Biju Patnaik University of Technology, Orissa

M. Tech in Wireless Communication Technology

Sem	Subject	Credit	Details of Subjects
I	WCPC101	4	Wireless Communication Network
	WCPC102	4	Information Theory and Coding
	WCPC103	4	Analog and Digital VLSI Design
	WCPE101	3	Wireless Communication System Design
	WCPE102		Data Encryption and Security
	WCPE103		Wireless Communication Management
	WCPE104		Telecommunications Network Planning and Management
	WCPE105	3	Spread Spectrum Communication Technique
	WCPE106		Network Architecture and Design
	WCPE107		Data Communication and Networking
	WCPR101	4	Wireless Communication System Design Lab
	WCPT101	2	Seminar on Pre-thesis work-1
Semester Credits:		24	
II	WCPC201	4	MIMO Wireless Communication Systems
	WCPC202	4	Ultra wide band communication system
	WCPC203	4	VLSI for Wireless Communication
	WCPE201		Next Generation Wireless Communication Network
	WCPE202		Network Optimization
	WCPE203		Satellite Communication System
	WCPE204	3	Adaptive Techniques in Signal Processing
	WCPE205		Embedded S/W Design for Communication Network
	WCPE206		Wireless Optical Communication

	CSPE204 WCPE207 ETPE205 WCPR201 WCPT201 WCCV201	3 2 2 2	Mobile Computing (RP) High Speed Telecom Switching Architecture Wireless Sensor Network MIMO Wireless Communication Lab Seminar on Pre-thesis work-2 Comprehensive Viva-Voce 1
Semester Credit		**25**	
Sem	**Subject**	**Credit**	**Details of Subjects**
III	**Open Elective (any one)** **Thesis-1**	**3** **14**	**Project Management** **Project Costing** **Technology Management** **Research Methodology** **Optimization Techniques** **Computational Intelligence** **Thesis – I**
Semester Credits:		**17**	
IV	**WCPT401** **WCCV401** **WCCV402**	**20** **2** **2**	**Thesis – II** **Seminar** **Comprehensive Viva-Voce – II**
Semester Credits:		**24**	
Total Credits:		**90**	

SEMESTER 1

WIRELESS COMMUNICATION NETWORK (4-0-0)

Module I: (14 hrs)

Communication Networks: LANs, MANs, WANs, Switching techniques, Wireless ATM networks, TCP/IP protocol architecture, OSI protocol architecture, Internetworking

Wireless Communication Technology: Propagation modes, LOS transmission, Fading in the mobile environment. Signal encoding: Criteria, Digital data-analog signals, Analog data-Analog signals, Analog data-Digital signals.
Coding and Error Control: Error detection, Block error correction codes, convolution codes, Automatic repeat request

Module II: (14hrs)

Cellular Wireless Networks - Principles of cellular network, first, second and third Generation systems. Cordless Systems and WLL: Cordless systems, Wireless Local Loop, IEEE 802.16 fixed broadband wireless access standard.

Mobile IP and wireless Access Protocol: Mobile IP, Wireless Application Protocol, Internet control message protocol, Message authentication, Service primitives and parameters.

Module III: (12 hrs)

Wireless LAN Technology: Overview, Infrared LANs, Spread spectrum LANs, Narrowband microwave LANs.

IEEE 802.11 Wireless LAN: IEEE 802 protocol architecture, IEEE 802.11 architecture and services, IEEE 802.11 MAC, IEEE 802.11 physical layer.
Bluetooth: Overview, Radio specification, baseband specification, Link manager specification, Logical Link control and adaptation protocol.

Text Books:

1. Wireless Communications & Networks, by *William Stallings,* 2nd Edition, 2009, Pearson Education, ISBN 81-7808-560-7

Reference Book:

1. Wireless communication and Networking by V.K. Garg, Morgan Kauffman Publisher, 2009, ISBN:9780123735805
2. Wireless Communication & Network, 3G & beyond, by *Iti Saha Misra,* McGrawHill, 2009, ISBN 10:0-07-015140-7

INFORMATION THEORY AND CODING (4-0-0)

Module I (12 Hours)

Source Coding: Introduction to Information theory, uncertainty and information, entropy, Source coding theorem, Huffman coding, Shannon-Fano coding, Arithmetic coding, run length coding, rate distortion function, JPEG and MPEG standards in image compression

Channel capacity and coding: channel model, channel capacity, channel coding, Information capacity theorem, The Shannon limit, Random selection of codes.

