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

Semester	Subject	Credit	Details of Subjects
I	ETPC101	4	Modern Digital Communication Techniques
	ETPC102	4	Information Theory, Coding and Cryptography
	ETPC103	4	Telecommunication Switching and Networks
			Electives - I ***(any one)***
	ETPE101	3	Adaptive Signal Processing
	ETPE102		Satellite Communication System
	VLPC102		Digital Integrated Circuit Design
	ETPE104		Mathematics for Communication Engineering
			Electives - II ***(any one)***
	ETPE105	3	Fiber-Optics Components and Devices
	CSPE102		Computational Intelligence
	VLPE104		Analogue Integrated Circuit Design
	VLPC103		Semiconductor Device Modeling and Simulation
	ETPR101	4	Lab-1-Communication System Engineering Lab
	ETPT101	2	Seminar I- on Pre-thesis Work-1
Semester Credits:		**24**	
II	ETPC201	4	Microwave and Antenna Engineering
	ETPC202	4	Wireless Communication
	VLPE208 (***any one***)	3	Statistical Signal Processing
	ETPE201		Radar System Engineering
	ETPE202		Digital Image Processing
	ETPE203	3	Biomedical Instrumentation and Signal Processing
	ETPE204		Optical Communication
	ETPE205		Wireless Sensor Network
	VLPC202	3	RF and Mixed Signal Integrated Circuit Design
	ETPE206		Industrial Telematics
	EL-4 (***any one***)		
	VLPC201		Embedded System Design
	CSPE204		Mobile Computing
	VLPE204		ASIC and SoC Design
	ETPE207		Internet and Web Technology
	EL-5 (***any one***)		

	ETPR201 ETPT201 ETCV201	4 2 2	Design and Simulation Lab Seminar on Pre-thesis work-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	ETPT401 ETCV401 ETCV402	20 2 2	Thesis – II Seminar Comprehensive Viva-Voce – II
Semester Credits:		**24**	
Total Credits		**90**	

Modern Digital Communication Techniques (3-1-0)

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)

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 & Networks (3-1-0)

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)

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)

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)

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 Ed, 2003.
4. M. Michael Vai, ***VLSI Design***, CRC Press, 2001.
5. John P. Uyemura, ***CMOS Logic Circuit Design***, Springer (Kluwer Academic Pub), 2001.
6. Ken Martin, ***Digital Integrated Circuit Design***, Oxford University Press, 2000.

Mathematics for Communication Engineering(3–0– 0)

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)

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)

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)

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 & Simulation(3–0–0)

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

2nd Semester

MICROWAVE AND ANTENNA ENGINEERING (3-1-0)

Module - I (15 hours)

Overview if microwave transmission line analysis and use smith chart in single and double stub matching. Planar transmission lines (strip line and microstrip line), Microstrip line impedance matching, quarter wave impedance transformers for broad band matching and lumped element matching, basics of design and fabrication of MMIC.

Scattering matrix representation of multiport networks (T junctions, magic TEE, circulators, directional couplers and isolators).

Semiconductor microwave devices (TEDS), negative resistance, Gunn effect, RWH theory LSA mode of operation, Avalanche transit-Time device READ diode, IMPATT, TRAPATT, BARITT diodes – principles of operation only. Solid state microwave generation and amplification (principles).

Module – II (12 hours)

The vector potential for an electric and magnetic current source, solution of in homogeneous vector potential wave equation, Duality theorem, reciprocity and reaction theorem.

Principles of radiation; radiation pattern, near and far field regions. Antenna efficiency, Radiation power density, radiation intensity, radiation efficiency, Directivity, power gain, bandwidth, beam efficiency, polarization of antennas. Antenna effective length and equivalent areas. Antenna temperature, noise temperature of cascaded networks (using antenna).

Dipole and loop antennas; current distribution, radiated field. Radiation resistance, dipole arrays; planar and circular array, array factor and directivity, broadside & end-fire array, phased array, pattern multiplication.

Module – III (15 hours)

Frequency independent and broad band antennas. Log periodic structure (of dipole antenna).

Reflector antenna: corner reflectors, parabolic reflectors, principle of analysis and operation, Aperture antennas (rectangular and circular apertures) TE_{10}, TE_{11} mode and beam efficiency. Directivity and gain.

Basic characteristics of microstrip antenna, rectangular and circular patch Q. factor, band width and efficiency; feed to microstrip antenna; probe feed; microstrip line. Microstrip antenna on Ferrite substrate.

