation"*, Tata McGraw Hill.
4. R R Gulati, "Monochrome and color Television Engineering", WileyEastern.
5. Arvind Dhake, *"Television Engineering"*, Tata McGraw Hill.

EC-364 Optoelectronic Devices [3 0 0 3]

Unit-I

Introduction: Semiconductor materials; Crystal lattices; Bulk Crystal growth, epitaxial growth.

Energy bands and Charge carriers in Semiconductors: direct and indirect semiconductors; variation of Energy bands with alloy composition. Charge carriers in semi-conductors-electrons, holes, effective mass; intrinsic and extrinsic materials. Drift of carriers in electric and magnetic fields.

Unit-II

Excess carries in Semiconductors: Optical absorption; luminescence - photoluminescence, electroluminescence ,electroluminescence. Carrier lifetime and photoconductivity, diffusion of carriers.

P-N Junction Diode: Current-Voltage Characteristics; hetrojunctions.

Unit-III

Optoelectronic Devices: Principle of operation and characteristics; Light emitting diodes, lasers, photo detectors, solar cells.

Relevance of III-V and IV-VI material-systems in optoelectronic devices.

Integrated Optics: Optical waveguides-passive, electro-optical; optical modulators and switches; optical storage devices.

Books Recommended

1. Pallab Bhattacharya, "Semiconductor Optoelectronic Devices", 2nd Edition
2. Street B G and Banerjee S, "Solid State Electronic Devices", PHI New Delhi, (2004)
3. Sze S M, "Physics of Semiconductors Devices", Wiley Eastern Limited, New Delhi.
4. Wilson and Hawkes, "Optoelectronics; An Introduction", 2nd Ed., PHI
5. Hummel R E, "Electronic Properties of Materials", Narosa Publishing House, New Delhi.

Departmental Electives (7th Semester)

EC-451 Biomedical Signal Processing [3 0 0 3]

Unit-I

Neurological Signal Processing: The Brain and its potentials; The Electrophysiology origin of brain waves; the EEG Signal and its characterstics; EEG analisis; Linear prediction theory; The autoregressive (AR) method; Transient detection and elimination-the case of epileptic patients.

Adaptive Filter and Algorithm: A Review of the Wiener filtering problem; Principle of an adaptive filter; Steepest – descent algorithm; Windrow-hoff least –mean-square adaptive algorithm.

Unit-II

Cardiological Signal Processing: Basic electrocardiography; ECG data acquisition; ECG lead system; ECG parameters and their estimation; Use of multi-scale analysis for parameters estimation of ECG waveforms.

Adaptive Noise Canceling: Adaptive noise canceller; Cancellation of 60 Hz interference in electrocardiography, canceling donor heart interference in heart –transplant electrocardiography, cancellation of the electrocardiography signal from the electrical activity of the chest muscles, canceling method to enhance fetal ECG monitoring

ECG Recording and Analysis: Long term continuous ECG recording; The wavelet approximation- discrete wavelet series; Discrete wavelet transform (DWT); Multi-resolution analysis; Pyramid algorithm.

Unit-III

HRV and Arrhythmia analysis: Heart rate variability-definition; comparison of short-term and long term HRV analysis; Time domain and spectral domain parametrs of short term recording.

Books Recommended

1. Reddy D C. "*Modern Biomedical Signal Processing – Principles and Techniques*", TMH, New Delhi, 2005
2. Akay M. "*Biomedical Signal Processing*", Academic press, California,1994.
3. Tompkins W J "*Biomedical Signal Processing*", Prentice hall of India, New Delhi, 1999.
4. Bronzino J D "*The Biomedical Engineering handbook*", CRC and Free press, Florida, 1995.
5. Arnon Cohen "*Biomedical Signal Processing"* Crc Pr I Llc; 2nd edition, May, 2002.

EC-453 **Image Processing** **[3 0 0 3]**

Unit-I

Image representation - Gray scale and colour Images, image sampling and quantization

Two dimensional orthogonal transforms - DFT, FFT, WHT, Haar transform, KLT, DCT

Image enhancement - filters in spatial and frequency domains, histogram-based processing, homomorphic filtering.

Edge detection - non parametric and model based approaches, LOG filters, localisation problem

Unit-II

Image Restoration- PSF, circulant and block- circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods.

Mathematical morphology – binary morphology, dilation, erosion, opening and closing, duality relations, gray scale morphology, applications such as hit-and-miss transform, thinning and shape decomposition.

Computer tomography – parallel beam projection, Radon transform, and its inverse, Back-projection operator, Fourier-slice theorem, CBP and FBP methods, ART, Fan beam projection.

Unit-III

Image communication - JPEG, MPEGs and H.26x standards, packet video, error concealment.

Image texture analysis - co-occurence matrix, measures of textures, statistical models for textures.

Hough Transform, boundary detection, chain coding, and segmentation, thresholding methods.

Books Recommended

1. Gonzalez, Woods, "Digital Image Processing", Pearson Education Asia, Ninth Indian Reprint, (2004).
2. Arthur R. Weeks, Jr, "Fundamental of Electronic Image Processing", Prentice Hall of India, (2003).
3. Anil K Jain, "Fundamental of Digital Image Processing", Prentice Hall of India, (2001).
4. Ioannis Pitas, "Digital Image Processing Algorithms and Applications", Wiley-Interscience. 2000.
5. A. Rosenfold and A.C. Kak, Digital Image Processing, Vol1 and 2 , PHI
6. H.C. Andrew and B.R.Hunt, Digital Image Retoration, PHI

EC-455 **Satellite Communication** **[3 0 0 3]**

Unit-I

Introduction: Origin and brief history of satellite communications, an overview of satellite system engineering, satellite frequency bands for communication.

Orbital Theory: Orbital mechanics, locating the satellite in the orbit w.r.t. Earth looks angle determination. Azimuth & elevation calculations.

Spacecraft Systems: Attitude and orbit control system, telemetry, tracking and command (TT&C), communications subsystems, transponders, spacecraft antennas.

Unit-II

Satellite Link Design: Basic transmission theory, noise figure and noise temperature, C/N ratio, satellite down link design, satellite uplink design.

Modulation, Multiplexing, Multiple Access Techniques: Analog telephone transmission, Fm theory, FM Detector theory, analog TV transmission, S/N ratio Calculation for satellite TV linking, Digital transmission, baseband and bandpass transmission of digital data, BPSK, QPSK, FDM, TDM, Access techniques: FDMA, TDMA, CDMA.

Unit-III

Encoding & FEC for Digital Satellite Links: Channel capacity, error detection coding, linear block, binary cyclic codes, and convolution codes.

