GOA UNIVERSITY

THIRD YEAR OF BACHELOR'S DEGREE COURSE IN ELECTRONICS AND TELECOMMUNICATION ENGINEERING

(REVISED COURSE-2007)

SCHEME OF INSTRUCTION AND EXAMINATION

SEMESTERV,

Sub code	Subjects	Scheme Of Instruction Hrs/Week			Scheme Of Examination					
					Th. Dur (Hrs)	Marks				
		L	T	P		Th.	S	P	O	Total
5.1	Probability Theory and Random Processes	4	0	-	3	100	25	-	-	125
5.2	Control System Engineering	4	0	2	3	100	25	-	-	125
5.3	Communication Engineering-I	4	0	2	3	100	25	-	50	175
5.4	Microprocessors	4	0	2	3	100	25	-	50	175
5.5	Digital Signal Processing	4	0	2	3	100	25	-	-	125
5.6	Transmission Lines and Waveguides	4	0	-	3	100	25	-	-	125
	Total	**24**	**0**	**8**		**600**	**150**		**100**	**850**

SEMESTER VI,

Sub code	Subjects	Scheme Of Instruction Hrs/Week			Scheme Of Examination					
					Th. Dur (Hrs)	Marks				
		L	T	P		Th.	S	P	O	Total
6.1	Communication Engineering-II	4	0	0	3	100	25	-	50	175
6.2	Peripheral Devices and Interfacing	4	0	2	3	100	25	-	-	125
6.3	Power Electronics	4	0	2	3	100	25	-	-	125
6.4	Antenna and Wave Propagation	4	0	-	3	100	25	-	-	125
6.5	Electronic Instrumentation	4	0	2	3	100	25	-	-	125
6.6	VLSI Technology and Design	4	0	2	3	100	25	-	50	175
	Total	**24**	**0**	**8**		**600**	**150**		**100**	**850**

L – Lectures, T-Tutorials, P-Practicals. Th. Dur. – Duration of Theory Paper
Th – Theory, S – Sessional, P– Practical, O – Oral.

ETC 5.1: Probability Theory and Random Processes

Course objectives: (Module-wise):

Module 1:

To teach basics of probability and probability distributions; Random variables and their distributions, their expectations and variance

Module 2:

To teach 2-D Random variables and their distributions, independence, covariance, correlation, computation of probabilities and expectation.

Module 3:

To teach sampling distributions, tests of hypothesis and significance, Analysis of variance.

Module 4:

To introduce state space, stochastic processes, Auto-Correlation, Cross Correlation, auto-covariance, cross-covariance with details study of Markov Chains and Poisson processes.

Instructional Objectives:

- To familiarize the students with the concept of probability, random variables and their distribution with emphasis on stochastic processes.
- The concepts so gained will be useful in understanding future subjects such as: Digital Communication, Data Communication, Mobile Communication, Adaptive Signal Processing, Statistical theory of Communication, etc.

ETC 5.1: Probability Theory and Random Processes

Module 1

Introduction to Probability Theory and Random Variables

Introduction - Sample Space and Events, Probabilities defined on Events, Conditional Probabilities, Independent Events, Total Probability Theorem, Bayes' Theorem and its Applications. **(2 hours)**

Random Variables, Discrete and Continuous Random Variables, Probability Distribution, Expectation, Variance, Cumulative Distribution Function,

Moment Generating Function, Functions of a Random Rariable and their Distribution, Expectation and Variance of functions of a random variable. **(4 hours)**

Some Important Probability Distributions and their Mean, Variance and Moments – Bernoulli Distribution, Binomial Distribution, Geometric Distribution Poisson Distribution, Uniform Distribution, Exponential Distribution, Gamma Distribution and Normal Distribution. **(4 hours)**

Module 2

Higher Dimensional Random Variables

Introduction, Discrete and Continuous Two Dimensional Random Variables- Joint Probability Distribution, Marginal Distributions, Independence of Random Variables, Covariance and Correlation, Uncorrelated Random Variables. **(5 hours)**

Real Valued Functions of Two Dimensional Random Variables and their Probability Distributions, Conditional Probability Distribution and Conditional Expectation, Computing Probabilities and Expectations by Conditioning, Moment Generating Function of Sums of Independent Random Variables. **(5 hours)**

Module 3

Tests of Hypotheses and Analysis of Variance (ANOVA)

Sampling Theory, Random Samples, Sampling Distributions, Statistical Decisions and Statistical Hypotheses, Tests of Hypothesis and Significance, Level of Significance, One-Sided and Two-sided Hypotheses, Two-Tailed and One-Tailed Tests. **(1 hour)**

Tests of Hypothesis for Large samples – Tests of hypotheses on the Mean, Tests of Hypothesis on the equality of Two Means, Tests of Hypothesis on a Proportion, Tests of Hypothesis on the Equality of Two Proportions, Tests of Hypothesis on a Standard Deviation, Tests of Hypothesis on the Equality of Two Standard Deviations. **(2 hours)**

Tests of Hypotheses for Small Samples – Test of Hypothesis on the Mean for a Normally Distributed Population, Tests of Hypothesis on the equality of Two Means for Normally Distributed Populations, Tests of Hypothesis on the Variance of a Normally Distributed Population, Tests of Hypothesis on Equality of Variances of two Normally Distributed Populations, Testing for Goodness of Fit, Tests for Independence of Attributes. **(6 hours)**

Analysis of Variance (ANOVA) – One-Way and Two- Way Classification Analysis of Variance. **(1 hour)**

Module 4

Stochastic Processes

Introduction, State Space, Higher Order Joint Distributions of a Stochastic Process, Independence of a Stochastic Process, Auto– Correlation Function, Auto – Covariance, Correlation Coefficient, Cross- Correlation Function, Cross-Covariance, Cross- Correlation Coefficient, Strict Sense Stationary Process, Wide Sense Stationary Process, Jointly Wide Sense Stationary Process, Evolutionary Process, Ergodicity in Mean and Auto - Correlation Function. **(3 hours)**

Markov Chains – Introduction, Transition Probabilities, Homogeneous Markov Chains, One-Step and n-Step Transition Probability Matrix , Initial Distribution, Probability Mass Function of the Random Variables of a Markov Chain, Joint Distribution of a Markov Chain, Chapman-Kolmogorov Equations, Absorbing States, Communication between States, Irreducible Markov Chains, Steady State Vector. **(5 hours)**

Poisson Processes – Introduction, Counting processes, Definition of Poisson Process, Sum of Two Independent Poisson Processes, Inter-Arrival and Waiting Time Distributions for a Poisson Process, Applications of Poisson Processes. **(2 hours)**

Text books

1. A first Course in Probability, Sixth Edition, Pearson Education, by Sheldon Ross.

2. Probability and Statistics in Engineering by William W. Hines, Douglas C. Montgomery, David M. Goldsman, and Connie M. Borror .

