Syllabus for
M.Tech in Electronics & Communication Engineering & Electronics & Telecommunication Engineering

Semester	Subject	Credit	Details of Subjects
I	PC-1	4	Modern Digital Communication Techniques
	PC-2	4	Information Theory, Coding and Cryptography
	PC-3	4	Telecommunication Switching and Networks
	EL-1	3	Adaptive Signal Processing
	(***any one***)		Satellite Communication System
			Digital Integrated Circuit Design
			Mathematics for Communication Engineering
	EL-2	3	Fiber-Optics Components and Devices
	(***any one***)		Computational Intelligence
			Analogue Integrated Circuit Design
			Semiconductor Device Modeling and Simulation
	Lab-1	4	Communication System Engineering Lab
	Seminar-1	2	Seminar on Pre-thesis Work-1
Semester Credits:		**24**	
II	PC-4	4	Microwave and Antenna Engineering
	PC-5	4	Wireless Communication
	EL-3	3	Statistical Signal Processing
	(***any one***)		Digital Speech Processing
			Digital Image Processing
			Biomedical Instrumentation and Signal Processing
	EL-4	3	Optical Communication
	(***any one***)		Wireless Sensor Network
			RF and Mixed Signal Integrated Circuit Design
			Industrial Telematics
	EL-5	3	Embedded System Design
	(***any one***)		Mobile Computing
			ASIC and SoC Design
			Internet and Web Technology
	Lab-2	4	Design and Simulation Lab
	Seminar-2	2	Seminar on Pre-thesis work-2
	Viva-1	2	Comprehensive Viva-Voce - I
Semester Credits:		**25**	

Semester	Subject	Credit	Details of Subjects
III	Open Elective (any one) Thesis-1	3 14	Project Management / Project Costing / Technology Management / Research Methodology / Optimization Techniques / / Thesis – I
Semester Credits:		**17**	
IV	Thesis -2 Seminar-2 Viva-2	20 2 2	Thesis – II Seminar Comprehensive Viva-Voce – II
Semester Credits:		**24**	
Total Credits		**90**	

Modern Digital Communication Techniques (3-1-0) Credit: 4

Module 1: **(12 hrs)**

Deterministic & Random Signal Analysis

Bandpass & Lowpass Signals, Lowpass Equivalent of Bandpass Signals, Energy Considerations, Lowpass Equivalent of a Bandpass System. Vector Space Concepts, Signal Space Concepts, Orthogonal Expansions of Signals, Gram-Schmidt Procedure. Bounds on Tail Probabilities, Limit Theorems for Sum of Random Variables. Complex Random Vectors. WSS Random Process, Cyclostationary Random Process, Proper and Circular Random Process, Markov Chains. Sampling Theorem for Band-limited Random Process, The Karhunen-Loeve Expansion. Banpass and Lowpass Random Processes. [Proakis & Salehi Sections 2.1, 2.2, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9]

Module 2: **(18 hrs)**

Digital Modulation Scheme

Representation of Digitally Modulated Signals, Memoryless Modulation Methods; Pulse Amplitude Modulation, Phase Modulation, Quadrature Amplitude Modulation, Multidimensional Signaling. Signaling Schemes With Memory; Continuous-Phase Frequency-Shift Keying, Continuous-Phase Modulation. Power Spectrum of Digitally Modulated Signals; Power Spectral Density of a Digitally Modulated Signal With Memory, Power Spectral Density of Linearly Modulated Signals, Power Spectral Density of Digitally Modulated Signals With Finite Memory, Power Spectral Density of Modulated Schemes With a Markov Structure, Power Spectral Density of CPFSK and CPM Signals. [Proakis & Salehi Sections 3.1, 3.2, 3.3, 3.4, 3.5]

Optimum Receivers for AWGN Channels

Waveform and Vector Channel Models; Optimum Detection for a General Vector Channel. Waveform and Vector AWGN Channels; Optimal Detection for the Vector AWGN Channel, Implementation of the Optima Receiver for the AWGN Channels. Optimal Detection and Error Probability for ASK, PAM,PSK AND QAM Signaling. [Proakis & Salehi Sections 4.1-1, 4.2-1,4.2-2, 4.3-1, 4.3-2, 4.3-3]