Satellite Systems: Satellite Earth station Technology, satellite mobile communication, VSAT technology, Direct Broadcast by satellite (DBS),GPS system

Books Recommended

1. Timothy Pratt, Charles W. Bostian, "*Satellite communication*" John Wiley & sons publication (2002).
2. Timothy Pratt, Charles W. Bostian, Jeremy Allnutt, "*Satellite Communications*" 2nd ed., Wiley, John & Sons, 2002.

3. Gerard Maral, Michel Bousquet, "*Satellite Communications Systems: Systems,Techniques and Technology*" 4th ed., Wiley, John & Sons, (2002).
4. Martin J, "*Communication satellite systems*", PH publication(1978)
5. Dennis Roddy "Satellite Communication"4th ed, McGraw-Hill (2006)

EC-457 Genetic Algorithms and Applications [3 0 0 3]

Unit-I

Introduction to Evolutionary Computation (EC): Biological and artificial evolution, Different branches of EC, e.g., GAs, EP, ES,GP, etc. A simple evolutionary algorithm

Search Operators: Recombination/ Crossover for strings (e.g. binary strings), e.g., one point, multipoint and uniform crossover operators, Mutation for strings, e.g., bit flipping, recombination/crossover and mutation rates, Recombination for real –valued representations, e.g. discrete and intermediate recombinations, Mutation for real-valued representations, e.g., Gaussian and Cauchy mutations, self-adaptive mutations, etc. Why and How a recombination or mutation operator works.

Unit-II

Selection Schemes: Fitness Proportional selection and fitness scaling, Ranking, including linear, power, exponential and other ranking methods, Tournament selection, Selection pressure and its impact on evolutionary search.

Search Operators and Representations: Mixing different search operators, an anomaly of self-adaptive mutations, The importance of representation, e.g., binary vs. Gray Coding, Adaptive representation, Analysis, some examples

Unit-III

Multiobjective Evolutionary Optimization: Pareto optimality, Multiobjective evolutionary algorithms, computational time complexity of EAs, No free lunch theorem

Some Applications

Books Recommended

1. David A Coley, "An introduction to Genetic Algorithms for Scientists and Engineers", World scientific publishing company(1997)
2. Mitsuo Gen Runwei Cheng, Wiley-Interscience, "Genetic Algorithms and Engineering Design", 1st Edition, (1997)
3. Thomas Back, "Evolution algorithms in theory and practice evolution strategies, Evolutionary programming, Genetic Algorithms", Oxford University press,(1996)
4. Kalyanmoy Deb, " Multi Objective Optimization using Evolutionary Algorithms", John Wiley and Sons(2001)
5. William M, "Evolutionary Algorithms: The Role of Mutation and Recombination",(Natural Computing Series), Springer-Verlag (2000)

EC-459 Wireless Communication [3 0 0 3]

Unit-I

Introduction: Mobile radio systems around the world, examples of wireless communication systems: paging system, cordless systems, cellular systems, Comparison of common wireless communication systems.

Multiple Access Techniques for wireless communication: Introduction, Time division multiple access (TDMA), Frequency division multiple access (FDMA), ALOHA Protocols**.**

Cellular Mobile Systems; A basic wireless/cellular system, performance criteria, uniqueness of mobile radio environment, operation of cellular systems, planning a cellular system, analog & digital cellular systems.

Unit-II

Interference: Introduction to co-channel interference, real time co-channel interference, co-channel measurement design of antenna system, antenna parameter and their effects, diversity receiver in co-channel interference – different types.

Cell Coverage for Signal & Traffic: General introduction, obtaining the mobile point to point mode, propagation over water or flat open area, foliage loss, propagation near in distance, long distance propagation, point to point prediction model- characteristics, cell site, antenna heights and signal coverage cells, mobile to

mobile propagation.

Unit-III

Frequency Management and Channel Assignment: Frequency management, fixed channel assignment, non-fixed channel assignment, traffic & channel assignment

Hand Off, Dropped Calls: Why hand off, types of handoff and their characteristics, dropped call rates & their evaluation

Operational Techniques: Parameters, coverage hole filler, leaky feeders, cell splitting and small cells, narrow beam concept.

Books Recommended

1. William, C Y Lee, *"Mobile Cellular Telecommunications"*, 2nd ed., McGraw- Hill.
2. Kamilo Feher (PHI), *"Wireless and Digital Communications"*.
3. *"Mobile Communication Hand Book"*, 2nd Ed., IEEE Press.
4. *"Mobile Communication Engineering"*, Theory & Applications, TMH.
5. Theodore S Rappaport, *"Wireless communications: Principles and practice"*, third Indian reprint Pearson Education Asia, (2003).

EC-461 Computer Communication Networks [3 0 0 3]

Unit-I

Introduction to computer networks, Basic concepts of analog and digital signals, Data transmission concepts, analog &digital transmission, transmission impairments.

Introduction To Parallel Distributed Processing, Application of network, Multiprocessing and multitasking, Multiplexing techniques, need of multiplexing

Network structures - network topologies, communication protocols and standards, design issues, messages and switching, circuit switching and packed switching

OSI reference model, physical layer and data drink layer, Network layer, session layer presentation layer, application layer, Data Transmission in the OSI model.

Unit-II

OSI Terminology Connection Oriented And Connection Less Service, service primitives, The relationship of service to protocols, public network, USENET, BITNET, ERNET, NICNET, VVCP, SNA, E-mail, voice mail & its services.

ISDN system architecture, digital PBX & PABX, ISDN interface, C-Dot PAD, PABX Terminal handling, polling.

The telephone system, modules, RS449, digital channel error detection/correction parity check, CRCs, ARQ, transmission strategies, stop - and wait ARQ, ARPANET ARQ, Go back ARQ, selective repeated ARQ, ALOHA protocols

Unit-III

Theoretical Basis For Data Transmission, maximum data rate of a channel base band coaxial cable, broadband coaxial cable, FDDI.

SONET and satellite network, communication satellites,packet radio network, routing algorithms Inter Networking - bridges and gateways, quality of services.

Connection management dialogue management, data exchange, activity management, RPC, Orphans, Data presentation, data compression, network security and privacy, application lever issues, virtual terminals, file transfer access and management.

Books Recommended

1. Andrew S Tanenbaum, *"Computer Network"*, PHI.
2. Dimitri Bertsekas & Robert Gallager, *"Data Network"*, PHI.
3. Gilli Wates, *"Computer Communication Network"*, McGraw- Hill.
4. William Stallings "*Data & Computer Communications*", 6th Edition, Pearson Education (2004).
5. Fayez Gebali, "*Computer Communication Networks, Analysis and Design*, 3rd Ed., NorthStar Digital Design, Inc., (2005).