3. Probability, Statistics and Random Processes, Second Edition, Tata McGraw-Hill, by T. Veerajan

Recommended Books

1. Probability and Statistics with Reliability, Queuing and Computer Science Applications, Prentice Hall, by Kishor S. Trivedi.
2. Statistics, Third Edition, Schaum's Outlines, by Murray R. Spiegel and Harry J. Stephens.

3. Introduction to Probability Models, Seventh Edition, Academic Press, by Sheldon Ross

ETC 5.2 Control System Engineering

Course Objective: (Module-wise)

Module 1: To introduce basic control system components, signal flow graphs and transfer functions.

Module 2:

- To teach about to transient response of systems.
- To introduce concept stability.

Module 3: To introduce frequency-domain analysis of system response.

Module 4:

- To teach about the design of compensators in frequency-domain to improve the system performance.
- To introduce digital control systems.

Instructional Objectives:

- To teach classical control system analysis and design and introduce basics of digital control systems.
- Making the students imbibe the concepts of time-domain analysis and frequency-domain analysis.
- To introduce modeling and analytical solutions to control system problems.

ETC 5.2: CONTROL SYSTEM ENGINEERING

MODULE 1

Introduction to control systems; types of control systems, basic concept of open-loop and closed-loop control systems; 1Hour

Mathematical modeling and representation of mechanical (translational & rotational) and electrical systems; 3Hours

Conversion of mechanical to analogous electrical systems (force-voltage and force-current analogy); 1Hours

Block diagrams, 3Hours

Signal flow graphs and transfer functions. 2Hours

MODULE 2

Transient response of first and second order systems; 3Hours

Type -0, -1 and –2. control systems; Steady state error and error co-efficient; 3Hours

Stability concept, Routh-Hurwitz criteria; 2Hours

Stability under parameter uncertainty: robust control; 2Hours

root-locus techniques. 3Hours

MODULE 3

Frequency-domain analysis, polar-plots, 2Hours

Bode-plots, 4Hours

Nyquist-plots; Relative stability using Nyquist-plot. 4Hours

MODULE 4

Concept of compensators; types of compensators; 1Hour

Design of Cascade compensator in time domain- Lead, Lag and Lead-Lag compensation 3Hours

Design of Cascade compensator in frequency domain -Lead, Lag and Lead-Lag compensation 4Hours

Introduction to digital control system, discrete time system, sampled data and digital control system-digital Vs analog controller, sampling process. 2Hours

TEXT BOOKS:

Control Systems-Principles and Design - M. Gopal, Tata Mc Graw Hill

1. Control Systems Engineering,– I.J. Nagrath and M. Gopal, The New Age International (P) Ltd., New Delhi
2. Modern Control Engineering—D. Roy Choudhry

REFERENCE BOOKS:

1. Modern Control Engineering, -K.Ogala, PHI
2. Control Systems, -A.Nagoor Kani, RBA Publications, Chennai
3. Automatic Control Systems, - B.C.Kuo ,PHI

ETC 5.3: Communication Engineering - I

Course objectives: (Module-wise):

Module 1:

To teach the fundamentals of analog modulation and detection techniques.

Module 2:

To teach about transmission and reception of signals and noise. A brief introduction of pulse modulation is to be given.

Module 3:

To teach about correlation and sampling of signals and cover the Pulse Code Modulation in details.

Module 4:

To teach the digital modulation techniques and multiplexing.

Instructional Objectives:

- To teach the analog modulation (which includes Pulse Modulation) and Digital Modulation techniques in detail, this being the first course in communication. However, more emphasis shall be given to digital modulation techniques.

ETC 5.3: COMMUNICATION ENGINEERING-I

MODULE 1

Need for modulation. Principles of AM, Frequency spectrum of AM wave, AM power and current relationship, modulation by multiple sine waves.
Generation of AM: Modulated transistor amplifier. AM Detection – Diode Detector

(3 Hrs)

DSB-SC Techniques, Suppression of carrier, Effect of non-linear resistance on added signals (Square law modulator), Balance modulator

Methods of generation of SSB -Filter systems, phase shift method & third method. Comparison of various methods. (3 hrs)

Principles of FM and PM, Mathematical representation, Spectrum, Narrowband and wideband FM, power contents of carrier and sideband. Effects of noise in FM. (2 hrs)

FM generation methods: Direct method, Armstrong method, Slope Detector, Foster-Seelay discriminator, Ratio detector. (2hrs)

MODULE 2

AM and FM transmitter, TRF receivers, super heterodyne receivers, solidstate circuits for RF-amplifiers, Mixer, IF amplifier, AGC, AFC, Amplitude limiter, Pre-emphasis, De-emphasis, Audio muting. (4hrs)

Noise- various noise sources, Noise calculations for – single noise sources, multiple noise sources, cascade amplifiers. Noise figure , Noise temperature, Equivalent input noise resistance. (4 hrs)

Pulse Modulation: Introduction, PAM, PWM, PPM. Generation and detection. (2 hrs)

MODULE 3

Correlation: Correlation between waveforms, Cross-correlation, Autocorrelation, Autocorrelation of a periodic waveform, autocorrelation of a non-periodic waveform of finite energy, autocorrelation of other waveforms (2 hours)
Sampling: Sampling theorem, Natural Sampling, Flat top sampling, recovery through holding. (2 hours)
Quantization: Quantization of signals, Midrise and Midtread Quantizers, Quantization error. (1 hour)
Pulse Code Modulation: Pulse Code Modulation, Electrical representation of binary digits, PCM system, Companding, μ Law and A Law Companders, Differential Pulse

Code Modulation (DPCM), Delta Modulation (DM), Adaptive Delta Modulation (ADM)
(5 hours)

MODULE 4

Multiplexing: Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM) (1 hours)

Digital Modulation Techniques: Binary Phase Shift Keying (BPSK), Differential Phase Shift Keying (DPSK), Differentially Encoded PSK(DEPSK),
(4 hrs)

Quadrature Phase Shift Keying (QPSK), M-ary PSK, Minimum Shift Keying (MSK), Gaussian MSK, Quadrature Amplitude Shift Keying(QASK), Binary Frequency Shift Keying(BFSK), Comparison of digital modulation techniques.
(5hours)