Module II (14 Hours)

Error correcting codes: Introduction, basic definitions, Linear block code, Equivalent codes, parity-check matrix, decoding of linear block codes, error probability, perfect codes, Hamming codes, LDPC codes, optimal Linear codes, MSD codes, Space Time Block Code.

Cyclic codes: Polynomials, division algorithm for polynomials, method of generating cyclic codes, matrix description, Quasi-cycle and shortened-cycle codes, burst error correction, Fire codes, Golay codes, CRC codes, circuit implementation.

Module III (14 Hours)

BCH codes: introduction, primitive elements, minimal polynomials, generator polynomial, decoding, Reed-Solomon codes, encoder and decoder, performance of RS codes over real channels, Nested codes.

Convolution codes: Tree codes, Trellis code, polynomial description, generating function, matrix description, decoding, distance and performance bounds, Turbo codes, Turbo decoding.

Trellis coded Modulation: Concept of coded modulation, mapping by set partitioning, Ungerboeck's TCM Design rule, TCM decoder, Performance evaluation for AWGN channel, TCM for fading channel.

Text Books:

1: Information Theory, Coding and Cryptography, by *Ranjan Bose*, 2nd Edn., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2008

Reference Books

1. Error Control Coding: by *Shu lin & Daniel J .Costello* – Pearson Education India, ISBN 8131734404, 9788131734407.
2. Information Coding Techniques, by *R. Avudaiammal*, 2nd Edn., Tat McGraw-Hill Education Pvt. Ltd., New Delhi.

ANALOG AND VLSI DESIGN (4-0-0)

Unit I: Introduction to Analog Design and Amplifier (12 Hours)
Why Analog, Why Integrated, Why CMOS, General concepts of Level of Abstraction and Robust Analog Design with basic MOS Physics
Single stage Amplifier, Differential Amplifiers, Passive and Active Current Mirrors, Frequency Response of Amplifiers

Unit II: Digital Integrated Circuit, Systems and Building Blocks (12 Hours)
Why Digital, A brief Review of CMOS based Combinational and Sequential circuit, High performance circuit like Domino, Pseudo, and NORA logic

Unit III: Advanced Analog and Digital Circuit Design (13 Hours)
Operational Amplifiers: One Stage, Double Stage and its characteristics, Stability and Frequency Compensation
Oscillators: General Considerations, Ring Oscillator, LC Oscillator, VCO
PLL: Simple PLL, Charge Pump PLLs, Delay Locked Loops
A digital Design System Perspective: Datapath in Digital Processor Architectures, Design of Multiplexers and Decoders, Barrel Shifters, Counters, Digital Adders (Single bit, Ripple Carry Adders, Carry Save Adders, Digital Substractors, Multipliers, Power considerations in Datapath Structures, Design as a trade-off

References:

1. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, TMH, 17th reprint 2010.
2. Ken Martin, “Digital Integrated Circuit Design”, Oxford Indian Edition Reprint, 2004
3. Jan M Rabaey, “Digital Integrated Circuits A Design Perspective”, PHI, 2000.

WIRELESS COMMUNICATION SYSTEM DESIGN (3-0-0)

Module I (12 Hours)

Transceiver architecture: General consideration, Receiver Architectures, Transmitter Architectures, Transceiver performance tests.

Low-noise amplifiers and mixers: General considerations, Input matching, Bipolar LNAs, CMOS LANs, Down conversion mixers: General considerations, Bipolar mixers, CMOS mixers, Noise in mixers.

Oscillators: General consideration, VCOs, Phase noise, Bipolar and CMOS LC oscillators, Monolithic inductors, Resonator based VCOs, Quadrature signal generation.

Module II (14 Hours)

Calculation of Fades and Methods of Reducing Fades: Amplitude Fades, Diversity Schemes, Combining Techniques, Bit-Error Rate and Word-Error Rate in Fading Environment, Calculation of Signal Strength above a Level in a Cell.

Frequency synthesizer: Phased locked loop, RF synthesizer architectures, Frequency divider.

Amplifiers for Wireless communications: Wideband amplifier techniques, Low noise amplifier, variable gain amplifier, Power amplifiers.