TEXT BOOKS:

1. Microwave Devices and Circuits (3rd Ed.), Prentice-Hall of India Pvt. Ltd.
2. Microwave Engineering, TMH.: Annapurna Das, Sisir K. Das.
3. Antennas Theory – Analysis and Design by C. Balanis, 2nd Edition, John Willey and sons.
4. Antennas by J. D. Kraus, Tata Mc-Graw Hill Pubkication.

REFERENCE BOOKS:

1. Microwave Circuits and Passive Devices, M. L. Sisodia, G. D. Raghu Vanshi, Willey Eastern Limited.
2. Electromagnetic Wave and Radiating Systens by E. C. Jordan and K. G. Balmain, 2nd edition, PHI Publication.
3. Antenna & Wave Propagation by K. D. Prasad.
4. Modern Antenna Handbook, John Willey & sons INC Publication.

WIRELESS COMMUNICATION (3-1-0)

Module – I (18 hours)

A brief introduction to evolution of mobile radio communications, technologies and choices. Development of Wireless networks, Cellular Concept – System Design: Fundamentals: Frequency reuse, channel Assignment, Handoff Strategies, Interfaces and System Capacity, Trunking and Grade of Service; Improving coverage and capacity in Cellular Systems- Cell Splitting, Sectoring, Repeaters and Range Extension, Microcell & Picocell Zone Concept, multipath effects in mobile communication, mobile communication – antennas.

Large – Scale Propagation: basic propagation mechanisms – Reflection, Diffraction, Scattering. Outdoor propagation Model – Longly Rice model, Durkin's model, Okumura model, Hata model, PCS extension; Indoor Propagation Model; Partition loses, Log distance Path loss Model, Attenuation Factor model, Ray tracing & site specific modeling.

Small Scale Propagation: small scale multi path propagation. Small scale multi path measurements, Parameters of multi path channels, types of multi path fading, Rayleigh and Ricean distribution, Clarke's model, multi path space factors, fading rate variance.

Module – II (12 hours)

Spread spectrum modulation techniques, Equalization Technique – Linear equalizer and Nonlinear equalization, algorithms for adaptive equalization, Diversity techniques – space, polarization, frequency and time, Speech coding – quantization, ADPCM, frequency domain coding, Vocoders, linear predictive coders, GSM codec. Multiple Access Techniques: Frequency Division Multiple Access (FDMA – Wideband and narrow band), Time Division Multiple Access (TDMA), Spread Spectrum Multiple Access – Frequency Hopped multiple Access (FHMA), Code Division Multiple Access (CDMA). Space Division Multiple Access (SDMA), Spectral efficiency of different access technologies, Packet ratio protocols – ALOHA, carrier sense Multiple Access (CSMA/CD, CSMA/CA), Packet reservation Multiple Access (PRMA), capacity of cellular systems

Module – III (15 hours):: Evolution of Modern Mobile Wireless Communication systems

WPAN, IEEE 802.15, DECT, PACS, brief survey of: 1G wireless networks, 2G wireless cellular networks, GSM (radio subsystem, operation subsystem), GSM multiple access scheme, GSM channel organization, call setup procedure, 2.5G networks, GPRS network architecture, classes of GPRS equipments. IS-95 systems, 3G (UMTS) (without details) of network architecture.

Fundamentals of WLAN (802.11) transmission technology (spread spectrum and infrared transmission) logical architecture, CSMA/CA, CSMA/CD, assess method, MAC frame format system performance.

Cellular and WLAN integration: (step towards 4G networks) benefits of integration. Suitable point of integration, integration architecture.

A brief overview of WiMAx technology (broadband wireless communication).

TEXT BOOKS:

1. Wireless Communications by T. S. Rappaport, 2nd Edition, Pearson Education.
2. Wireless Communications & Network 3G and beyond Itisaha Mishra, Tata Mc-Graw Hill Education Pvt. Ltd.
3. Mobile cellular Telecommunications by W. C. Y. Lee, 2nd Edition, McGraw Hill.

REFERENCE BOOKS:

1. Wireless Communication by T. L. Singal, Tata Mc-Graw Hill Education Pvt. Ltd.
2. Wireless Communication and Networks by V. K. Garg, Elsevier.