TEXT BOOK

1. Electronic Communication System – George Kennedy- Tata McGraw Hill
2. Principles of Communication Systems by Taub, Schilling, Saha, Third Edition, Tata McGraw Hill Publishing Company.,

BOOKS RECOMMENDED:

1. Modern Digital and Analog Communication Systems - B.P. Lathi 3rd edition - OXFORD University Press
2. Electronic Communication System – Dennis Roddy and John Coolen- PHI
3. Electronic communications Systems-Wayne Tomasi, Pearson Education, 3rd edition
4. Digital Communications by John Proakis, 4th Edition, McGraw Hill International
5. Communication Systems : Analog & Digital by Singh & Sapre, Tata McGraw Hill Publishing Company
6. Digital Communications : Fundamental & Applications by Bernard Sklar, Second Edition, Pearson Education

ETC 5.4 MICROPROCESSORS

Course objectives (module-wise):

Module 1 : -To teach all aspects of 8085 Microprocessor and introducing the basic concepts of programming, the block diagrams instructions and timing diagrams.

Module 2 : -To teach about the organization, memory, operating modes, timing, instruction set and programming of 8086 microprocessor.

Module 3 : -To teach about the Logical and string control instructions, flag manipulation instructions, assemblers, stack and macros and related programming.

Module 4 : -To teach about 8086 interrupts, Multiprocessor systems, Numeric processor 8087, I/O processor 8089 and Intel processors (from 80186 to Pentium).

Instructional Objectives:

-To teach the Architecture, Programming and applications of microprocessors 8085, 8086, 8087, 8089 with emphasis on interfacing and programming.

ETC 5.4: MICROPROCESSORS

MODULE 1

Introduction to microprocessors, block diagram of microprocessor, difference between microprocessor & microcontroller, CISC & RISC processors, different ways of programming: machine, assembly & high level language, (2)

8085 Microprocessor: pin out and signal description, (1)

architecture, demultiplexing Address/Data bus, Generating Control Signals, (2)

addressing modes, (1)

timing diagrams for Opcode Fetch, memory read and write signals , (1)

stack organization (stack ,push & pop instructions with example) , (1)

interrupts (types, priorities), (1)

overview of instruction set (classification of instruction set),

limitations of 8085,introduction to 8086, comparision between 8085 & 8086 . (1)

MODULE 2

8086 Microprocessor: Register organization, pipelining, (1)

architecture, (1)

physical memory organization, (1)

pin out & signal description, (1)

operating modes of 8086 and timings, (1)

Addressing modes of 8086, (1)

Calculation of physical address, constructing machine codes for

instructions (2)

data transfer , arithmetic instructions & related programming (2)

MODULE 3

8086 Microprocessor:Logical, string control instructions & related programming, (2)

Machine control, conditional, unconditional, flag manipulation instructions

& related programming , (2)

Assembler directives, (1)

Writing programs using assembler (1)

Stack, macros & related programming, (2)

Procedures. (2)

MODULE 4

8086 Interrupts, related programming, (2)

Multiprocessing systems: Software aspects of multiprocessor systems, (1)

Numeric processor 8087: architecture, signal description, register set, exception handling, interconnection of 8087 with CPU ,communication with CPU , (3)

I/O processors 8089: Architecture, communication with CPU, bus arbitration and Control, arbitration schemes, (3)

Comparison of features of Intel Processors: from 80186 to Pentium . (1)

TEXTBOOKS:

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S. Gaonkar, Penram International Publishing (India).
2. Microprocessors and Interfacing programming and Hardware-Douglas V. Hall

REFERENCE BOOKS:

1. Advanced Microprocessors and Peripherals –A .K. Ray and K. M. Bhurchandi
2. Introduction to microprocessor, Aditya Mathur, Tata McGraw hill.
3. Microprocessor and Microcomputer based System Design, Rafiquzzaman, USB, New Delhi.
4. Microprocessors and Microcomputers, B. Ram, Tata McGraw Hill.
5. Microcomputer Systems The 8086 /8088 family Architecture, Programming and Design-Yu-Cheng Liu and Glenn A. Gibbon
6. Advanced Microprocessors and Interfacing –Badri Ram

ETC 5.5 – Digital Signal Processing

Course Objectives (Module-wise):

Module 1 : To teach the applications of Fourier Transform to discrete-time signals and FFT algorithms.

Module 2 : To teach the realization of discrete-time systems.
To teach the design of IIR digital filters.

Module 3 : To teach the design of Linear phase FIR filters.
To introduce multi-rate signal processing and its applications.

Module 4 : To teach the architecture of Digital Signal processors.

Instructional Objectives :

To introduce students to discrete-time signal processing, digital filtering, multi-rate signal processing and architecture of Digital Signal processors.
To prepare the students to pursue such exotic electives as Adaptive signal processing, Speech process processing, Image processing, Computer vision, Smart Antennas.

ETC 5.5 DIGITAL SIGNAL PROCESSING

MODULE I

Discrete-Time signal and its application to LTI system Discrete-Time Fourier transform (DTFT), Discrete Fourier Transform (DFT), Relationship between the DTFT and DFT and their inverses - (2hrs)
DFT properties, Linear and circular convolution, Linear filtering methods based on DFT. (2 Hrs)

Efficient computation of DFT: Fast Fourier transform [F.F.T] direct computation of DFT, Divide and conquer approach of DFT- (2 Hrs)
Radix-2 FFT algorithm: Decimation in Time [D.I.T] and Decimation in frequency [D.I.F] , Shuffling of the data and bit reversal (4 Hrs)

MODULE 2

Realisation of Discrete Time System -introduction, Basic Realisation block diagram and the signal flow graph, Basic structures of IIR filter: Direct, canonical, cascade and parallel realizations. (2 Hrs)

Design of Digital Filters: General considerations: causality and its implications, characteristics of practical frequency selective filters. (2 Hrs)

Design of IIR filter: IIR filter design by impulse invariance, bilinear transformation, Butter worth filter, Chebyshev filters (6 Hrs)

MODULE 3

Design of FIR filters: Linear phase FIR systems. Symmetric FIR Filters, design of linear phase-FIR filters using windows (Rectangular, Hann, Hamming, Kaiser), frequency sampling method. (4 Hrs)

Multirate Digital Signal Processing : Introduction, Decimation by factor D, Interpolation by factor I, sampling, sampling rate conversion by rational factor I/D - (4 hrs)

Application of Multirate signal processing, Design of Phase shifters, interfacing of digital systems with different sampling rates, Subband coding of speech signals.- (2 Hrs)

MODULE 4

Introduction to programmable Digital signal processors: Multiplier and Multiplier Accumulator (MAC), modified bus structure and memory access schemes, pipelining, special addressing modes, on–chip peripherals.