Carrier and Symbol Synchronization

Signal Parameter Estimation; The Likelyhood Function, Carrier Recovery and Symbol Synchronization in Signal Demodulation. Carrier Phase Estimation; Maximum Likelyhood Carrier Phase Estimation, The Phase-Locked Loop, Effect of Additive Noise in the Phase Estimate. Symbol Timing Estimation; Maximum Likelyhood Timing Estimation. [Proakis & Salehi Sections 5.1-1, 5.1-2, 5.2-1, 5.2-2,5.2-3]

Module 3: **(15 hrs)**

Digital Communication Through Band-Limited Channels

Characterization of Band-Limited Channels. Signal Design for Band-Limited Channels; Design of Band-Limited Signals for No Intersymbol Interference-The Nyquist Criterion, Optimum Maximum-Likelihood Receiver. [Proakis & Salehi Sections 9.1, 9.2-1, 9.3-1]

Multichannel and Multicarrier Systems

Multichannel Digital Communications in AWGN Channels; Binary Signals, M-ary Orthogonal Signals. Multicarrier Communications; Single Carrier verses Multicarrier Modulation, Capacity of a Nonideal Linear Filter Channel, OFDM, Modulation & Demodulation in an OFDM, An FFT Algorithm Implementation of an OFDM System. [Proakis & Salehi Sections 11.1, 11.2-1, 11.2-2, 11.2-3, 11.2-4, 11.2-5]

Spread Spectrum Signals for Digital Communication

Model of Spread spectrum Digital Communication System. Direct Sequence Spread Spectrum Signals; Error Rate Performance of the Decoder, Some Applications of DS Spread Spectrum Signals. Frequency-Hopped Spread-Spectrum Signals; Performance of FH Spread Spectrum Signals in an AWGN Channel, A CDMA System Based on FH Spread Spectrum Signals. [Proakis & Salehi Section 12.1]

Text Book

1. John G. Proakis and Masoud Salehi, ***Digital Communication***, McGraw-Hill, 5th Edition

Reference Books

1. Simon Haykin, ***Digital Communication***, Willy
2. Tube & Schilling, ***Principle of Communication***, PHI

Information Theory, Coding and Cryptography (3-1-0) Credit : 4

Module: 1 **12 Hours**

Source Coding

Introduction to information theory, uncertainty of information, Information measure, entropy, source coding Theorem, Huffman Coding, runlength encoding, rate distortion function, JPEG and MPEG standards in image compression.

Channel Capacity and Coding

Channel models, Channel Capacity, Channel Coding, Information Capacity Theorem, The Shannon Limit.

Module: 2 **14 Hours**

Error Control Coding

Linear Block Codes: Introduction, Basic definition, equivalent codes, parity - check matrix, decoding, syndrome decoding, Perfect Codes, Hamming Codes, Optimal Linear codes.

Cyclic Codes

Introduction polynomials, The division Algorithm, Method for generating cyclic codes, Burst Error correction, Fire Codes, Golay Codes, CRC Codes, Circuit implementation.

Bose Chaudhuri Hocquenghem (BCH)

Introduction, Primitive elements, minimum polynomials, Examples of BCH codes, Decoding of BCH codes, Recd - Solomon codes.

Module: 3 **14 Hours**

Convolution Codes

Introduction, Tree Codes and Trellis Codes, Polynomial description, The Generating function, Matrix Description, Viterbi Decoding, Distance bounds, Turbo Codes, Turbo Decoding.

Trellis Coded Modulation (TCM)

Introduction, the concept of coded modulation, Mapping by set Partitioning, Design rules, TCM Decoder.

Coding for Secure Communication, Cryptography

Introduction, encryption techniques, Symmetric cryptography, data encryption standard, Asymmetric Algorithm the RSA Algorithm.

Textbooks:

1. *Ranjan Bose, **Information Theory, Coding and Cryptography**, 2nd Edn., Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2008. ISBN-10: 0-07-066901-5, ISBN-13: 978-0-07-066901-7.*

Recommended Reading:

1. *R. Avudaiammal, **Information Coding Techniques**, 2nd Edn., Tat McGraw-Hill Education Pvt. Ltd., New Delhi. ISBN(10): 0-07-067282-2, ISBN(13): 978-0-067282-6.*
2. *J. G. Proakis, **Digital Communication**, 3rd Edition, McGraw-Hill Publication,.*

Telecommunication Switching and Networks (3-1-0) Credit: 4

MODULE – I **(16 hours)**

Introduction

Evolution, simple telephone communication, basis of switching system, telecommunication networks.