Module III (14 Hours)

Design Parameters at the Base Station: Antenna Locations, Antenna Spacing and Antenna Heights, Antenna Configurations, Noise Environment, Power and Field Strength Conversions.

Design Parameters at the Mobile Unit: Antenna Spacing and Antenna Heights, Mobile Unit Standing Still and in Motion, Independent Samples and Sampling Rate, Directional Antennas and Diversity Schemes.

Text Books:

1. RF Microelectronics, By Behzad Razavi, Printice Hall 1998, ISBN:0138875715

2. Mobile Communications Design Fundamentals, By William C. Y. Lee, 2nd Edition, 1998, Wiley-Interscience Publication, ISBN 0-471-57446-5

Reference Books:

1. Microwave and RF Wireless Systems, By David M. Pozar, Wiley Publication,2001, ISBN: 978-0-471-32282-5

DATA ENCRYPTION AND SECURITY (3-0-0)

Module I (14 Hours)

Introduction: Security Goals, Attacks, Services and Mechanism, Techniques
Traditional Symmetric-Key Ciphers: Introduction, Substitution Ciphers, Transposition Ciphers, Stream and Block Ciphers

Modern Symmetric-Key Ciphers: Modern Block Ciphers, Modern Stream Ciphers
Data Encryption Standard (DES): Introduction, DES Structure, DES Analysis, Multiple DES, Security of DES, Differential Cryptanalysis, Linear Cryptanalysis of DES

Module II (16Hours)

Advanced Encryption Standard (AES): Introduction, Transformations, Key Expansion, Cipher, Analysis of AES
Message Integrity and Message Authentication: Message integrity, Random Oracle Model, Message authentication.
Cryptographic Hash Functions: Introduction, SHA – 512, Whirlpool
Entity Authentication: Introduction, Passwords, Challenge – response, Zero – knowledge
Key Management: Symmetric – key Distribution, Kerberos, Symmetric – key agreement, Public – key distribution

Module III (10Hours)

Security at application layer: E-mail, PGP, S/MIME
Security at the Transport layer: SSL architecture, Four protocols, SSL message format, Transport layer security
Security at the network layer: Two modes, two security protocols, security association, security policy, Internet key exchange

Textbooks:

1. Cryptography and Network Security – B. Forouzan, McGraw-Hill.2007, ISBN-10 0-07-066046-8:

References

1. Elements of Information Theory, By T.M. Cover & Joy.A.Thomas, 2nd edition, Wiley-Interscience, ISBN-10 0-471-24195-4
2. Cryptography & Network Security: Atul Kahate, TMH. 2nd Edition, ISBN-10: 0-07-064823-9

WIRELESS COMMUNICATION MANAGEMENT (3-0-0)

Module-I (14 hrs)
Resource Management: Call admission control in wireless LANs, Traffic aware routing for RTC in wireless Multi-hop Networks, Reliable multicast for Wireless LAN, Wireless Network Tele-traffic modeling with Lossy Link.
Heterogeneous Wireless Nteworks: Optimal resource management and QoS Provisioning, Medium Access Control in Wireless Ad Hoc Networks, Advanced Radio resource management for future Mobile Networks.

Module – II (12 hrs)
Mobility Management: Fractional resource reservation in mobile cellular systems, Fractional Guard channel schemes
Mobility management for Mobile IP networks: Triangular routing, smooth handoffs in mobile IPv6.
Location management in Wireless Networks: Issues and Technologies, Network Topologies, Time based location update. Network Mobility.

Module – III (14 Hrs)
Security Management:
Key management in wireless sensor networks: Challenges and Solutions, Global Key management schemes, vehicle location register
Secure routing for Mobile Ad Hoc Networks. Security and privacy in future Mobile networks, vehicle networks, user identity confidentiality, User untracability,
The effects of Authentication on Quality - of – service in wireless networks.

Text Book:

1. Resource, mobility, and security management in wireless networks and mobile communications, by Yan Zhang, Masayuki Fujise, Auerbach Publications, 2007, Taylor and Francis group, ISBN:0849380367

Reference Book:

1. Resource management in wireless Networking, by Mihaela Cardei, Ionut Cardei, Dingzhu Du, Springer, 2005, ISBN:0387238077

TELECOMMUNICATION NETWORK PLANNING AND MANAGEMENT (3-0-0)

Module –I (12 hrs)

Transport Network life-cycle modeling: Advanced modeling techniques for designing survivable telecommunication network: Introduction, network model, design, and resilience.