Architecture of TMS320C5X-Introduction, bus structure, central arithmetic logic unit(CALU), registers, flags, on-chip memory, on-chip peripherals

TEXT BOOKS:

Digital Signal Processing, Algorithm and Applications: John C. Proakis & Dimitries G. Manolakis, PHI
Digital signal processors architecture, programming and applications: B Venkataramani M Bhaskar,Tata McGrawHill

REFERENCE BOOKS:

Digital Signal Processing: Salivahanan
Signal Processing & Linear systems: B.P.Lathi, Oxford
Understanding Digital Signal Processing: Lyons, Addison Wesseley
Theory and Application of Digital Signal Processing: Rabiner and Gold, PHI
Introduction to Digital Signal Processing: Johny R. Johnson,PHI
Discrete Signal Processing: Oppenheim & Schaffer, PHI

ETC 5.6 –Transmission Lines and Waveguides

Course Objectives (Module-wise):

Module 1 : To study the general solution of a transmission-line under various terminal conditions.

Module 2 : To study a transmission line at radio frequency, matching of the line under different loads.
To study dissipationless lines.

Module 3 : To study single-stub and double-stub matching on a line.
To acquaint the students with Smith chart.

Module 4 : To study guided-waves.
To teach propagation in waveguides.

Instructional Objectives:

To acquaint the students with all aspects of guided-wave propagation over transmission lines and wave-guide structures.
To enable the students to integrate their learning seamlessly with what they learned from "Electromagnetic Waves and Fields" in semester IV and also with what they are going to learn in "Antenna and Wave Propagation' in VI semester, the three forming a trilogy of field subjects.

ETC 5.6 –Transmission Lines and Waveguides

MODULE 1

Transmission-Line Theory: A line of cascaded T-sections (line constants: Z, Y, characteristic impedance Zo, propagation constant γ); The transmission line-general solution; Physical significance of the equations; the infinite line. (3hrs)

Wavelength; velocity of propagation; Waveform Distortion; The distortionless line. (2hrs)

Reflection on a line not terminated in Zo (Voltage and current-phasors, Energy view point of Reflection); Reflection coefficient. (3hrs)

Input and transfer impedance; Open- and short-circuited lines. (2hrs)

MODULE 2

The Line At Radio Frequencies : Introduction; Constants for the line of zero dissipation (Lossless Lines); Voltages and currents on the dissipationless line (Voltage and Current phasors on the line for various terminations); Standing waves; nodes; standing wave ratio (SWR);Directional Coupler.

(3hrs)

Input-impedance of the dissipationless line; Input impedance of open- and short-circuited lines.

(3hrs)

Power and Impedance measurement on lines; Reflection losses on the unmatched line.(2hrs)

The eighth- wave line; The quarter-wave line; impedance matching; The half-wave line. (2hrs)

MODULE 3

Single-stub impedance matching on a line; The Smith circle diagram. (3hrs)

Applications of the Smith chart; Single-stub matching with the Smith chart; Double-stub impedance matching on a line. (4hrs)
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Lines of small Dissipation: Constants for the line of "small" dissipation; Voltages and currents on the line of small dissipation; Open- and short-circuit impedances when considering dissipation; Quarter- and half-wave lines of small dissipation. (3hrs)

MODULE 4

Guided waves: Waves between parallel planes; Transverse electric(TE) waves; Transverse magnetic (TM) waves; Characteristics of TE and TM waves; Transverse electromagnetic (TEM) waves; Velocities of propagation. . (3hrs)

Wave Guides: Rectangular guides; Transverse magnetic waves in rectangular guides; Transverse electric waves in rectangular guides (field configurations of TE and TM waves in rectangular guides); Excitation methods for various modes; Impossibility of TEM wave in waveguides.

(4hrs)
Wave impedances (for rectangular guides); Transmission- line analogy for wave guides; Wave-guide discontinuities. .
(3hrs)

Text Books:

1. Networks, Lines and Fields by J.D. Ryder, PHI.
2. Electromagnetic Waves & Radiating Systems by E.C. Jordan and K. G. Balmain, PHI.

Reference Books:

1. Electronic Communication Systems,3rd Edition, Tata McGraw Hill by George Kennedy.
2. Fields and Waves in Communication Circuits, Ramo & Whinnery, John , Wiley & Sons.

ETC 6.1: Communication Engineering - II

Course objectives: (Module-wise):

Module 1:

To teach about the basics of Information Theory and coding and the optimum digital reception.

Module 2:

To teach about various coding methods and their comparison.

Module 3:

To teach prepare students for topics in advanced communication, namely, spread spectrum and Mobile communication.

Module 4:

To give an introduction to Telephony, switching techniques and traffic engineering.

Instructional Objectives:

- To emphasize the reliability and efficiency achieved in Digital communication vis-à-vis analog communication. In addition students shall be introduced to wireless communication.

ETC 6.1 COMMUNICATION ENGINEERING – II

MODULE 1

Optimal Reception of Digital Signal :

A Baseband Signal Receiver: Peak Signal to RMS Noise Output Voltage Ratio, Probability of Error, Optimum Threshold : Maximum Likelihood Detector and Bayes Receiver. (1 hour)

Optimum Receiver for both Baseband and Passband ::Calculation of Optimum Filter transfer Function, Optimum Filter Realization using Matched Filter, Probability of Error of the Matched Filter, Optimum Filter realization using Correlator (2 hours)

Information Theory:

Discrete messages and information content: The Concept of amount of Information, Average Information, Entropy, Information rate.
(1 hour)
Source Coding to increase average information per bit: Shannon Fano Coding, Huffman Coding, Lempel Ziv Coding.
(2 hours)
Shannon's Theorem and Channel capacity: Capacity of a Gaussian Channel, Bandwidth S/N tradeoff.
(1 hour)
Use of orthogonal signals to attain Shannon's limit: Orthogonal Signals, Matched Filter reception, Calculation of Error Probability, Efficiency of Orthogonal transmission, Shannon Limit.
(2 hour)
Mutual Information and Channel Capacity, Rate Distortion Theory and Lossy Source Coding.
(1 hour)

MODULE II

Coding :