3. Wireless Digital Communication by Kamilo Feher, PHI.
4. Wireless Communication and Networks by William Stalling, 2nd Ed, LPE, Pearson.
5. Introduction to CDMA Wireless Communication by Mosa ali Abu Rgheff, Elsevier.
6. 3G Networks by Sumit Kasera & Nishit Narang, Tata McGraw Hill.

Statistical Signal Processing (3 – 0 – 0)

Module – 1 **(9 hrs)**

Discrete Random Process: Random Process- Ensemble Average, Gaussian Process, Stationary Process, The Autocorrelation and Autocovariance Matrix, Ergodicity, White Noise, The Power Spectrom, Filtering Random Process, Special Types of Random Process-ARMV Process, AR Process, MA Process, Harmonic Process. [Read Hayes Chapter 3.3.1 – 3.3.8, 3.4, 3.6.1 – 3.6.4]

Signal Modeling: Introduction, Stochastic Models- ARMA Models, AR Models, MA Models, Application: Power Spectrum Estimation. [Read Hayes Chapter 4.1, 4.7.1 – 4.7.4]

Module – 2 **(18 hrs)**

Winer Filtering: Introduction, The FIR Wiener Filter- Filtering, Linear Prediction, Noise Cancellation, IIR Wiener Filter- Noncausal IIR Wiener Filter, The Causal IIR Wiener Filter, Causal Wiener Filtering, Causal Linear Prediction, Wiener Deconvolution, Discrete Kalman Filter. [Read Hayes Chapter 7.1, 7.2.1 – 7.2.3, 7.3.1 – 7.3.5, 7.4)

Spectrum Estimation: Introduction, Nonparametric Method- The Periodogram, Performance of Periodogram. Parametric Methods- AR Spectrum Estimation, MA Spectrum Estimation, ARMA Spectrum Estimation. Frequency Estimation- Eigendecomposition of the Autocorrelation Matrix, MUSIC. [Read Hayes Chapter 8.1, 8.2.1, 8.2.2, 8.5.1 – 8.5.3, 8.6.1, 8.6.3]

Module – 3 **(11 hrs)**

Adaptive Filtering: Introduction, FIR Adaptive Filters- The Steepest Descent Adaptive Filter, The LMS Algorithm, Convergence of LMS Algorithm, NLMS, Noise Cancellation, LMS Based Adaptive Filter, Channel Equalization, Adaptive Recursive Filter, RLS- Exponentially Weighted RLS, Sliding Window RLS. [Read Hayes Chapter 9.1, 9.2.1 – 9.2.6, 9.2.9, 9.3, 9.4]

Text Book

1. Monson H. Hayes, Statistical Digital Signal Processing & Modeling, John Wiley & Sons

Reference Books

1. Steven M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall.

RADAR SYSTEM ENGINERRING (3 – 0 – 0)

Module – I (18 hours)

The radar equation in terms of the key radar parameters and target-radar cross section. False alarm, minimum detectable signal, Receiver noise and the SNR. Probabilities of detection and False alarm, integration of radar pulses, radar cross section of targets; complex targets, transmitted power, prf, antenna parameters, beam shape, cosecant-squared antenna pattern; basic ideas on system losses

MTI and pulse doppler radar, delay line canceller, doppler effect on blind speeds in MTI, staggered prf. doppler filter banks, digital MTI processing, Limitations to MTI performance MTI from a moving platform (AMTI), pulse doppler radar, FM-CW radar for range and velocity determination, SLAR & SAR

Module – II (10 hours)

Tracking with radar, monopulse tracking, amplitude comparison monopulse, phase-comparison monopulse, conical scan and sequential lobing, Glint (example from a simple target model) tracking in range. Target acquisition, servo system tracking in doppler, track with scan (limited sector scan), Automatic tracking with surveillance Radars.

Module – III (14 hours)

Functions of the radar antenna, antenna radiation pattern, effective aperture and aperture illumination, side lobe radiation, reflector antennas, grain antenna,

Electronically steered phased-array antennas, Beam steering and array-feed networks, change of beam width with steering angle, phase shifters, diode phase shifters, ferrite phase shifters; Frequency-scan arrays, bandwidth limitation, transmission lines for frequency scan. Radiators and architectures for phased arrays, effect of errors on radiation patens, errors in arrays, adaptive antennas array.

General ideas on radar transmitters (RF power sources) and super heterodyne radar receiver, radar displays, scan converter, displexer and receiver protectors.