Electronic space division switching

Stored program control, centralized and distributed SPC, software architecture, application software, enhanced software, two and three stage networks.

Time Division Switching

Basic time division space switching, basic time division time switching, time multiplexed space and time switching, combination switching, three-stage combination switching.

MODULE – II **(12 hours)**

Traffic Engineering

Network traffic load and parameters, Grade of service, modelling switching systems, incoming traffic, blocking models and loss estimates.

Telephone Networks

Subscriber loop systems, switching hierarchy and routing, transmission plan, transmission systems, signalling techniques

MODULE – III **(12 hours)**

Data Networks

Data transmission in PSTN, switching techniques, Data communication architecture, link-to-link layers, end-to-end layers, satellite based data networks, LAN, MAN, Fibre optic networks, an overview of data network standards

Integrated Service Digital Network, motivation, new services, transmission channels, signalling, service characterization, ISDN standards, broad band ISDN, voice data integration.

Textbooks:

1. *Thiagarajan Viswanathan,* ***Telecommunication Switching Systems and Networks*** *by, PHI Learning Pvt. Ltd., New Delhi.*
2. *Alberto Leon-Gracia and Indra Widjaja,* ***Communication Networks****, Tata McGraw Hill Education Pvt. Ltd., New Delhi.*

Recommended Reading:

1.

Adaptive Signal Processing

(3 – 0 – 0) Credits: 3

MODULE – I **(11 hours)**

Adaptive System

Definition and Characteristics, Areas of Application, Example of an Adaptive System, Adaptive Linear Combiner, The Performance Function, Gradient and Minimum Mean-Square Error, Alternative Expression of the Gradient, Decorrelation of Error and Input Components. [Read Widrow: Chapter 1 and 2]

Winer Filter

Linear Optimum Filtering, Principle of Orthogonality, Minimum Mean Square Error, Winer-Hopf Equation, Error Performance Surface. [Read Haykin: Chapter 2.1-2.5]

Linear Prediction

Forward Linear Prediction, Backward Linear Prediction, Properties of Prediction Error Filters. [Read Haykin: Chapter 3.1, 3.2, 3.4]

MODULE – II **(11 hours)**

Method of Steepest Descent

Basic Idea of Steepest-Descent Algorithm, Steepest-Descent Algorithm Applied to Winer Filter, Stability of Steepest-Descent Algorithm, Limitations of Steepest-Descent Algorithm. [Read Haykin: Chapter 4.1 – 4.3, 4.6]

Least-Mean Square Adaptive Filter

Overview, LMS Adaptation Algorithm, Application, Comparison of LMS With Steepest-Descent Algorithm. [Read Haykin: Chapter 5.1 – 5.3, 5.5]

Normalized Least-Mean Square Adaptive Filter

Normalized LMS Filter as the Solution to Constrained Optimization Problem, Stability of the NLMS. [Read Haykin: Chapter 6.1, 6.2]

MODULE – III **(11 hours)**

Frequency-Domain and Subband Adaptive Filters

Block Adaptive Filters [Read Haykin: Chapter 7.1]

RLS Adaptive Filters

Statement of Linear Least-Square Estimation Problem, Matrix Inversion Lemma, The Exponentially Weighted RLS Algorithm. [Read Haykin: Chapter 8.1, **9.1 – 9.3]**

Kalman Filter

Recursive Minimum Mean-Square Estimation For Scalar Random Variable, Kalman Filtering Problem, Initial Conditions, Summary of Kalman Filter. [Read Haykin: Chapter 10.1, 10.2, 10.6, 10.7]

Textbooks:

1.Bernard Widrow and Samuel D. Stearns, ***Adaptive Signal Processing***, Pearson Education.
2.Simon Haykin, ***Adaptive Filter Theory***, 4th Edn. Pearson Education.

Recommended Reading:

1.

Satellite Communication System

(3-1-0) Credit : 4

Module: 1 **13 Hours**

Satellite Communication Technology

Satellite orbits, Satellite constellation and ISL, orbital parameters, look angle determination, launching procedures. Spacecraft subsystems - Attitude and orbit control, power, TT & C, communication and antennas. Earth station design - Digital transmitter and receiver, antenna and beam steering techniques.