Coding : Introduction, Error Probability with Repetition in the Binary Symmetric Channel, Parity Check bit for error detection, Coding for Error detection and correction, Block Codes, Hamming distance.
(2 hours)
Upper Bound of the Probability of error with Coding, Hard Decision Coding.
Block Codes : Coding and Decoding, Decoding the received Code Word. (1 hour)
Hadamard , Hamming, Cyclic, BCH and other Algebraic Codes: Single Parity Check Bit Code, Repeated Codes, Hadamard Code, Hamming Code, Cyclic Codes, Golay Code, BCH Codes.
(1 hour)
Burst Error Correction : Block interleaving, Convolutional Interleaving, Reed Solomon Code, Concatenated Codes.
(1 hour)
Convolutional Coding : Code Generation, Decoding Convolutional Code : The Code Tree, decoding in the presence of Noise, Sequential Decoding, State and Trellis Diagrams, The Viterbi Algorithm.
(2 hours)
Comparison of Error rates in Coded and Uncoded Transmission, Turbo Codes, Automatic Repeat Request, Performance of ARQ Systems. (1 hour)
An Application of Information Theory : An Optimum Modulation System, Comparison of Amplitude Modulation System with Optimum System, A Comparison of FM Systems, Comparison of PCM and FM Communication Systems. (1 hour)

Feedback Communication : System description, Calculation of Average Transmitted Signal Energy per bit, Comparison of Information Rate with Channel capacity.
Trellis Decoded Modulation (
1 hour)

MODULE III

Spread Spectrum Modulation :

Use of Spread Spectrum
Direct Sequence (DS) Spread Spectrum: Effect of Thermal Noise, Single Tone interference and Jamming.
(2 hours)
Spread Spectrum and Code Division Multiple Access, Multipath Fading and its avoidance. Ranging using DS Spread Spectrum
(2 hour)
Frequency Hopping (FH) Spread Spectrum : The Need for Coding, The Near Far Problem, Spectrum of FH Spread Spectrum, Detection of FH/BFSK Signal.
(1 hour)
Pseudo random Sequences : Generation and characteristics, Sequence Length, Independence of Sequences, Number of ones and zeros in a maximal sequence, Clustering in a PN Sequence, Properties of Shifted Sequences, Autocorrelation of a PN Sequence, Power Spectral Density.
(2
hours)
Synchronization in Spread Spectrum Systems: Acquisition of an FH Signal, Tracking of an FH Signal, Acquisition of a DS Signal, Tracking of a DS Signal
(1 hour)
Mobile Telephone Communication : The Cellular Concept, Call Setup in Mobile Communication, Mobile to Mobile Communication, Mobile to Mobile Calls, Mobile to Fixed Subscriber Calls, Digital Cellular Phone Systems : TDMA/GSM, CDMA/CDMAONE, Global Positioning System.
(1 hour)
Application of Phase Locked Loops : Carrier Recovery, Clock Recovery, Frequency Synthesis, Phase and Frequency Modulation
(1 hour)

MODULE IV

TELECOMMUNICATION SWITCHING SYSTEMS

Switching Systems : Classification of switching systems, simple telephone communication, Basics of a switching system, Signaling tones, Principle of common control, touch tone dial telephone, Centralized SPC and Distributed SPC.
(4 hours)
Time Division Switching : Basic Time Division Space Switching, Basic Time division time switching, Time multiplexed Space Switching, Time multiplexed time switching.

(3 hours)

Traffic Engineering : Network Traffic Load & Parameters, Grade of Service & Blocking Probability, Incoming traffic & Service time characterization. (2 hours)

Numbering Plan, Common Channel Signaling (1 hour)

TEXT BOOKS :

(1) Principles of Communication Systems by Taub, Schilling, Saha, Third Edition, Tata McGraw Hill Publishing Company.,

(2) Telecommunication Switching Systems & Networks by K Vishwanathan, Prentice Hall of India.

REFERENCE BOOKS :

1. Digital Communications by John Proakis, 4th Edition, McGraw Hill International
2. Communication Systems : Analog & Digital by Singh & Sapre, Tata McGraw Hill Publishing Company
3. Digital Communications : Fundamental & Applications by Bernard Sklar, Second Edition, Pearson Education
4. Digital Modulation & Coding by Stephen Wilson, Pearson Education
5. Communication Systems by Simon Haykins, 3rd edition, John Wiley & Sons.
6. Information Theory, Coding & Cryptography by Ranjan Bose, 2nd edition, Tata McGraw Hill Publishing Company Limited.
7. Digital Communications by Sanjay Sharma, S.K.Kataria & Sons.
8. Digital and Analog Communication Systems by K. Sam Shanmughan, John Wiley & Sons Pvt. Ltd.

ETC 6.2 Peripheral Devices and Interfacing

Course Objectives (module-wise):

Module 1: To teach about the peripheral devices at the input/output of processors, their instruction set and multipurpose (8155) Programmable peripheral devices.

Module 2: To teach Programmable devices such as 8255(Programmable I/O device) 8259(Programmable Interrupt controller) and 8251(Programmable communication Interface).

Module 3: To teach about following peripherals:

- 8279(Keyboard/ display controller)
- 8253(Programmable Interval Timer)
- 8237(Programmable DMA Interface).

Module 4: To teach about the following peripherals:

- 8272(Floppy disk controller)
- 8275(CRT Controller) and
- Interfacing ADCs and Buses.

Instructional Objectives:

- To give an exhaustive coverage of peripheral devices used for interfacing with microprocessors in various applications.
- To train the students to analyse and design microprocessor-based systems used in instrumentation and process control.