EC-463 Digital Signal Processors [3 0 0 3]

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

Books Recommended

1. Kuo, Digital Signal Processors: Architectures, Implementations, and Applications, Prentice Hall, 2004.
2. Kuo, Real-Time Digital Signal Processing: Implementations and Applications, Wiley, 2006
3. Nasser Kehtarnavaz, Real-Time Digital Signal Processing: Based on the TMS320C6000, Newnes, 2004
4. Rulph Chassaing, DSP Applications Using C and the TMS320C6x DSK, Wiley Interscience, 2002
5. Application Notes and Product Brochures from Texas Instruments and Analog Devices websites

EC-465 Digital Integrated Circuits [3 0 0 3]

Unit-I

MOS Inverter: Introduction to resistive - load inverter, inverter with n-type MOSFET load, CMOS inverter

Switching Characteristics and Interconnects Effects: Introduction, Delay time definitions, Calculation of delay times, Inverter design with delay constraints, Estimation of interconnect parasitic

Unit-II

Sequential MOS Logic Circuits: Introduction, SR latch circuits, Clocked latch and Flip-flop circuits, CMOS D-latch and edge -triggered flip-flop.

Unit-III

Semiconductor Memories: Introduction, Dynamic random access memory (DRAM), Static random access memory(SRAM),Non-volatile memory.

Low Power CMOS Logic Circuits: Introduction, Overview of power consumption, Switching power dissipation of CMOS inverter, Estimation and optimization of switching activity.

Books Recommended

1. Rabaey J.M, Chandrakasan A, Nikolic B , "Digital Integrated Circuits- A Design Perspective", Second Edition, Prentice Hall
2. S M Kang and Y Lebici,"CMOS Digital Integrated Circuits-analysis and design", 3rd ed, McGraw Hill.
3. Pucknell D A and Eshraghian K, *"Basic VLSI Design"*, Prentice Hall India, New Delhi (2003).
4. Glaser L and Dobberpuhl D, *"The Design and Analysis of VLSI Circuits"*, Addison Wesley (1985).
5. Weste N and Eshranghian K, *"Principles of CMOS VLSI Design"*, Pearson Education Asia (2001).

EC-467 VLSI Testing [3 0 0 3]

Unit-I

Introduction -Scope of testing and verification in VLSI design process. Problem in analog and digital testing.

Logic simulation & **Fault modelling:** Circuit Modelling Compiled simulation Event-driven simulation Simulation Techniques. Fault detection and redundancy. Fault equivalence and fault dominance. Stuck-at faults bridging faults, transistor faults, delay faults etc. Fault Detection using Boolean Difference. Path Sensitization Fault Collapsing

Unit-II

Testing Algorithm for Combinational Circuits: Introduction to combinational circuit, Problems in combinational circuit testing,D- Algorithm, Boolean Difference, Podem; Random, Deterministic and Weighted Random Test Pattern Generation; ATPG

Testing Generation for Sequential Circuit: . Models of Sequential Circuits, State Table Method, Self Initializing Test Sequences, Undetectability, Distinguishing and Synchronizing Sequences. Complexity o

Sequential ATPG

Unit-III

PLA Testing: Cross Point Fault Model and Test Generation, PAL Testing

Memory Testing: Different method of memory testing, Marching Tests; Delay Faults; BIST BIST for testing of logic and memories

Recent Trends in VLSI Testing

Books Recommended

1. M. Bushnell and V. D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed- Signal VLSI Circuits", Kluwer Academic Publishers, 2000.
2. M. Abramovici, M. A. Breuer and A. D. Friedman, "Digital Systems Testing and Testable Design", IEEE Press, 1990.
3. T.Kropf, "Introduction to Formal Hardware Verification", Springer Verlag, 2000.
4. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers, 2001.
5. J.M. Rabaey, A. Chandrakasan and B. Nikolic: Digital Integrated Circuits- A Design Perspective, 2nd ed., PHI, 2003

Departmental Electives (8th Semester)

EC-452 Antenna and Wave Propagation [3 0 0 3]

Unit-I

Radiation: Review of electromagnetic fields, Displacement current, Maxwell's equations in free space, plane wave & uniform plane wave in free space. Electromagnetic radiations, Physical concept of radiation, Retarted potential, Radiation from a Hertizian dipole, monopole and a half wave dipole, Fields in the vicinity of an antenna and far field approximation.

Antenna Parameters: Introduction, Isotropic radiators, Radiation pattern, Gain, Directive gain, Directivity, Reciprocity theorem & its applications, effective aperture, radiation resistance, terminal impedence, noice temperature, elementary ideas about self & mutual impedence, front-to-back ratio, antenna beam width, antenna bandwidth, antenna beam efficiency, antenna beam area or beam solid angle, polarization, antenna temperature.

Unit-II

Antenna Arrays: Introduction, various forms of antenna arrays, arrays of point sources, non-isotropic but similar point sources, multiplication of patterns, arrays of n-isotropic sources of equal amplitude and spacing (Broad-side & End-fire array cases), array factor, directivity and beam width, array of n-isotropic sources of equal amplitude and spacing end-fire array with increased directivity, scanning arrays, Dolph-Tchebysceff arrays, tapering of arrays, binomial arrays, continuous arrays, rectangular arrays, superdirective arrays.

Practical Antennas: Aperture Antennas, loop antennas, slot radiators, scanning antennas, signal processing antennas, travelling wave antennas, Smart Antennas. long wire antenna, V-antenna, Rhombic antenna, Folded dipole antenna, Yagi-Uda antenna, and helical antenna, slot antenna, microstrip or patch antennas, and turnstile antenna, frequency independent antennas, and microwave antennas, antenna measurement.

Unit-III

Wave Propagation: Introduction, structure of atmosphere, basic idea of ground wave, surface wave, and space wave propagation, tropospheric propagation and duct propagation.

Books Recommended

1. Krauss J D, *"Antennas"*, 4th edition, McGraw - Hill Inc., New York (1991).
2. Balanis A Constantine, *"Antenna Theory, analysis and design",* 2nd edition, Wiley, New York (1997).
3. Prasad K D, *"Antenna and Wave Propagation"*, 3rd edition, Satya Prakashan, New Delhi (1996).
4. Stutzman W L, Thieele G A, "*Antenna Theory and Design*", 2nd Ed., Wiley (1997)
5. Gosling William, "*Radio Antennas and Propagation*", Newens

EC-454 Neural Networks and Fuzzy Logic [3 0 0 3]

Unit-I

Neural Networks Characteristics: History of Development in neural networks, Artificial neural net terminology, model of a neuron, Topology, Types of learning. Supervised, Unsupervised learning.
Basic Learning laws, Hebb's rule, Delta rule, widrow and Hoff LMS learning rule, correlation learning rule instar and ouster learning rules.