Module: 2 **13 Hours**

Link Design

Digital satellite link analysis and design for FSS and BSS - link budget and Eb/No calculations. Performance impairments - Noise, interference, propagation effects and frequency considerations.

Module: 3 **14 Hours**

Access Techniques

FDMA concept- Intermodulation and back off - SPADE system. TDMA concept - Frame and burst structure - Frame acquisition and synchronization - Satellite Switched TDMA system. CDMA concepts - DS and FH System acquisition and Tracking.

Audio broadcasting via satellite – World Space Services through Teledesic, LEO system and Glob star.

Textbooks:

1. Tri T. Ha, ***Digital Satellite Communication Systems Engineering***, McGraw Hill, 1990.
2. Wilbur L. Pritchard, Henri G. Suyderhoud, and Robert A. Nelson, ***Satellite Communication System Engineering***, 2nd Edn., Pearson Education, New delhi.

Recommended Reading:

3. Pratt and Bostain, ***Satellite Communication***, John Wiley and Sons, 1986.
4. M. Richharia, ***Mobile Satellite Communications – Principles and Trends***, Pearson Education, 2003.
5. Robert.M.Gagliardi, ***Satellite Communication***, CBS Publishers.

Digital Integrated Circuit Design

(3 – 0 – 0) Credits: 3

MODULE – I **(11 hours)**

Introduction, Design Metrics and Manufacturing Process:
A Historical Perspective, Issues in Digital Integrated Circuit Design, Quality Metrics of a Digital Design, Introduction to Manufacturing Process, Manufacturing CMOS Integrated Circuits, Design Rules – The Contract between Designer and Process Engineer, Packaging Integrated Circuits

The Devices:
Introduction, The Diode, The MOS(FET) Transistor, The Wire, Interconnect Parameters – Capacitance, Resistance, and Inductance, Electrical Wire Models, SPICE Wire Models

The CMOS Inverters and CMOS Logic Gates – the Static View:
Introduction to CMOS Inverter, The Static CMOS Inverter – An Intuitive Perspective, Evaluating the Robustness of the CMOS Inverter, Introduction to Static CMOS Design, Complementary CMOS, Ratioed Logic, Pass-Transistor Logic

CMOS Inverter – the Dynamic View:
Performance of CMOS Inverter: The Dynamic Behavior, Power, Energy, and Energy-Delay, Perspective: Technology Scaling and its Impact on the Inverter Metrics

MODULE – II **(11 hours)**

Dynamic CMOS Logic, Timing Metrics:
Dynamic CMOS Design, CMOS Logic Design Perspectives, Timing Metrics: Timing Metrics for Sequential Circuits, Classification of Memory Elements

Static and Dynamic Sequential Circuits:
Static Latches and Registers, Dynamic Latches and Registers, Alternative Register Styles: Pulse Registers and Sense-Amplifier Based Registers, Pipelining: An Approach to Optimize Sequential Circuits – Latch Vs Register-Based Pipelines and NORA-CMOS – A Logic Style for Pipelined Structures, Nonbistable Sequential Circuits

Coping with Interconnect:
Introduction, Capacitive Parasitics, Resistive Parasitics, Inductive Parasitics, Advanced Interconnect Techniques, Networks-on-a-Chip

Timing Issues in Digital Circuits:
Introduction, Timing Classification of Digital Systems, Synchronous Design – An In-depth Perspective, Self-Timed Circuit Design, Synchronisers and Arbiters, Clock Synthesis and Synchronisation Using a Phase-Locked Loop, Future Directions and Perspectives

MODULE – III **(12 hours)**

Designing Arithmetic Building Blocks:
Introduction, Datapaths in Digital Processor Architecture, The Adder, The Multiplier, The Shifter, Other Arithmetic Operators, Power and Speed Trade-off's in Datapath Structures, Perspective: Design as a Trade-off

Designing Memory and Array Structures:
Introduction, The Memory Core, Memory Peripheral Circuitry, Memory Reliability and Yield, Power Dissipation in Memories, Case Studies in Memory Design: The PLA, A 4-Mbit SRAM and A 1-Gbit NAND Flash memory, Perspective: Semiconductor Memory Trends and Evolution

Validation and Test of Manufactured Circuits:
Introduction, Test Procedure, Design for Testability, Test Pattern Generation

Textbooks:

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, ***Digital Integrated Circuits*** – A Design Perspective**,** 2nd edn., Pearson Education, 2003. ISBN: 8178089912.