ETC 6.2 PERIPHERAL DEVICES & INTERFACING

MODULE I

1. **Input Output Organization**
   Peripheral devices, Input output interface: I/O bus and interface Modules, I/O bus versus Memory Bus, Isolated V/s Memory mapped I/O, Example of I/O interface
   Asynchronous data transfer: strobe control, hand shaking Asynchronous Serial transfer, Asynchronous Communication Interface, FIFO buffer.
   Modes of transfer: Programmed I/O, Interrupt initiated I/O
   Priority interrupt: Daisy chaining priority, Parallel Priority Interrupt, Priority Encoder, Interrupt Cycle, Software routines, Initial And final Operations
   Direct Memory Access(DMA): IDMA controller, DMA transfer,

Input output processor(IOP): CPU – IOP Communication, IBM 370 I/O Channel, Intel 8089 IOP
Serial Communication: Character Oriented Protocol, Data Transparency, Bit oriented Protocol (6)

2. **Interfacing I/O devices**
Peripheral I/O Instructions and Execution, Device selection and data transfer, Input interfacing, Interfacing I/Os using Decoders, Interfacing Output Displays, Interfacing Input devices, Memory Mapped I/O (2)

3. **8155 - Multipurpose Programmable Device**
Pin Configuration and Block diagram, Programmable I/O ports and Timer, Interfacing 8155 I/O ports, 8155 timer, 8155 ports in handshake mode. (2)

MODULE II

1. **8255 - Programmable I/O Device / Programmable Parallel Port**
Internal Block diagram, Operational modes and Initialization, Control words, Interfacing 8255. (3)

2. **8259 - Programmable Interrupt Controller**
Block diagram, Pin diagram, Architecture and signal descriptions, Command words, modes of operation, Interfacing and programming of 8259 (3)

3. **8251 - Programmable Communication Interface - USART**
Block diagram, Pin diagram, Architecture and signal descriptions, operating modes, command instruction format, interfacing & programming 8251 with 8086.
(4)

MODULE III

1. **8279 - Keyboard/Display Controller**
Internal Architecture, Pin configuration, Signal descriptions, Modes of operation,

Command words, Key code and Status Data Formats, Interfacing & programming

8279 with 8086. (3)

2. **8253 - Programmable Interval Timer**
Architecture & signal description, Operating modes of 8253, Control word, programming & interfacing 8253. (3)

3. **8237 - Programmable DMA interface**
   Internal Architecture, Register Organization, Signal descriptions, Register Organization, DMA operations with 8237, Transfer modes, 8237 Commands and Programming. Interfacing 8237 with 8086. (4)

MODULE IV

1. **8272 - Floppy Disk Controller**
   Internal Architecture, Signal description, Functional details (2)

2. **8275 - CRT Controller**
   Internal Architecture, Signal description, System Operation, Display formats & operational features. (2)

3. **Analog to Digital Converters and interfacing**:
   ADC 0808/0809, Interfacing 0808 with 8086 through 8255. (2)

4. **Interfacing Digital to Analog Converters :**
   DAC 0800, interfacing DAC 0800 with 8086 (2)

5. **Interfacing buses**
   IEEE 488 (GPIB) & RS - 232C (2)

Textbooks:

1. Advanced Microprocessors & Peripherals by A.K.Ray & K.M.Bhurchandi
2. Computer System Architecture by Morris Mano
3. Microprocessors & interfacing by D.V.Hall
4. Microprocessors - Architecture, Programming & Applications by Ramesh Gaonkar

Reference books:

1. Introduction to Microprocessors by A.P. Mathur
2. Microprocessors - Principle & Applications by Ajit Pal.

ETC 6.3 POWER ELECTRONICS

Course Objectives (Module-wise) :

Module 1 **:** To teach about the characterization of various semiconductor devices used in power electronics.

To study the switching of various devices and also their protection in power electronic application.

Module 2 **:** To study the mechanical aspects such as mounting and heat sinking of power semiconductor devices.

To teach about the triggering of power semiconductor devices.

To teach the working principle and applications of AC to DC converters.

Module 3 **:** To teach about choppers and their control schemes.

Module 4 **:** To teach about Inverters and control of AC drives using power semiconductor devices.

Instructional Objective:

To familiarize the students with the power semiconductor devices and their applications in industry.

ETC 6.3 POWER ELECTRONICS

MODULE –I

Introduction to Thyristor family :
Structure, Symbol, V.I. Characteristics of SCR

(2 Hours)

Transistor analogy
Thyristor Turn-on methods,
Switching characteristics of Thysistors during Turn On & Turn OFF
Thyristors commutations

(4 Hours)

Thyristor protection:– over voltage protection, suppression of over voltages, over current protection, di/dt protection, dv/dt protection, snubber circuits.

(4 Hours)

MODULE II

Mounting of thyristors, series and parallel operation of thyristors,
Thyristor trigger circuits:- RC firing circuits (half wave & Full wave) Ramp triggering,

Ramp and pedestal trigging. (4 Hours)

Triac
Gate turn off Thyristors its structure, characteristics, applications (1 Hour)
PUT
Insulated gate bipolar transistor (1 Hour)

AC to DC converters :- Principle of phase control, single phone half-wave thysistor rectifier with RL load and RLE load. Single phase mid-point thysistor converter.
(4 hours)

MODULE III

DC to DC converters (choppers) :– principle of operation, (2 hours)
Control Schemes :– Constant frequency scheme, variable frequency scheme, step up choppers. (6 hours)
Choppers classification:- Class A,B,C, D,& E (Numericals) (2 Hours)

MODULE IV

Inverters :- parallel inverter :- Basic Parallel inverter, modified parallel inverter.
(2 Hours)
Series inverter :- Basic series inverter, modified series inverter, (2 Hours)

Single phase half bridge inverter (mathematical analysis)
Single phase full bridge inverter (mathematical analysis)
MC murray –bedford half bridge inverter. (3 Hours)

Three phase inverter for 1800 and 1200 mode operations
DC motor speed control: – principle of speed control, phase controlled converters.
(2 Hours)
AC Drives: - Speed control by static voltage control, variable voltage variable frequency control.
(1 hours)

Text books:

1. Introduction to Power Electronics By V. Jagannathan (prentice –Hall of India Pvt. Ltd, New Delhi)

2. Power Electronics circuits, Devices & applications By mohammed H Rashid (Prentice –Hall of India Pvt. Ltd., New Delhi)

Reference Books:

1. Thysistor Engineering by Berde
2. Power Electronics by P.C. Sen

ETC 6.4 ANTENNA AND WAVE PROPAGATION

Course Objectives (Module-wise) :

Module 1 **:** To teach basic antenna concepts and parameters.

To teach about the analysis and synthesis of antenna field patterns.

Module 2 **:** To teach about the Antenna arrays, and analysis of their field patterns.

Module 3 **:**To teach about the special purpose antennas and their field patterns.

To teach about the antenna measurements.

Module 4 **:** To teach about the radiowave propagation by means of ground-wave, Troposheric wave and sky-wave.

Instructional Objective:

To expose the students to the fundamentals of electromagnetic radiation and propagation.

To teach about the composition, characteristics and application of antennas as an efficient electromagnetic interface and as a vital link in communication.