TEXT BOOK

1. Introduction to Radar system (3rd Edition); Merrill L. Skolnik Tata McGraw Hill publishing Ltd.

REFERENCE BOOKS

1. Ridenour, L. N. Radar System Engineering, MIT radiation laboratory series, Vol. I & II, New York: Mc Graw Hill 1047.
2. Krous, J. D. Antennas, 2nd Edition. Mc Graw Hill, 1988
3. Nathanson, F. E. Radar Design Principle, 2nd Edition, Mc Graw Hill, 1991 (N.Y.)
4. Barton, D. K. Modern Radar System Analysis, Norwood, MA: Ar.Tech House, 1988

5. Hansen, R. C. Phased Array Antennas N.Y. John Willey, 1998 (Chap. 5)

DIGITAL IMAGE PROCESSING (3 – 0 – 0)

Digital Image Fundamentals, Image Transforms: Fourier, Hadamard, Walsh, Discrete cosine and Hotelling Transforms; Image Enhancement: Histogram modification, Histogram equalisation, Smoothing, Filtering, Sharpening, Homomorphic filtering. ; Image restoration, Segmentation: Pixel classification, Bi-level thresholding, Multi-level thresholding, P-tile method, Adaptive thresholding, Spectral & spatial classification, Edge detection, Hough transform, Region growing. Matching and Registration: Image modeling, Stereo mapping, Landmark matching, Rectification in geometric transformations, Match measurement, Matching of binary pattern, Distortion tolerant matching; Digital geometry and its applications: Neighborhood, Path, Connectedness, Holes and Surroundness, Borders, Distances, Medial Axis Transform (MAT), Shrinking and Expanding, Thinning. Introduction to Mathematical morphology and its application, Morphological Operations, Dilation, Erosion, Opening, Closing, Smoothing, Extraction of connected components, Thinning.

Essential Reading:

1. R.C. Gonzalez, R.E. Woods, *Digital Image Processing,* Pearson Prentice Hall, 2007.
2. B. Chanda, D.D. Majumder, *Digital Image Processing and Analysis,* Prentice Hall, 2007.

Supplementary Reading:

1. W.K. Pratt**,** *Digital Image Processing (Fourth Edition)***,** John Wiley & Sons, Inc., 2007
2. A.K. Jain, *Fundamentals of Digital Image Processing*, Prentice Hall, 1988.

OPTICAL COMMUNICATION (3 – 0 – 0)

Module – I (12 hours)

Evolution of Fibre Optic systems, Elements of an optical Fibre transmission link, Basic optical laws and definitions, Optical fibre modes and configurations, Rays and modes, Ray optics representation, Wave representation, mode theory for circular wave guides, wave guide equations, wave equation for step index Fibres, modes in step index fibres, linearly polarised modes, power flow in step index fibres, Single mode fibres, propagation modes in single- modes fibres. Graded index fibre structure, graded-index numerical aperture (NA). Elementary ideas on fibre Materials, fabrication and fibre optic cables.

Module – II (18 hours)

Signal degradation in Optical fibres, Attenuation, Absorption, scattering losses, bending loses core and cladding losses. Signal distortion in optical wave guides, information capacity of optical fibres, Material dispersion, wave guide dispersion, signal distortion in single mode fibres, Inter modal distortion. Pulse broadening in graded index fibre guides, Design optimization of single-mode fibres (elementary concepts)

Basic ideas of light sources and their principle of operation (LEDs and LASERS), power-bandwidth product of LEDs and modulation capability, resonant frequencies of LASER diodes, Physical principles of photo detectors, Avalanche photo diodes

Optical receiver operation (Fundamentals) digital signal transmission, error sources, Digital transmission systems, link power budget, Rise time budget Transmission distance for single mode links, first window transmission distance, Line codes used computer aided modeling of an optical fibre link; Receiver noises.

Module – III (12 hours)

Coherent Optical fibre communications, definition and classification of coherent system, fundamental concepts; Homodyne detection, heterodyne detection, source line widths, wavelength tuning, modulation techniques. Direct-detection OOK, OOK homodyne system, PSK homodyne system, heterodyne detection schemes. Performance improvement with coding. Polarization control requirements.

Wave length division multiplexing optical fibre ring as LAN, FDDI. Optical amplifiers; type of amplifiers with expression for gains and noise figure, optical bandwidth, Photonic switching integrated optical switches.