Unit-II

Unsupervised Learning: Competitive learning, K-means clustering algorithm, Kohonen's feature maps.
Radial Basis function neural networks- recurrent networks, Real time recurrent and learning algorithm.
Introduction to Counter propagation Networks- CMAC Network, ART networks, Application of NN in pattern recognition, optimization, Control, Speech and decision making.

Unit-III

Fuzzy Logic: Basic concepts of Fuzzy logic, Fuzzy vs Crisp set, Linguistic variables, membership functions, operations of Fuzzy sets, Fuzzy if-then rules, Variables inference techniques, defuzzification techniques, basic Fuzzy interference algorithm, application of fuzzy logic , Fuzzy system design implementation , useful tools supporting design.

Books Recommended

1. Berkin Riza C and Trubatch, " Fuzzy System design principles- Building Fuzzy IF-THEN rule bases", IEEE Press.
2. Yegna Narayanan, "Artificial Neural Networks". 8th Printing. PHI(2003)
3. Patterson Dan W, "Introduction to artificial Intelligence and Expert systems", 3rd Ed., PHI
4. Simon Haykin, "Neural Networks" Pearson Education.
5. Yen and Langari, "Fuzzy Logic: Intelligence, Control and Information", Pearson Education.
6. Jacek M Zaurada, "Introduction to artificial neural Networks Jaico Publishing Home, Fouth Impression.

EC-456 Wavelet Theory and Applications [3 0 0 3]

Unit-I

Continuous Wavelet Transform Introduction, Continuous-time wavelets, Definition of the CWT, the VWT as a Correlation, Constant-Factor Filtering Interpretation and Time-Frequency Resolution, the VWT as an Operator, Inverse CWT, Problems.
Introduction to Discrete Wavelet Transform And Orthogonal Wavelet Decomposition: Introduction, Approximation of Vectors in Nested Linear Vector Subspaces, Examples of an MRA, Problems.

Unit-II

MRA, Orthonormal Wavelets, And Their Relationship To Filter Banks: Introduction, Formal Definition of an MRA, Construction of General Orthonormal MRA, a wavelet Basic for the MRA, Digital Filtering Interpretation, Examples of Orthogonal Basic Generating Wavelets, Interpreting Orthonormal MRAs for Discrete-Time signals, Miscellaneous Issues Related to PRQME Filter Banks, generating Scaling Functions and wavelets from Filter Coefficient, Problems.

Unit-III

Wavelet Transform And Data Compression: Introduction, Transform Coding, DTWT for Image Compression, Audio Compression, And Video Coding Using Multiresolution Techniques: a Brief Introduction.
Other Application 0f Wavelet Transforms: Introduction, Wavelet denoising speckles Removal, Edge Detection and Object Isolation, Image Fusion, Object Detection by Wavelet Transform of Projections, Communication application.

Books Recommended

1. James S. Walker, "*A Primer on Wavelets and their Scientific Applications*", CRC Press, (1999).
2. Rao, "*Wavelet Transforms*", Pearson Education, Asia.
3. C. Sidney Burrus, Ramesh A. Gopinath, "*Introduction to Wavelets and Wavelets Transforms"*, Prentice Hall, (1997).

4. Paul S. Addison, Napler Addison, "*The Illustrated Wavelet Transform Handbook*", Institute of Physics Publishing. (2002).
5. Dwight F. Mix, Kraig J. Olejniczak, "*Elements of Wavelets for Engineers and Scientists*", Wiley-Interscience. (2003).

EC-458 Photonic Systems and Networks [3 0 0 3]

Unit-I

Introduction: Overview of the architectures and principles of optical systems and networks; Access networks; LANS, WANS & MANS; SONET, SDH and ATM

Components for Optical Networks: Fused fibre devices such as couplers, WDMs and WFCs; filters and WDMs such as interference filters

Fabry Perot etalons and Bragg gratings; optical isolators; integrated optic modulators and switches; wavelength converters, Dispersion Compensating techniques

Unit-II

Optical Amplifiers (EDFAs and SOAs): Principles of operation; gain characteristics; wavelength characteristics**,** cross talk and wavelength conversion; noise characteristics and noise figure; characteristics of amplifiers cascades.

Design and Analysis of Optically Amplified links: Systems performance analysis and power budget analysis for BERs of 10^{-9} for optically Amplified links.

Unit-III

Design and Analysis of Common Optical Systems and Networks: Power budgets, issues of component specification and tolerances, PONs, BPONs, WDM systems, wavelength routing networks and all optically switched systems, Optical Fiber impairment issues like: higher order dispersion, fiber nonlinearities in optical systems and Networks, optical solitions

Note: *Design and analysis is to be learned practically using simulation tool OptSim or OptiSystem and Artifex.*

Books Recommended

1. Ramaswami R & Safarajan K, "*Optical Networks: A Practical Perspective*" 2nd Edition, Morgan Kaufmann.
2. OptSim/OptiSystem Mannuals.
3. Abdellatif Marrakchi, " *Photonic Switching and Interconnects*," Marcel Dekker, November 1993.
4. Jean-Pierre Laude, " *DWDM Fundamentals, Components, and Applications*," Artech House, January 2002.
5. Debra Cameron, *" Optical Networking*," Wiley, December 2001..

EC-460 Wireless Sensor Networks [3 0 0 3]

Unit-I

Introduction: Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks

Sensor Node Hardware and Network Architecture: Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.

Unit-II

Deployment and Configuration: Localization and positioning, Coverage and connectivity, Single-hop and multihop localization, self configuring localization systems, sensor management

Network Protocols: Issues in designing MAC protocol for WSNs, Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and Zig Bee, Dissemination protocol for large sensor network.

Routing protocols: Issues in designing routing protocols, Classification of routing protocols, Energy-efficient routing, Unicast, Broadcast and multicast, Geographic routing.

Unit-III

Data Storage and Manipulation: Data centric and content based routing, storage and retrieval in network, compression technologies for WSN, Data aggregation technique.

Applications: Detecting unauthorized activity using a sensor network, WSN for Habitat Monitoring.