ETC 6.4: ANTENNA AND WAVE PROPAGATION

MODULE 1

Basic Antenna Concepts and Antenna Parameters, Antenna Aperture and Aperture Efficiency. (3 Hours)

Maximum Effective Aperture of a Short Dipole and a Linear Half-Wave Antenna Friss transmission formula. (2 Hours)

Point Sources, Power patterns, power theorem, radiation intensity, different power patterns (hemispherical, unidirectional and bi-directional cosine, sine, sine-squared cosine squared and (cosine). (4 Hours)

Field and phase patterns, effect of earth field patterns. (1 Hour)

MODULE 2

The short electric dipole: Retarded vector potential, fields and radiation resistance, Radiation resistance of a half wave dipole and half wave antennas with a uniform traveling wave. (3 Hours)

Various forms of Antenna arrays; Arrays of point sources: Isotropic point sources of : (i) same amplitude and phase (ii) same amplitude but opposite phase (iii) same amplitude and in phase quadrature (iv) equal amplitude and any phase (v) unequal amplitude and any phase. (3 Hours)
Patterns multiplication: Radiation pattern of four and eight isotropic elements fed in phase, linear array with n isotropic point sources with equal amplitude and spacing; broadside case; End-fire case. (2 Hours)

End-fire array with increased directivity, phased array and scanning arrays. (2 Hours)

MODULE 3

Loop antenna: field of a small loop, field pattern of circular and square loop, ferrite-rod antenna; Helical Antenna: Geometry, transmission and radiation modes, design of monofilar axial mode type, Wide-band characteristics, tapered monofilar axial mode type. (2 Hours)

Construction, characteristics of : Slot antennas, slotted cylindrical antennas, Aperture antenna, Horn antennas (rectangular and circular), Reflector antennas: Corner, paraboloidal, cylindrical parabolic, Cassegrain feed, Lens antennas, dielectric rod antennas. (3 Hours)

Yagi-Uda array, V- and Rhombic-antenna;, Turnstile antennas; Baluns and traps. (1 Hour)

Antenna Measurements: Directivity, gain, phase, terminal impedance, current distribution, polarization; system temperature and signal-to-noise ratio. (2 Hours)

Broad-band and frequency-independent antennas: Planar spiral, conical-spiral, Log-periodic antenna and array. (2 Hours)

MODULE 4

Ground-wave propagation, Plane-earth reflection, space wave, elevated dipoles above plane earth, line of sight propagation, wave tilt of the surface wave, spherical earth propagation. (2 Hours)

Tropospheric propagation: waves, abnormal refraction and reflection, Duet propagation, Tropospheric scattering, Fading and Diversity reception. (3 Hours)

Ionospheric Propagation: Layers, permittivity and conductivity, collision and plasma frequency. (1 Hour)

Reflection and refraction, refractive index, electron density, determination of critical frequency and virtual height (1 Hour)

Maximum usable frequency, skip distance, optimum frequency, regular and irregular variations. (1 Hour)
Sky-wave transmission, effect of Earth's magnetic field, Whistlers; Incoherent scatter, VLF propagation. (2 Hours)

TEXT BOOKS

I. Antenna & Wave Propagation by K. D. Prasad.
2. Electromagnetic Fields and Waves by Jordan & Balmain.

REFERENCE BOOKS

3. Antennas by J.D. Kraus

ETC 6.5. Electronics Instrumentation

Course objectives: (Module-wise):

***Module 1*:**

To teach the principles of measurement of fundamental quantities such as time and frequency.

To teach the block schematic and principle working of signal generator and measuring instruments.

***Module 2**:*

To teach about the 'Electronic Eye' (Cathode Ray Oscilloscope) in all it aspects and also the principle of working and applications of a spectrum analyzer.

Module 3:

To teach in detail about various transducers and their applications in measurements.

To teach about the basics of a Data Acquisition system.

Module 4**:**

To familiarize the students with Programmable logic controllers, associated devices and programming

Instructional Objectives**:**

- **To teach the basic principles of measurements of non-electrical quantities such as displacement, velocity, pressure, temperature, flow, time period.**
- **To teach the basic principle of measurements of electrical quantities such as voltage , frequency, spectrum**
- **To teach the block schematic, merits and demerits and principle of operation of all the instruments used in measurements.**
- **To teach about the Programmable logic controller and related aspects of Process control instrumentation.**
- **To train the students in the design and analysis of instrumentation systems.**

ETC 6.5 ELECTRONIC INSTRUMENTATION

MODULE1

Frequency & Time Measurements: Time definition & standards, Standard Frequency & Time Signal Broadcasts, Time and Frequency Standards (2) Signal generators: Frequency synthesized signal generators, sweep frequency signal generators, (1) Electronic Voltmeters (Analog): Chopper stabilized DC(Low frequency) voltmeter, different methods of chopping, true RMS responding voltmeters. (1)
Electronic Voltmeter(digital):
Non-integrating type: Ramp type, Staircase Ramp, Continuous balance, Successive Approximation (2)
Integrating type: Voltage to frequency, Potentiometer Integrating, Dual Slope integrating Voltmeter (2)
Digital Multimeter: Block Diagram, General specification of a DVM, Sensitivity & Resolution of a DVM (1)
Electronic Voltmeter (High Frequency measurement): Sampling Voltmeter (1)

MODULE 2

Oscilloscope: Block diagram, Classification of CRO's, CRT control circuits, Electrostatic focusing, Delay lines, single trace, multiple trace CRO's, Time base circuits, Synchronizing circuits, Z-modulation.
(4) CRO probes: Active & Passive probes, Compensation for probes. Screen for CRTs Graticule
(1) Types of Oscilloscops :Digital storage oscilloscope, sampling oscilloscope
(1) Applications of CRO's: Phase & frequency measurements using triggered sweep method and by using Lissajous patterns (1)
Spectrum Analyzer: General Block Diagram, Swept Super heterodyne Spectrum Analyzer, FFT based Spectrum Analyzers, frequency Resolution & Bandwidth, Sweep Desensitization, sensitivity of spectrum Analyzer, Application of spectrum Analyzers (3)

MODULE 3

Displacement Transducer: Basic displacement measurement scheme, different types of displacement transducers: strain gauge, linear variable differential transformer, Capacitive, Inductive, Piezoelectric, Potentiometer.
(2) Velocity Transducers: Basic principle of measuring velocity, Tachogenerator, Stroboscopic method of measuring rpm (revolutions/minute)
(1) Pressure Transducers: Inductive, resistive and capacitive transducers for measuring pressure.
(1) Temperature Measurement Transducers: Resistance Temperature Detectors, Thermistors, Thermocouples.
(2) Flow measurement transducers: Turbomagnetic Flowmeter, Electromagnetic