TEXT BOOK

1. Gerd keiser, Optical Fibre Communications, Mc Graw Hill, Inc.

REFERENCE BOOK

1.G. K. Sarksr, D. C. Sarkar –Opto Electronics and Fibre Optics Communication, New Age International Published (P) Limited, Delhi.

Wireless Sensor Network (3 – 0 – 0)

Introduction to wireless sensor network: Application and Motivation, Network Performance objective, Development of Wireless Sensor Network; Canonical Problem Localization and Tracking: Tracking Multiple Objects, State space decomposition, Data association, Sensor Models, Performance Comparison and Metrics; Networking Sensors: The S MAC Protocol,IEEE 802.15.4 Standard and ZigBee , Routing in sensor network; Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Clocks and Communication Delays, Sensor Tasking and Control; Sensor Network Databases: Sensor Database Challenges, Querying The Physical Environment, Query Interfaces, Cougar sensor database and abstract data types, Probabilistic queries, High level Database Organization, In Network Aggregation, Query propagation and aggregation, TinyDB query processing, Query processing scheduling and optimization, Data Centric Storage. Special topics in wireless sensor networks.

Essential Reading:

1. F. Zhao and L. Guibas, *Wireless Sensor Network: Information Processing Approach,* Elsevier.
2. E. H. Callaway, Jr. E. H. Callaway, *Wireless Sensor Networks Architecture and Protocols*: CRC Press.

Supplementary Reading:

1. A. Hac, *Wireless Sensor Network Designs*, John Wiley & Sons

RF and Mixed-Signal Integrated Circuits (3 – 0 – 0)

MODULE – I **(11 hours)**

Introduction: Overview of wireless principles, Characteristics of passive IC components – resistors, Capacitors, Inductors, Transformers, Interconnect at RF and high frequencies, Skin effect.

Bandwidth Estimation Techniques: Method of open-circuit time constants, Method of short-circuit time constants, Rise time, Delay and Bandwidth.

High-frequency Amplifier Design: Zeros as bandwidth enhancers, Shunt-series amplifier, Bandwidth enhancement with f_T doublers, Tuned amplifiers, Neutralization and unilateralization, Cascaded amplifiers, AM-PM conversion.

MODULE – II **(11 hours)**

Voltage Reference: Review of diode behavior, Diodes and Bipolar Transistors in CMOS technology, Supply-independent bias circuits, Bandgap voltage reference, Constant-g_m bias.

Noise: Thermal noise, Short noise, Flicker noise, Popcorn noise, Classical two-port noise theory, Examples of noise calculations.

Low-Noise Amplifier (LNA) Design: Derivation of intrinsic MOSFET two-port noise parameters, LNA topologies – Power match Vs. Noise match, Power-constrained noise optimization, Design Example, Linearity and large signal performance, Spurious-free dynamic range.

MODULE – III **(12 hours)**

Mixers: Mixer fundamentals, Non-linear systems as linear mixers, Multiplier-based mixers, Sub-sampling mixers, Diode-ring mixers.

RF Power Amplifiers: Classes of power amplifiers, RF power amplifier design example, Power amplifier characteristics and Design consideration.

Phase-Locked Loops (PLL): Introduction to PLL, Linearized PLL models, Some noise properties of PLLs, Phase detectors, Sequential phase detectors, Loop filters and charge pumps, PLL design examples.

Oscillators and Synthesizers: Problems with purely linear oscillators, Describing functions, Resonators, Tuned oscillators, Negative resistance oscillators, Frequency synthesis.

Textbooks:

1. Thomas H. Lee, ***The Design of CMOS Radio-Frequency Integrated Circuits,*** 2nd Edn., Cambridge University Press, 2004.

Recommended Reading:

1. E.N. Farag and M.I. Elmasry, Mixed Signal VLSI Wireless Design: Circuits & Systems, Kluwer, 1999.

Industrial Telematics (3 – 0 – 0)

MODULE – I (11 hours)

Ethernet and Wireless Network Technologies: Approaches to Enforce Real-Time Behavior in Ethernet, Switched Ethernet in Automation Networking, Wireless LAN Technology for the Factory Floor: Challenges and Approaches, Wireless Local and Wireless Personal Area Network Technologies for Industrial Development.

MODULE – II (11 hours)

Linking Factory Floor with the Internet and Wireless Fieldbuses: Linking Factory Floor and the Internet, Extending EIA-709 Control Networks across IP Channels, Interconnection of Wireline and Wireless Fieldbuses.