Recommended Reading:

2. K. Eshraghian, and N.H.E. Weste, Principles of CMOS VLSI Design – a Systems Perspective, 2nd edn., Addison Wesley, 1993.
3. Wayne Wolf, ***Modern VLSI Design System – on – Chip Design***, 3rd edn., Pearson Education, 2003.
4. M. Michael Vai, ***VLSI Design***, CRC Press, 2001.
5. John P. Uyemura, ***CMOS Logic Circuit Design***, Springer (Kluwer Academic Publishers), 2001.
6. Ken Martin, ***Digital Integrated Circuit Design***, Oxford University Press, 2000.

Mathematics for Communication Engineering (3 – 0 – 0) Credits: 3

MODULE – I **(11 hours)**

Introduction and Foundations:

Markov and hidden Markov Models [Read Moon: 1.7]

Vector Spaces and Linear Algebra:

Metric Spaces.Vector Spaces,Norms and Normed vector Spaces,Inner Products and Inner Product Spaces, Induced Norms,The Cauchy- Schwarz Inequality,Orthogonal Sub Spaces, Projections and Orthogonal Projection,Projection Theorem Orthogonalization of Vectors. [Read Moon: 2.1 – 2.6, 2.10, 2.13, 2.14, and 1.15]

Representation and Approximation in Vector Spaces:

The Approximation Problem in Hillbert Space, The Orthogonality Principle, Matrix Representation of Least-Squares Problems, Linear Regression, Least Squares Filtering, Minimum Mean Square Estimation, Minimum Mean Squared Error (MMSE) Filtering, Comparison of Least Squares and minimum Mean Squares. [Read Moon: 3.1, 3.2, 3.4, 3.8 - 3.12]

MODULE – II **(11 hours)**

Some Important Matrix Factorization:

The Cholesky Factorization, Unitary Matrices and the QR Factorization. [Read Moon: 5.2 and 5.3]

The Singular Value Decomposition:

Theory of the SVD, Matrix Structure from the SVD, Pseudo-inverses and the SVD, Rank – Reducing Approximations: Effective Rank, System Identification Using the SVD. [Read Moon: 7.1 – 7.3, and 7.5]

Introduction to Detection and Estimation, and Mathematical Notation:

Detection and Estimation Theory, Some Notational Conventions, Conditional Expectation, Sufficient Statistics, Exponential Families. [Read Moon: 10.1 – 10.3, 10.5, and 10.6]

MODULE – III **(11 hours)**

Detection Theory:

Introduction to hypothesis testing, Neyman-Pearson theory, Neyman Pearson testing with Composite Binary Hypotheses, Bayes Decession Theory, Some M-ary Problems, Maximum–Likelihood Detection. [Read Moon: 11.1 – 11.6]

Estimation Theory:

The Maximum Likelihood principle, ML Esimates and sufficiency, Applications of ML Estimation, Bayes Estimation Theory, Bayes risk [Read Moon: 12.1 – 12.6]

Textbooks:

1. Todd K.Moon and Wynn C. Stirling, ***Mathematical Methods and Algorithms for Signal Processing***, Pearson Education.

Recommended Reading:

1. *Probability and Random Processes with Application to Signal Processing*, Pearson Education.

Fibre-Optic Components and Devices (3–0–0) Credits: 3

MODULE – I **(11 hours)**

Fibre-Optic Light Sources and Detectors

Brief description on the principle of optical sources,Internal Quantum efficiency of LED,Modulation capability,Power-Bandwidth product, Laser diodes, Laser diode modes, Threshold conditions, Resonant frequencies, Laser diode structures, Single mode lasers, modulation of laser diodes.

Brief description on the principle of optical detectors, photodetector noise, Noise sources, Signal-to-Noise ratio, Detector response time, Depletion layer photocurrent, Response time, Avalanche multiplication noise.

MODULE – II **(11 hours)**

Optical Fibre Connection

Joint loss, Multi mode fibre joints, Singe mode fibre joints, Fibre splices, Fusion splices, Mechanical splices, Multiple splices, Fibre connectors, Cylindrical ferrule connectors, Biconical ferrule connectors, Double eccentric connectors, Duplex fibre connectors, Expanded beam connectors, Fibre couplers, Three port couplers, Four port couplers, Star couplers, WDM couplers.