Strategic Network Topology and Capacity planning: Introduction, strategic capacity planning, C-plan in action.

A Bayesian data mining approach for modeling the physical condition of copper access networks: Introduction, taking a Bayesian viewpoint, forming the problem space and data description, constructing the Bayesian network, application of Bayesian network models.

Module –II (14 hrs)

Emergent properties of the BT SDH network: Introduction, multi-layer and large scale networks, emergent properties, self-organizing criticality and multi-layered feedback.

Performance modeling: Introduction, modeling techniques, validation of models, drivers to models, Voice over ATM, overall GoS.

Adaptive Security and Robust Network: Introduction, Epidemic propagation and cascade failure, Adaptive security and epidemic control.

Module – III (14 hrs)

Telecommunication Network Management: Introduction, TMN, Operation Systems, TMN Conceptual Model, TMN Standards, TMN Architecture, Functional Architecture, Physical Architecture, Information Architecture, TMN Management Service Architecture, TMN Integrated View, Implementation Issues, Implementation Using OMNIPoint.

Network management application: Configuration Management, Network Provisioning, Network Topology, Fault Management, Fault Detection, Fault Location and Isolation Techniques, Performance Management, Performance Metrics, Problem Isolation, Performance Statistics, Security Management, Resources to Prevent Security Breaches, Accounting Management.

Reports Management, Policy Based Management.

Text Books:

1. Telecommunications network modeling, Planning and Design, By Sharon Evans, The institute of Engineering and technology, London, UK, 2003
2. Network Management: Principles and Practice, By Mani Subramanian**,** Addison-Wesley / Prentice Hall, ISBN-10: 0201357429

Reference:

1. Telecommunications network planning**,** By Brunilde Sansó, Patrick Soriano

SPREAD SPECTRUM COMMUNICATION TECHNIQUE (3-0-0)

Module – I (12 hrs)

Direct-Sequence Systems: Definitions and concepts, Spreading sequences and waveforms, Systems with PSK modulation, Quaternary systems, Pulsed interference, De-spreading with matched filter, Rejection of narrowband interference

Frequency Hopping System: Concepts and characteristics, Modulation, Codes for partial-band interference, Frequency synthesizers

Module – II (14 hrs)

Code Synchronization: Acquisition of spreading Sequences, Serial-search Acquisition, Acquisition correlator, code tracking, frequency-hopping patterns

Code-Division Multiple Access: Spreading sequence for DS/CDMA, Systems with random spreading sequences, wideband Direct-sequence systems, Cellular networks and power control, multi-user detectors, Frequency-Hopping Multiple access

Module –III (14 hrs)

Detection of Spread-Spectrum signals: Detection of Direct-sequence signals: Ideal detection, radiometer, Detection of frequency-hopping signals: Ideal detection, Wideband Radiometer, Channelized Radiometer

Application of Spread spectrum methods: Space systems, Avionic systems, Test systems and equipments, Message protection, position location, Real systems.

Test and evaluation: Sensitivity, selectivity, Jamming margin, Sync acquisition, Loss of synchronization, SNR vs Interference level, Process gain.

Text Book:

1. Principles of Spread- Spectrum communication systems, by Don Torrieri, Springer, 2005, ISBN: 0-387- 22782 - 2

References:

1. IS-95 CDMA and cdma2000: Cellular/PCS Systems Implementation, By V.K Garg, Pearson Education, 2005, ISBN: 8177584170, 9788177584172
2. Spread spectrum in communication, By Reidar Skaug, Jens F. Hjelmstad, Peter Peregrinus Ltd, London, 1985, ISBN: 0-86341-034-0
3. Multi-Carrier and Spread Spectrum Systems, By K. Fazel, S. Kaiser, John Wiley & Sons, 2003, ISBN: 0-470-84899-5
4. Spread spectrum Systems with Commercial application, By Robert C. Dixon, Wiley- Inter science Publication, 3rd edition, 1994, ISBN: 0-471-59342-7.

NETWORK ARCHITECTURE AND DESIGN (3-0-0)

Module-I (12 Hours)
Introduction: overview of analysis, architecture, and design processes, System description, Service description, service characteristics, performance characteristics, Network supportability.

Network Architecture: Component architecture, Reference architecture, Architectural models, System and network architectures.