Network Security and Safety Technologies in Industrial Networks: Security Topics and Solutions for Automation Networks, PROFIsafe: Safety Technology with PROFIBUS.

MODULE – III (12 hours)

Applications of Networks and Other Technologies: Automotive Communication Technologies, Design of Automotive X-by-Wire Systems, FlexRay Communication Technology, The LIN Standard, Volcano: Enabling Correctness by Design, Networks In Building Automation, The Use of Network Hierarchies in Building Telemetry and Control Applications, EIB: European Installation Bus, Fundamentals of LonWorks/EIA-709 Networks: ANSI/EIA-709 Protocol Standard (LonTalk), Manufacturing Message Specification In Industrial Automation, The Standard Message Specification for Industrial Automation Systems: ISO 9506 (MMS), Virtual Factory Communication System Using ISO 9506 and Its Application to Networked Factory Machine, Motion Control, The SERCOS interface™, Train Communication Network, The IEC/IEEE Train Communication Network, Smart Transducer Interface, A Smart Transducer Interface Standard for Sensors and Actuators, Energy Systems, Applying IEC 61375 (Train Communication Network) to Data Communication in Electrical Substations, SEMI, SEMI Interface and Communication Standards: An Overview and Case Study.

Textbooks:

1. Richard Zurawski, ***The Industrial Communication Technology Handbook (Industrial Information Technology)***, Taylor and Francis, (CRC Press), ISA – The Instrumentation, Systems, and Automation Society, 2005, ISBN-10: 0849330777, ISBN-13: 978-0849330773.

Recommended Reading:

1. Richard Zurawski, ***Integration Technologies for Industrial Automated Systems (Industrial Information Technology)***, Taylor and Francis, (CRC Press), ISA – The Instrumentation, Systems, and Automation Society, 2006, ISBN-10: 0849392624, ISBN-13: 978-0849392627.
2. Richard Zurawski, ***The Industrial Information Technology Handbook (Industrial Electronics)***, Taylor and Francis, (CRC Press), ISA – The Instrumentation, Systems, and Automation Society, 2004, ISBN-10: 0849319854, ISBN-13: 978-0849319853

Embedded System Design (3 – 0 – 0)

MODULE – I **(11 hours)**

Introduction to Embedded Computing: Terms and scope, Application areas, Growing importance of embedded systems.

Specifications: Requirements, Models of computation, State Charts: Modeling of hierarchy, Timers, Edge labels and StateCharts semantics, Evaluation and extensions, General language characteristics: Synchronous and asynchronous languages, Process concepts, Synchronization and communication, Specifying timing, Using non-standard I/O devices, SDL, Petri nets: Introduction, Condition/event nets, Place/transition nets, Predicate/transition nets, Evaluation, Message Sequence Charts, UML, Process networks: Task graphs, Asynchronous message passing, Synchronous message passing, Java, VHDL: Introduction, Entities and architectures, Multi-valued logic and IEEE 1164, VHDL processes and simulation semantics, System C, Verilog and System Verilog, Spec C, Additional languages, Levels of hardware modelling, Language comparison, Dependability requirements.

MODULE – II **(11 hours)**

Embedded System Hardware: Introduction, Input: Sensors, Sample-and-hold circuits, A/D-converters, Communication: Requirements, Electrical robustness, Guaranteeing real-time behaviour, Examples, Processing units: Application-Specific Circuits (ASICs), Processors, Reconfigurable Logic, Memories, Output: D/A-converters, Actuators.

Standard Software: Embedded Operating Systems, Middleware, and Scheduling: Prediction of execution times, Scheduling in real-time systems: Classification of scheduling algorithms, Aperiodic scheduling, Periodic scheduling, Resource access protocols, Embedded operating systems: General requirements, Real-time operating systems, Middleware: Real-time data bases, Access to remote objects

MODULE – III **(12 hours)**

Implementing Embedded Systems: Hardware/Software Co-design: Task level concurrency management, High-level optimizations: Floating-point to fixed-point conversion, Simple loop transformations, Loop tiling/blocking, Loop splitting, Array folding, Hardware/software partitioning: Introduction, COOL, Compilers for embedded systems: Introduction, Energy-aware compilation, Compilation for digital signal processors, Compilation for multimedia processors, Compilation for VLIW processors, Compilation for network processors Compiler generation, retargetable compilers and design space exploration, Voltage Scaling and Power Management: Dynamic Voltage Scaling, Dynamic power management (DPM), Actual design flows and tools: SpecC methodology, IMEC tool flow, The COSYMA design flow, Ptolemy II, he OCTOPUS design flow.