MODULE – III **(12 hours)**

Optical Amplification and Integrated Optics

Optical amplifiers, Semiconductor laser amplifiers, Fibre amplifiers, Rare earth doped fibre amplifiers, Raman fibre amplifiers, Brillouin fibre amplifiers, Integrated optics, Integrated optical devices, Beam splitters, Directional couplers, switches, Modulators, Periodic structures for filters and injection lasers, Opto-electronic integration, Optical bistability and digital optics, Optical computation.

Textbooks:

1. G. Keiser, ***Optical Fibre Communications***, Mc-Graw-Hill.
2. J.M.Senior, ***Optical Fibre Communications Principles and Practice***, PHI.

Recommended Reading:

1.

Computational Intelligence

(3 – 0 – 0) Credits: 3

Introduction to Soft Computing: Soft computing constituents and conventional Artificial Intelligence, Neuro-Fuzzy and Soft Computing characteristics.

Fuzzy Sets, Fuzzy Rules and Fuzzy Reasoning: Introduction, Basic definitions and terminology, Set-theoretic operations, MF Formulation and parameterization, More on fuzzy union, intersection, and complement, Extension principle and fuzzy relations, Fuzzy If-Then rules, Fuzzy reasoning.

Fuzzy Inference System: Mamdani fuzzy models, Sugeno Fuzzy Models, Tsukamoto fuzzy models, other considerations.

Least Square Method for system Identification: System Identification , Basic of matrix manipulations and calculus, Least-square estimator, Geometric interpretation of LSE, Recursive least-square estimator, Recursive LSE for time varying systems, Statistical Properties and maximum likelihood estimator, LSE for nonlinear models.
Derivative-based optimization: Descent methods, the method of steepest descent, Newton's methods, Step size determination, conjugate gradient methods, Analysis of quadratic case, nonlinear least-squares problems, Incorporation of stochastic mechanism.
Derivative-free optimization: Genetic algorithm simulated annealing, random search, Downhill simplex search, Swarm Intelligence, genetic programming.
Adaptive Networks: Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule: combing steepest descent and LSE.

Supervised learning neural networks: Perceptions, Adaline, Back propagation multi layer perceptions, Radial Basic Function networks.
Learning from reinforcement: Failure is the surest path to success, temporal difference learning, the art of dynamic programming, Adaptive heuristic critic, Q-learning, A cost path problem, World modeling, other network configurations, Reinforcement learning by evolutionary computations.

Unsupervised learning and other neural networks: Competitive learning networks, Kohonen self-organizing networks, learning vector quantization, Hebbian learning, principal component networks, and the Hopfield network.

Adaptive Neuro-fuzzy inference systems: ANFIS architecture, Hybrid learning algorithms, Learning methods that cross-fertilize ANFIS and RBNF, ANFIS as universal approximator, Simulation examples, Extensions and advance topics.
Coactive Neuro-fuzzy modeling: towards generalized ANFIS: Framework, Neuro functions for adaptive networks, Neuro-Fuzzy spectrum, Analysis of adaptive learning capability.

Books:

1. J.S.R. Jng, C.T. Sun and E. Mizutani,"Neuro-fuzzy and Soft Computing", PHI.

2. S. Rajasekaran, G.A. Vijaylakshmi Pai,:Neural Networks, Fuzzy Logic, and Genetic Algorithms," PHI.

Analogue Integrated Circuit Design

(3 – 0 – 0) Credits: 3

MODULE – I **(11 hours)**

Introduction:

The MOS Transistor, I-V Characteristics, Equivalent Circuits, Noise

Resistor, Capacitors and Switches:

Integrated Resistors, Integrated Capacitors, Analog Switches, Layout of Switches

Basic Building Blocks:

Inverter with Active Load, Cascode, Cascode with Cascode Load, Source Follower, Threshold Independent Level Shift, Improved Output Stages

MODULE – II **(11 hours)**

Current and Voltage Sources:

Current Mirrors, Current References, Voltage Biasing, Voltage References

CMOS Operational Amplifiers:

General Issues, Performance Characteristics, Basic Architecture, Two Stages Amplifier, Frequency Response and Compensation, Slew Rate

MODULE – III **(12 hours)**

Operational Amplifiers and OTAs

Design of Two Stage OTAs: Guidelines, Single Stage Schemes, Class AB Amplifiers, Fully Differential Op-Amps, Micro-Power OTAs, Noise Analysis, Layout