Books Recommended:

1. Holger Kerl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Network", John Wiley and Sons, 2005 (ISBN: 978-0-470-09511-9)
2. Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, "Wireless Sensor Network", Springer 1st Ed. 2004 (ISBN: 978-4020-7883-5).
3. Feng Zhao, Leonidas Guibas, " Wireless Sensor Network",Elsevier, 1st Ed. 2004 (ISBN: 13- 978-1-55860-914-3)
4. Kazem, Sohraby, Daniel Minoli, Taieb Zanti, "Wireless Sensor Network: Technology, Protocols and Application", John Wiley and Sons 1st Ed., 2007 (ISBN: 978-0-471-74300-2).
5. B. Krishnamachari, " Networking Wireless Sensors", Cambridge University Press.
6. N. P. Mahalik, "Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications" Springer Verlag.

EC-462 Advanced Communication Systems [3 0 0 3]

Unit-I

Spread Spectrum Communication: Direct sequence and frequency hopped spread spectrum, spreading sequences and their correlation functions, Acquisition and tracking of spread spectrum signals

Code Division Multiple Access (CDMA): DS-CDMA on AWGN channels, DS-CDMA on frequency selective fading channels, Performance analysis of cellular DS-CDMA, Capacity estimation, Power control effect of imperfect power control on DS-CDMA performance, Soft Hand offs, **S**preading/coding tradeoffs, multi carrier CDMA, IS95A CDMA systems, 3rd Generation CDMA systems, Multi user detection, Optimum receivers, SIC, PIC receivers and performance.

Networks & Services: Network Transmission System Design Services, Characterization of networks & teleservices, The Telephone Network - Past, Present & Future, and Network issues.

Unit-II

Data Communication Networks: Basic principles of data communication - synchronous and asynchronous transmission - digital data transmission formats NRZ, RZ, AMI, ASI & Manchester coding, Error correcting codes, Hamming codes, Orthogonal codes, Switching - Circuit switching, Message switching, Packet switching, Standard communication interface multipliers and concentrators, Protocols (BOP-COP - standard networks and standards, OSI, (D) ARPANET, NICNET, SNA, SELS etc. Lan types of LAN - WAN, Digital telephony, Basic principle of ISDN - E Mail - Voice mail.

Transmission Principles: Transmission aspects, Signals and Impairments, Digital Speech Transmission Digitisation of Speech & Audio.

Unit-III

Teletraffic: Digital Networks, Network Synchronization, Multiplexing - Digital Hierarchies, Synchronous Digital Hierarchy, Digital Switching, Signaling, Introduction to Teletraffic.

ISDN & ATM: Integrated Services Digital Network – ISDN, Broadband ISDN & ATM, Broadband Access Networks, Optical Networks.

Network Aspects: Intelligent Network, Network Management, and Introduction to Network management softwares.

Books Recommended

1. Andrew J Viterbi, *"CDMA Principles of spread spectrum communications"*, Addition Wesley, (1995).
2. J S Lee and L E Miller, *"CDMA systems engineering handbook"*, Artech House, (1998).
3. Marvin K Simon, Jim K Omura, Robert A Scholtz, Bary Klevit, *"Spread Spectrum Communications"*, (1995).
4. Sergio Verdu, *"Multiuser Detection",* Cambridge University Press, (1998).
5. Andrew S Tanenbaum, *"Computer Networks"*, Prentice Hall of India.

EC-464 Mobile Computing [3 0 0 3]

Unit-I

Introduction to Mobile Computing

Introduction, Added Dimensions of Mobile Computing, Condition of the Mobile User, Architecture of Mobile Software Applications

Introduction to Mobile Development Frameworks and Tools

Workflow for Mobile Application Development, Techniques for Composing Applications.
Java, Brew, Windows CE, Symbian, WAP, Android.

Unit-II

Mobility and Location Based Services

Introduction, Data Acquisition of Location Information, GIS, Location Information Modeling, Utilizing Location Based Services with Mobile Applications, Localization and Internationalization, latest development in Location based efforts.

Overview of Mobile Internet Protocol: MIP

Mobile Internet Protocol version 6:MIPv6

Wireless Application Protocols: WAP – Architecture and Protocol Suite

Bluetooth – Architecture, Network, Protocols

Unit-III

Overview of Wireless LAN Protocols: WiFi

WiMAX – 802.16

Books Recommended

1. Reza B'Far, Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML, Cambridge University, 2004
2. Reto Meie, Professional Android Application Development (Wrox Programmer to Programmer), Wrox, 2008
3. Axel Küpper, Location-Based Services: Fundamentals and Operation, Wiley, 2005.
4. H. Labiod, H. Afifi and C. De Santis, Wi-Fi, Bluetooth, Zigbee and WiMax , Springer 20
5. Marcus Taylor , Understanding WAP : Wireless Applications, Devices, and Services, Artech House Publishers, 2000

EC-466 Optical Communication Systems and Networks [3 0 0 3]

Unit-I

Optical Sources: optical source properties, what is inside an LED? What causes the LED to emit light and what determines the color of the light?, how much energy does an LED emit?, finding the energy from the voltage, finding the frequency from the wavelength of light, operating wavelength of optical sources, semiconductor light-emitting diodes and laser diodes, semiconductor material and device operating principles, light-emitting diodes, surface-emitting LEDS, edge-emitting LEDS, super luminescent diodes, laser diodes, comparison of LED and ILD. Fiber optic transmitters, basic optical transmitters, direct versus external modulation, fiber optic transmitter applications, digital applications, analog applications.

Optical Detectors: Basic Information on light detectors, Role of an optical detector, Detector characteristics: Responsivity, Noise Equivalent Power, Detectivity, Quantum efficiency, Detector response time, Linearity, Spectral response, Noise considerations: Johnson noise, Shot noise, 1/*f* noise, Photon noise, The PN junction photo diode - PIN photodetectors - Avalanche photo diode construction characteristics and properties, APD Specifications, Applications of APD - comparison of performance noise sources - simple - simple model of photo receiver - Its equivalent for circulation of noise SNR, Optical Receivers.

Unit-II

APD Specifications, Applications of APD - comparison of performance noise sources - simple - simple model of photo receiver - Its equivalent for circulation of noise SNR, Optical Receivers.

Optical Fiber Communication System: telecommunication, local distribution series, computer networks local data transmission, Digital optical fiber communication system, first & second-generation system, future system

Advanced Multiplexing Strategies: Optical TDM, subscriber multiplexing (SCM), WDM and Hybrid multiplexing methods**.**

Unit-III

Optical Networking: Data communication networks, network topologies, MAC protocols, Network Architecture- SONET/TDH, optical transport network, optical access network, optical premise network.