Flowmeter, and Ultrasound Flowmeter.
(2) Data Acquisition Systems (DAS): Basic block diagram of Data Acquisition System, Objective of DAS, Signal Conditioning of the inputs, Instrumentation Amplifier, Isolation Amplifier.
(2)

MODULE 4

Programmable Logic Controllers (PLC): PLC Advantages & Disadvantages, Overall PLC System, CPU & Programmable Monitors, PLC input & Output Modules(Interfaces). (1) General PLC Programming Procedure : Proper Construction of PLC Ladder diagrams, Process Scanning considerations.
(1) Devices to which PLC input & output are connected: Input ON/OFF switching devices, Input analog devices, ON/OFF devices, Output analog devices. (1) Basic PLC Programming :
(7) (i) Programming ON-OFF inputs to produce ON-OFF outputs: PLC input instructions, Outputs Coils, Indicators, Operational Procedures, Constant Coil input & output programming examples, Fail Safe circuits, Industrial Process Example. (ii) Relation of digital gate Logic to Contact /Coil Logic: Digital logic gates & PLC equivalents, Boolean Algebra PLC programming, Conversion Examples.
(iii) Creating Ladder Diagrams from Process Control Descriptions: Ladder diagrams & Sequence listing, Large Process Ladder diagram construction.
(iv) PLC Timer Functions: PLC timer functions, Examples of timer and their industrial applications, Industrial process timing applications.
(v) PLC Counter functions : PLC Counters, Examples of Counter Functions, Industrial applications.
(vi) Selecting a PLC: PLC versus Personal Computer, Factors to consider while selecting a PLC

TEXT BOOKS:

1. **Modern Electronic instrumentation & Measurement by Helfrick & Cooper, Prentice Hall of India.**
2. **Electronic Measurements & Instrumentation by Oliver, Cage, Tata McGraw Hill Publishing Company Limited**
3. **Principles of Industrial Instrumentation by D.Patranabis, Tata McGraw Hill Publishing Company Limited**
4. **Programmable Logic Controllers: Principles & Applications, 5th Edition, John Webb, Ronal Weiss, Prentice Hall of India.**

REFERENCE BOOKS :

1. **Electronic Instrumentation by Kalsi, Tata McGraw Hill.**
2. **Introduction to Programmable Logic Controllers by Gary Dunning, 3rd Edition, Thomson/Delmar Learning.**
3. **Principle of Measurement and Instrumentation by Alan S. Morris, Prentice Hall of India, 2nd Edition.**
4. **A First Course in Electronics & Electrical Measurement and Instrumentation by**

J.B.Gupta, S.K.Kataria & Sons.
5. Principles of Electronic Instrumentation by D.Patranabis, Prentice Hall of India

ETC 6.6 VLSI TECHNOLOGIES AND DESIGN

Course Objectives (Module-wise) :

Module 1 **:** To introduce the structure, characteristics and principle of operation of MOS devices.

Module 2 **:**To introduce students to SPICE modeling.

To teach in detail the switching characteristics of MOS devices.

To teach in detail, CMOS logic gate design.

Module 3 **:** To introduce the silicon semiconductor technology and basic CMOS technology

To teach about the circuit layout design of MOS devices and components.

Module 4 **:**To teach VLSI design methodologic using VHDL.

Instructional Objective :

To introduce students to the field of microelectronics in general and VLSI in particular .

To teach about the characterization of MOS devices and components, their fabrication and circuit design (Application specific or custom) Automatic testing and design verification.

ETC 6.6VLSI TECHNOLOGY AND DESIGN

Module I

MOS transistor switches : CMOS logic- Inverter, NOR, NAND and combinational logic , compound gates , Multiplexers ,Transmission gates, latches and Registers. **2 hrs**

MOS Transistor : Structures, MOS system under external bias, operation of MOS transistor (MOSFET), threshold voltage, MOSFET I-V characteristics , **3 hrs**

Channel Length Modulation, substrate bias effect, measurements of parameters – K_N, V_{TP} & γ, MOSFET capacitances. **2 hrs**

MOS Inverters : Static load MOS Inverters , CMOS Inverter Design: Operation ,DC Characteristics, Noise margins , Power and Area considerations. **3 hrs**

Module II

Modeling of MOS transistor circuits using **SPICE** (level1 model equations) **3 hrs**

Switching Circuit Characteristics : Rise , fall and delay time , Gate delays , Transistor sizing , static and dynamic power dissipations. **3 hrs**

CMOS logic gate design : Fan –in and fan out , NOR , NAND and Complex logic gates and their layouts (Euler paths). CMOS logic- Inverter, NOR, NAND and combinational logic , compound gates , Multiplexers ,Transmission gates, latches and Registers **4 hrs**

Module III

Silicon semiconductor Technology: Wafer processing, Oxidation, Epitaxy, Deposition, Ion-implantation and Diffusion silicon gate process. **4 hrs**

Basic CMOS technology: n-well and p-well CMOS process. Silicon on insulator. **2 hrs**

MOSIS layout design rules (full-custom mask layout designs), stick diagrams, layout editors (Magic/Micro Wind) and circuit extraction. **3 hrs**

FPGA and CPLD: features , differences and working **1 hr**

Module IV

VLSI design methodologies: VLSI design flow, design analysis, simulations: circuit, timing, switch-level, gate-level (or logic). Using HDLs : **VHDL** **5 hrs**

Design verification: Electrical, timing, functional . **Design synthesis:** Circuit and logic Synthesis. **1 hr**

Testing : Test procedure, Design for Testability (DFT) Scan – Based Test, Boundary- Scan Design, Built in self test (BIST). **2 hrs**

Automatic Test-Pattern generation (ATPG). Fault models and its simulation. **2 hrs**

Textbooks:

1. CMOS Digital Integrated Circuits (Analysis and Design) by Yusuf and Kong.
2. Principles of CMOS VLSI Design by Neil H.E. Weste, Kamran Eshranghian.
3. Digital Integrated Circuits – (Design perspective) by Jan M. Rabaey.
4. Fundamentals of Digital logic with VLSI design by Stephen Brown, Zvonco Vranesic

Reference books:

1. Basic VLSI Design by Douglas Pucknell, Kamran Eshraghian, PHI.
2. Modern VLSI design (Systems on Silicon) by Wayne Wolf.
3. Introduction to VLSI design by Eugene D. Gabricius.
4. VHDL by Douglas Perry.
5. VHDL Primer by J. Bhaskar.