CMOS Comparators:

Performance Characteristics, General Design Issues, Offset Compensation, Latches

Textbooks:

1. Franco Maloberti, ***Analog Design for CMOS VLSI Systems***, Kluwer Academic Publishers, 2001. ISBN: 0-7923-7550-5.

Reference Books:

1. Behzad Razavi, ***Design of Analog CMOS Integrated Circuits***, McGraw-Hill, 2001. ISBN: 0-07-238032-2.
2. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, and Robert G. Meyer, ***Analysis and Design of Analog Integrated Circuit***, John Wiley & Sons, Inc., 4th edn., 2000. ISBN: 0-471-32168-0.
3. Phillip E. Allen and Douglas R. Holberg, ***CMOS Analog Circuit Design***, Oxford University Press, 2nd edn., 2002. ISBN: 0-19-511644-5
4. Johan H. Huijsing, ***Operational Amplifiers – Theory and Design***, Kluwer. ISBN: 0792372840

Semiconductor Device Modeling and Simulation (3 – 0 – 0) Credits: 3

MODULE – I **(11 hours)**

Semiconductor Electronics Review:

Elements of Semiconductor Physics, Physical Operation of a ***PN*** Junction, MOS Junction, MS Junction

PN–Junction Diode and Schottky Diode:

DC Current-Voltage Characteristics, Static Model, Large-Signal Model, Small-Signal Model, Schottky Diode and its Implementation in SPICE2, Temperature and Area Effects on the Diode Model Parameters, SPICE3, HSPICE and PSPICE Models

Bipolar Junction Transistor (BJT):

Transistor Convention and Symbols, Ebers-Moll Static Model, Ebers-Moll Large-Signal Model, Ebers-Moll Small-Signal Model, Gummel-Poon Static Model, Gummel-Poon Large-Signal Model, Gummel-Poon Small-Signal Model, Temperature and Area Effects on the BJT Model Parameters, Power BJT Model, SPICE3, HSPICE and PSPICE Models

MODULE – II **(11 hours)**

Junction Field-Effect Transistor (JFET):

Static Model, Large-Signal Model and its Implementation in SPICE2, Small-Signal Model and its Implementation in SPICE2, Temperature and Area Effects on the JFET Model Parameters, SPICE3, HSPICE and PSPICE Models

Metal-Oxide-Semiconductor Transistor (MOST):

Structure and Operating Regions of the MOST, LEVEL1 Static Model, LEVEL2 Static Model, LEVEL1 and LEVEL2 Large-Signal Model, LEVEL3 Static Model, LEVEL3 Large-Signal Model, The Effect of Series Resistances, Small-Signal Models, The Effect of Temperature, BSIM1, BSIM2, SPICE3, HSPICE and PSPICE Models

MODULE – III **(12 hours)**

BJT Parameter Measurements:

Input and Model Parameters, Parameter Measurements

MOST Parameter Measurements:

LEVEL1 Model Parameters, LEVEL2 Model (Long-Channel) Parameters, LEVEL2 Model (Short-Channel) Parameters, LEVEL3 Model Parameters, Measurements of Capacitance, BSIM Model Parameter Extraction

Noise and Distortions:

Noise, Distortion

Metal-Semiconductor Field-Effect Transistor (MESFET), Ion-Sensitive Field-Effect Transistor (ISFET) and Semiconductor-Controlled Rectifier (Thyristor):

The MESFET, The ISFET, The Thyristor

Textbooks:

1. Paolo Antognetti and Giuseppe Massobrio, ***Semiconductor Device Modeling with SPICE,*** 2nd edn., McGraw-Hill, New York, 1993, ISBN 0071349553 (paperback) or 007 0024693 (hardback).

Recommended Reading:

1. Richard S. Muller, Theodore I. Kamins, and Mansun Chan, ***Device Electronics for Integrated Circuits***, 3rd edn., John Wiley and Sons, New York, 2003. ISBN: 0-471-59398-2. Listed as D
2. H. Craig Casey, ***Devices for Integrated Circuits: Silicon and III-V Compound Semiconductors***, John Wiley, New York, 1999. Listed as DI
3. Dieter K. Schroder, ***Semiconductor Material and Device Characterization***, John Wiley and Sons, New York, 1990. Listed as S