Fiber Optic System Design Considerations and Components: Components: Indoor Cables, Outdoor Cables, Cabling Example**,** Power Budget, Bandwidth and Rise Time Budgets, Electrical and Optical Bandwidth, Connectors, Fiber Optic Couplers

Optical Switching & Networks: Transport Networks, Applications, Requirements, Architectures, Technologies, and Solutions, Introduction to Optical Access Networks

Books Recommended:

1. Silvello Betti, Giancarlo De Marchis and Eugenio Iannone, *"Coherent Optical Communications Systems"*, John Wiley, (1995).
2. Casimer Decusatis, "Hanbook of Fiber Optic Data Communication" 2nd edition, Academic Press.
3. Ivan Kaminow, " Fiber Optical telecommunications IV A" Academic Press,2002.
4. Ivan Kaminow, " Fiber Optical telecommunications IV B" Academic Press,2002.
5. Vivek Alwyn, " Optical Design and Implementation" Cisco Press,2004.

EC-468 Telecommunication-Switching and Networks [3 0 0 3]

Unit-I

Telecommunications Transmission: Basic Switching System, Simple Tele-phone Communication, evolution of switching systems -Stronger switching systems

Switching Used in telecommunications cross bar switching, Electronic Switching – Space Division Switching, Time Division Switching –Time Division space switching, Time Division Time Switching, Time multiplexed space switching, Time multiplexed Time Switching, Combination Switching

Control of Switching Systems: Call processing functions, common control, stored program control (For all type of switching systems)

Unit-II

Speech Digitization and Transmission: Quantization Noise, Companding, Differential Coding, Vocodors, Pulse Transmission, Line Coding, NRZ and RZ Codes, Manchester Coding, AMI Coding, Walsh Codes, TDM.

Traffic Engineering: Grade of Service and Blocking Probabity – Telephone Networks, Subscriber Loops, Switching Hierchy and Routing, Transmission Plans and Systems, Signaling Techniques, In Channel, Common Channel.

Unit-III

Telephone Networks and Signaling: Introduction, subscriber loops systems, switching hierarchy, transmission and numbering plans, common channel signaling principles, CCITT signaling systems.

Data Networks: Data transmission in PSTNs, Switching Techniques for data transmission, Data communication architecture, Satellite based Data networks

Books Recommended

1. Flood J E, "*Telecommunications switching, traffic and networks*" first Indian reprint, Pearson education Asia, (2001).
2. Viswanathan T, "*Telecommunication switching systems and networks*" 17th Indian reprint, PHI, India, (2003).
3. Bosse J G van, Bosse John G., "*Signaling in Telecommunication Networks*" Wiley, John & Sons, (1997).
4. Bruce S. Davie, Paul Doolan, Yakov Rekhtor, "*Switching in IP Networks: IP Switching, Tag Switching, and Related Technologies"* Elsevier Science & Technology Books, (1998).
5. Joseph Yu Hui, "*Switching and Traffic Theory for Integrated Broadband Networks*", Kluwer Academic Publishers, (1990).

EC-470 Mixed Signal IC Design [3 0 0 3]

Unit-I

Introduction: Introduction to analog VLSI and mixed signal issues in CMOS technologies

MOS transistor: Introduction, Short channel effects, current source and current mirror, C-MOS circuit

Basic Integrated Circuit Devices and Modeling: MOS and BJT transistor modeling, CMOS and bipolar processing – CMOS and analog layout consideration

MOS and CMOS sample and hold circuit – bipolar and BiCMOS sample and hold – switched capacitor circuits – data converters

Unit-II

D/A and A/D converters : introduction A/D and D/A, various type of A/D converter, ADCs, ramp, tracking, dual slope, successive approximation and flash types, Multi-stage flash type ADCs

OP-AMP : Op-amp- analysis, approximations and modelling; Ideal op-amp building blocks, Open loop op-amp configurations, Practical op-amp- Offset voltage analysis and compensation, Input bias and offset current analysis and compensation, frequency response, slew rate, Block diagram representations and analysis of configurations using negative feedback, Designing of Op-amp

Unit-III

Specialized IC's: 555 Timer-Monostable, multivibrator, astable multivibrator, Applications and Phase locked loop-Operating principles and applications of PLL.

Books Recommended

1. D. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley Student Edition, 2002. 2. P. R. Gray and R. G. Meyer, Analysis and design of Analog Integrated circuits 4th Edition, Wiley Student Edition, 2001.
2. R.Jacob Baker,H.W.Li, and D.E. Boyce CMOS Circuit Design ,Layout and Simulation, Prentice-Hall of India,1998
3. Mohammed Ismail and Terri Faiz Analog VLSI Signal and Information Process, McGraw-Hill Book company,1994
4. Paul R. Gray and R.G.Meyer, Analysis and design of Analog Integrated circuits John Wiley and sons,USA,(3rd Edition),1993
5. B. Razavi, RF Microelectronics, Prentice-Hall PTR,1998
6. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, 2nd edition, Oxford University Press, 1997.

EC-472 Low Power Design [3 0 0 3]

Unit-I

Introduction: Introduction to Low-Power VLSI Design, sources of Dissipation in Digital Integrated circuit, Degree of freedom, Recurring Themes in Low power, Low Power Approaches

Device and Technology Impact on Low Power Electronics: Dynamic Dissipation in CMOS, Effect on speed, Constrictions on Reduction, Transistor Sizing and Gate oxide Thickness, Impact of Technology Scaling

Unit-II

Low Power Circuit Techniques: Power consumption in circuits, Flip-Flop and Latches, Logic, High Capacitance Nodes

Low Power Clock Distribution: Power Dissipation in clock Distribution, Single Driver vs Distributed Buffer, Zero Skew vs Tolerable Skew, Chip and Package Co-Design of clock.

Unit-III

Logic Synthesis for low power: Power Estimation Technique, power Minimization Technique

Low power Memory Design: Sources of power dissipation in D-RAM and S-RAM, Low power DRAM circuit, Low power SRAM circuit

Books Recommended

1. Jan M.Rabay and Massoud Pedram "Low Power Design Methodology" Kluwer Academic Publishers 1996
2. Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP, 2002
3. Rabaey, Pedram, "Low power design methodologies" Kluwer Academic, 1997

4. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley, 2000
5. J.M. Rabaey, A. Chandrakasan and B. Nikolic: Digital Integrated Circuits- A Design Perspective, 2nd ed., PHI, 2003

EC-474 Digital IC Design [3 0 0 3]

Unit-I

Introduction: Digital IC, Digital Combinational and sequent ional circuit, issue in digital IC design, Quality metrics of Digital Design

Designing Combinational Logic Gate in CMOS : Static C-MOS Inverter and its characteristics, CMOS Design consideration Transistor Sizing, Power Dissipation, Design Margining, Ratioed Logic, Pass Transistor Logic, Dynamic C-MOS design, basic principle, speed and power Dissipation of Dynamic Logic, Signal Integrity in Dynamic Design, Cascaded Dynamic.