Validation: Introduction, Simulation, Rapid prototyping and emulation, Test: Scope, Design for testability and Self-test programs, Fault simulation, Fault injection, Risk- and dependability analysis, Formal verification.

Textbooks:

1. Peter Marwedel, ***Embedded System Design***, Springer, 2006 http://ls12-www.cs.uni-dortmund.de/~marwedel/kluwer-es-book/

Recommended Reading:

1. Wayne Wolf, ***Computers as Components***, Morgan Kaufmann, 2001 http://www.ee.princeton.edu/~wolf/embedded-book
2. G. De Micheli, Rolf Ernst and Wayne Wolf, eds, ***Readings in Hardware/Software Co-Design***, Morgan Kaufmann, ***Systems-on-Silicon Series Embedded***
3. Frank Vahid and Tony D. Givargis, ***System Design: A Unified Hardware/Software Introduction***, Addison Wesley, 2002.
4. Michael Barr, ***Programming Embedded Systems in C and C++***, O'Reilly, 1999.
5. David E. Simon, ***An Embedded Software Primer***, Addison Wesley, 1999.
6. Jack Ganssle, The Art of Designing Embedded Systems, Newnes, 2000.
7. K. Short, Embedded Microprocessor System Design, Prentice Hall, 1998.

C. Baron, J. Geffroy and G. Motet, Embedded System Applications, Kluwer, 1997.

Mobile Computing

Overview of wireless technologies. Wireless multiple access protocols. Cellular systems: Channel allocation. Location management. Wireless LANs: Medium access, Mobile IP routing. TCP over wireless. Mobile ad hoc networking. Energy efficiency. Impact of mobility on algorithms and applications. Disconnected operation of mobile hosts. Data broadcasting. Mobile agents.

References:

1. J. H. Schiller. Mobile Communications. Addison Wesley, 2000.
2. A. Mehrotra. GSM System Engineering. Artech House, 1997.
3. Charles Perkins. Mobile IP. Addison Wesley, 1999.
4. Charles Perkins (ed.) Adhoc Networks. Addison Wesley, 2000 Relevant RFCs, internet drafts and research papers.

ASIC and SoC Design (3 – 0 – 0)

MODULE – I **(11 hours)**

Introduction: Voice over IP SOC, Intellectual Property, SOC Design Challenges, Design Methodology.

Overview of ASICs: Introduction, Methodology and Design Flow, FPGA to ASIC Conversion, Verification.

MODULE – II **(11 hours)**

SOC Design and Verification: Introduction, Design for Integration, SOC Verification, Set-Top-Box SOC, Set-Top-Box SOC Example. Summary. References.

Physical Design: Introduction, Overview of Physical Design Flow, Some Tips and Guidelines for Physical Design, Modern Physical Design Techniques.

MODULE – III **(12 hours)**

Low-Power Design: Introduction, Power Dissipation, Low-Power Design Techniques and Methodologies, Low-Power Design Tools, Tips and Guidelines for Low-Power Design.

Low-Power Design Tools: PowerTheater, PowerTheater Analyst, PowerTheater Designer.

Open Core Protocol (OCP): Highlights, Capabilities, Advantages, Key Features.

Phase-Locked Loops (PLLs): PLL Basics, PLL Ideal Behavior, PLL Errors.

Text Books:

1. Farzad Nekoogar and Faranak Nekoogar, ***From ASICs to SOCs: A Practical Approach***, Pearson Education, 2003, ISBN-10: 0-13-033857-5, ISBN-13: 978-0-13-033857-0

Recommended Reading:

1. Michael Smith, ***Application Specific Integrated Circuit***, Addison-Wesley, 1997, ISBN: 0201500221
2. Jari Nurmi, ***Processor Design: System-On-Chip Computing for ASICs and FPGAs***, Springer, 1st edition, 2007, ISBN: 1402055293

3. Douglas J. Smith, ***HDL Chip Design*** – a practical guide for designing, synthesizing and simulating ASICs and FPGAs using VHDL or Verilog, Doone Publications, 2000, ISBN: 0965193438