Unit-II

Designing Sequential Logic Circuits: : Introduction ,Static Latches and registrars, Dynamic Latches and Registers, Alternative Register Styles, Pipelining.

Implementation Strategies for Digital ICS: Custom, Semi custom Circuit Design, Cell –Based Design Methodology, Array Based Implementation Approach**,** Layout

Designing Memory: Memory Classification, Memory Architecture and Building Block,Read only Memories, Nonvolatile Read Write Memories, Read-Write Memories, Memory Peripheral Circuits

Unit-III

Programmable logic devices: Introduction to PLA, PAL, PLD/CPLD, PGA/ FPGA, ASIC their applications and Architecture

Books Recommended

1. J.M. Rabaey, A. Chandrakasan and B. Nikolic: Digital Integrated Circuits- A Design Perspective, 2nd ed., PHI, 2003
2. D.A. Pucknell and K. Eshraghian, Basic VLSI Design, PHI, 1995
3. E.D. Fabricius, Introduction to VLSI Design, McGraw Hill, 1991
4. N.H.E. Weste and K. Eshraghian, Principles of CMOS VLSI Design - a System Perspective, 2nd ed., Pearson Education Asia, 2002
5. S.M. Kang and Y. Leblevici, CMOS Digital Integrated Circuits Analysis and Design, 3rd ed., McGraw Hill, 2003
6. J. P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley & Sons (Asia) Pte Ltd, 2002
7. W. Wolf, Modern VLSI Design - System on Chip design, 3rd ed., Pearson Education, 2004
8. R. Jacob Baker, CMOS Circuit Design, Layout, and Simulation, IEEE Press, 1997

EC-476 Analog IC Design [3 0 0 3]

Unit-I

Review of MOS Devices: MOS transistor models. NMOS, PMOS, CMOS, Introduction to analog VLSI and mixed signal issues in CMOS technologies

Basics of system hardware design methodology: Hierarchical design using top-down and bottom-up methodology

Basic Electrical Properties And Circuit Concepts: Basic Electrical Properties of MOS circuits: MOS transistor operation in linear and saturated regions, MOS transistor threshold voltage

Unit-II

MOS switch and inverter, latch-up in CMOS inverter; sheet resistance and area capacitances of layers, wiring capacitances MOS models, SPICE Models

Circuit Characterization and Performance Estimation: Estimation of R, C, L, Switching Characteristics-delay models. Power dissipation. ; MOSFET scaling - constant-voltage and constant-field scaling

CMOS Analog blocks: Current Sources and Voltage references. Differential amplifier and OPAMP design.

Unit-III

Practical Aspects and Design Verification: Semi-custom and cell library based design. Design of. Hardware description languages for high level design. Logic, circuit and layout verification. Analog Testing and Layout issues. Introduction to different tool used in Analog design

Books Recommended

1. Weste N and Eshranghian K, *"Principles of CMOS VLSI Design"*, Pearson Education Asia (2001).
2. Glaser L and Dobberpuhl D, *"The Design and Analysis of VLSI Circuits"*, Addison Wesley (1985).
3. Rabaey J, *"Digital Integrated Circuits: Design perspective"*, Prentice Hall India (1997).
4. Perry D, *"VHDL"*, 2nd Ed., McGraw-Hill International (1995).
5. Pucknell D A and Eshraghian K, *"Basic VLSI Design"*, Prentice Hall India, New Delhi (2003).
6. D. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley Student Edition, 2002
7. P. R. Gray and R. G. Meyer, Analysis and design of Analog Integrated circuits 4th Edition, Wiley Student Edition, 2001.
8. B. Razavi, RF Microelectronics, Prentice-Hall, 1998.
9. P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, 2nd edition, Oxford University Press, 1997.

EC-478 MEMS [3 0 0 3]

Unit-I

Introduction to Microelectromechanical Systems (MEMS) and MEMS Fabrication Technologies, Materials and Substrates for MEMS, Processes for Micromachining - Basic Process Tools, Advanced Process Tools MEMS Structure and Systems: General Design Methodology, Techniques for Sensing and Actuation, Passive MEM Structures, Sensors. Actuators, Mechanical Vibrations, Computer-Aided Design of MEMS and tools.

Unit-II

Applications of MEMS in RF/Microwave – The MEMS Switch and its Design Consideration. The MEM Resonator and its Design Considerations, Micromachining-Enhanced Planar Microwave Passive Elements. Other MEMS Based RF/Microwave Circuits and Systems

Unit-III

Packaging & Reliability for MEMS - Key Design and Packaging Considerations. Die-Attach Processes. Wiring and Interconnects. Types of Packaging Solutions. Reliability and Failure Analysis

Books Recommended

1. Nadim Maluf and Kirt Williams, "An Introduction to Microelectromechanical Systems Engineering", Artech, 2004 Second Edition
2. Hector J. De Los Santos, " Introduction to Microelectromechanical Microwave Systems", Artech, 2004, Second Edition

EC-480 RF Circuit Design [3 0 0 3]

Unit-I

Introduction: Importance of RF Design, RF Behavior of Passive Components, Chip Components and Circuit Board Considerations, General Transmission Line Equation, Micro Strip Transmission Lines

Single and Multi Port Networks: Interconnecting Networks, Network Property and Application, Scattering Parameters

Active RF Component and Modeling: Semiconductor Basics, RF Diode, Bipolar Junction Transistor, RF Field Effect Transistors, High Electron Mobility Transistor, Diode Models, Transistor Models

Unit-II

Matching & Biasing Network & RF Filter: Overview of RF Filter design, Matching and Biasing Networks. Basic blocks in RF systems and their VLSI implementation, Low noise, Amplifier design in various technologies, Design of Mixers at GHz frequency range, various mixers- working and implementation. Oscillators- Basic topologies VCO and definition of phase noise, Noise power and trade off. Resonator VCO

designs, Radio frequency Synthesizers- PLL, Various RF Synthesizer architectures and frequency dividers, Power Amplifier design, Design issues in integrated RF filters.

Unit-III

RF Transistor Amplifier: Characterstics of Amplifiers, Amplifiers Power Relation, Stability Considerstions, Constant Gain, Noise Figure Circles, Constant VSWR Circles, Broad Band, High Power and Multistage Amplifiers

Oscillators and Mixers: Basic Oscillator Model, High Frequency Oscillator Configuration, Basic Characterstics of Mixers

Books Recommended

1. Reinhold Ludwig, Pavel Bretchko,"RF Circuit Design",1st Indian Reprint,2001,Pearson Education Asia
2. B Razavi,"Design Of Analog CMOS Integrated Circuit",Mc Graw Hill,2000.
3. R. Jacob Baker, H.W. Li, D.E. Boyce " CMOS Circiut Design, layout and Simulation" PHI 1998
4. Y.P. Tsividis "Mixed Analog and Digital Devices and Technology" TMH 1996
5. Thomas H. Lee "Design of CMOS RF Integrated Circuits" Cambridge University Press 1998.

EC-482 DSP Applied to VLSI Design [3 0 0 3]

Unit-I

Introduction to DSP Systems: Review of common DSP systems and functional elements; number representations. Implementation of bit-parallel, bit-serial, and digit-serial multiplier and adder structures; carry-save arithmetic; register minimization. Bit Level Arithmetic Architecture, Redundant Arithmetic, Numerical Strength Reduction, Iteration bound.

Architectural transformation techniques: Pipelining & Parallel Processing, Synchronous Wave & Asynchronous Pipelines, Retiming of computations, Unfolding, Folding Systolic Architecture Design, Fast Convolution, Algorithm Strength, Reduction of Filters & Transforms.

Unit-II

Adaptive Filtering: Pipelined & Parallel Recursive & Adaptive Filter, Scaling & Round off Noise, Digital Lattice Filter Structures, Basics of minimum mean-square and least-squares estimation. Lattice orthogonalization. Stochastic gradient adaptive filters: derivations, performance analyses and variations. Recursive least-squares adaptive filters: fast algorithms, least-squares lattice filters, numerical issues, and performance comparisons with stochastic gradient adaptive filters. Adaptive IIR filters. Fundamentals of adaptive nonlinear filtering. Selected applications.

Unit-III

Performance and hardware tradeoffs in VLSI DSP system design. Pipelined and parallel direct-form FIR and IIR filter structures. Pipelined adaptive filter structures. Architectures for the fast Fourier transform, Low Power Design, Programmable Digital Signal Processors.

Books Recommended

1. VLSI DSP System: Design & Implementation, by Keshab K. Parhi, Publisher John Wiley, ISBN: 978-0-471-24186-7
2. VLSI Design Methodologies for Digital Signal Processing Architectures (The Springer International Series in Engineering and Computer Science) by Magdy A. Bayoumi ISBN-10: 0792394283, ISBN-13: 978-0792394280
3. *VLSI Digital Signal Processors: An Introduction to Rapid Prototyping and Design Synthesis*, by Vijay Madisetti, IEEE Press/Butterworth-Heinemann.
4. Architectures for Digital Signal Processing by Peter Pirsch Publisher: Wiley, ISBN-10: 0471971456 , ISBN-13: 978-0471971450.
5. High-Performance VLSI Signal Processing Innovative Architectures and Algorithms, Algorithms and Architectures by H. J. Ray Liu (Editor), Kung Yao (Editor) , Publisher: Wiley-IEEE Press. ISBN-10: 078033468X , ISBN-13: 978-0780334687
6. Fundamentals of Adaptive Filtering by Ali H. Sayed Publisher: Wiley-IEEE Press, ISBN-10: 0471461261, ISBN-13: 978-0471461265

EC-484 Electromagnetic Interference/Electromagnetic Compatibility [3 0 0 3]

Unit-I

Introduction to Electromagnetic Compatibility (EMC): Aspects of EMC and Electrical Dimensions used in EMC Standards. EMC Requirements for Electrical Systems used in Commercial Products as well as Military Products, Measurement of Radiated Emission and Conducted Emission, Radiated Susceptibility and Conducted Susceptibility, Electrostatic Discharge (ESD), and Design Constrains for products. Effects of Component Leads and Electrical Components like, Resistors, Capacitors, Inductors and Ferrite Beads; Electro-Mechanical Devices, Digital Circuit Devices, Mechanical Switches, Arc Suppression, Radio Suppression Circuits for Automobiles.

Unit-II

Electromagnetic Interference (EMI): Inter-System and Intra-System EMI, EMI Design and Control of Intra-System at Inter-System Interference, Classification of EMI Sources; Natural Sources of EMI, Man-made Sources of EMI, EMI Receptors and Susceptibility Criteria.

Unit-III

EMC Design: Shielding of lines, Twisted wires, Balancing of lines, Avoidance of Cross-talk in Time Domain and Frequency Domain. Power Supply Filters, Grounding of Systems, De-Coupling, Ground Loops, Design of PCBs, Shielding of Components, Wiring layout etc.

Radiation Hazards to Humans

Books Recommended

1. Clayton RE Paul, "*Introduction to Electromagnetic Capability (MW and Optical Engg.Series)*", Wiley Interscience (2006).
2. J L Norman Violette, Donald R J White, Michael F Violette, "*Electromagnetic Compatibility Handbook*" ISBN 0-442-28903-0, Van Nostrand Reinhold Company
3. John S Scott, "*Introduction to EMC*" (1997)
4. Bruce Archambeault, Colin Brench, Omar M. Ramahi, "*EMI/EMC Computational Modeling Handbook (2nd Edition)*", Kluwer Academic Publishers (2001).
5. V. Prasad Kodali, Motohisa Kanda, "*EMI/ECI: Selected Readings*", IEEE Press (1996)

EC-486 Sensor Technology [3 0 0 3]

Unit-I

Introduction: Sensor fundamentals, Basic Sensor technology and systems, Applications of sensors, Sensor characteristics, system characteristics and instrument selection.

Different types of Sensors : Classification of sensors. Sensors for signal conditioning, acceleration , shock and vibration sensors, capacitive and inductive displacement sensors, electromagnetic sensors, optical and radiation sensors, position and motion sensors , temperature sensors.

Unit-II

Smart Sensors: Basics of smart sensors , integration of micromachining and microelectronics , interfacing electronics and measurement techniques for smart sensor systems. Microcontroller and Digital Signal Processors for Smart Sensor Systems. Smart sensor design at software level.

Unit-III

Future of Sensor Technology: Nanotechnology -enabled sensors, MEMS sensors.

Books Recommended

1. Clayton RE Paul, "*Introduction to Electromagnetic Capability (MW and Optical Engg.Series)*", John Wiley (1992).
2. J L Norman Violette, Donald R J White, Michael F Violette, "*Electromagnetic Compatibility Handbook*" ISBN 0-442-28903-0, Van Nostrand Reinhold Company
3. John S Scott, "*Introduction to EMC*" (1997)
4. Bruce Archambeault, Colin Brench, Omar M. Ramahi, "*EMI/EMC Computational Modeling Handbook (2nd Edition)*", Kluwer Academic Publishers (2001).
5. V. Prasad Kodali, Motohisa Kanda, "*EMI/ECI: Selected Readings*", IEEE Press (1996)