Addressing and routing Architecture: Addressing mechanisms, Routing mechanisms, Addressing strategies, Routing strategies, Architectural considerations.

Module: II (14 Hours)
Network Management Architecture: Defining network management, Network management mechanisms, Architectural consideration.
Performance Architecture: Goals for performance, Performance mechanisms, Architectural consideration.
Security and Privacy Architecture: Security and privacy administration, Security and privacy mechanisms, Architectural consideration.

Module: III (14 Hours)
Designing a Network: LAN specifics, Network type, Ethernet fundamentals
Network operating systems, Hardware considerations, considering the client, choosing a protocol, connectivity devices, WAN technologies, Remote connectivity, Internet connectivity, securing the network.

Text Books:

1. Network Analysis, Architecture and Design, By James D. McCabe, Morgan Kauffmann publishers, 3rd edition, 2003
2. Network Architecture and Design, By J. F. DiMarzio, Sams Publishing, 2001, ISBN : 0-672-32082-7.

DATA COMMUNICATION AND NETWORKING (3-0-0)

Module-I (12 Hours)
Overview of Data Communications and Networking: Introduction, Network Models,
Physical Layer: Signals, Digital Transmission, Analog Transmission, Multiplexing, Transmission Media, Circuit Switching and Telephone Network.
Data Link Layer: Error Detection and Correction, Data Link Control and Protocol, Point to Point Access: PPP, Multiple Access, Local Area Networks: Ethernet, Wireless LANs, Connecting LANs, Backbone Networks, Virtual LANs, Cellular Telephone and Satellite Networks, Virtual Circuit Switching.

Module: II (12 Hours)
Network Layer: Host-to-Host Delivery: Internetworking, Addressing and Routing, Network Layer Protocols: ARP, IPv4, ICMP, IPv6, and ICMPv6, Unicast and Multicast Routing: Routing Protocols.
Transport Layer: Process-to-Process Delivery: UDP and TCP, Congestion Control and Quality of Service.

Module: III (12 Hours)
Application Layer: Client-Server Model: Socket Interface, Domain Name System (DNS), Electronic Mail (SMTP), and File Transfer (FTP), HTTP and WWW, Multimedia.
Security: Cryptography, Message Security, User Authentication, and Key Management, Security Protocols in the Internet.

Text Books:

1. B A Forouzan: Data Communications and Networking, TMH, 4th Edition, 2003, ISBN: 0-07-063414-9

Reference:

1. A S Tanenbaum: Computer Networks, PHI, 2004
2. W Stallings: Data and Computer Communications, PHI/Pearson

SEMESTER 2

PC4. MIMO Wireless Communication Systems (4-0-0)

Module I (12 Hours)

Introduction: MIMO Wireless communication, MIMO Channel and signal model, A fundamental trade-off, MIMO transceiver design, MIMO in wireless networks, MIMO in wireless standards.

Capacity Limits of MIMO systems: Introduction, Mutual information and Shannon capacity, Single – user MIMO, Multi - user MIMO, Multi – cell MIMO, MIMO for ad-hoc networks.

Module II (14 Hours)

Precoding Design: Transmit channel side information, Information – theoretic foundation for exploiting CSIT, A transmitter structure, Precoding design criteria, Linear precoder design, Precoder performance results and discussion, Application in practical systems.

Space – time coding for wireless communications: Introduction, background, Space – time coding principles, Applications, Discussion and future challenges.

Module III (14 Hours)

Fundamentals of Receiver design: Introduction, Reception of uncoded signals, Factor graphs and iterative processing, MIMO receiver for uncoded signals, MIMO receiver for coded signals.

Multi-user Receiver design: Introduction, Multiple access MIMO systems, Iterative space – time multi – user detection, Multi – user detection in space time coded system, adaptive linear space-time multi-user detection.

Text Book:

1. MIMO Wireless Communications By E.Biglieri, R. Calderbank, A.Constantinides, Andrea Goldsmith, A. Paulraj & H. V. Poor, Cambridge University Press, ISBN: 9780521873284

Reference:

1. Fundamentals of Wireless Communication by David Tse and Pramod Viswanath, Cambridge University Press, 2005

Ultra Wide Band Communication System (4-0-0)

Module 1 (14 Hours)

UWB: Single-Band Approaches**:** Overview of Single-Band Approaches, Modulation Techniques, Multiple Access Techniques, Demodulation Techniques, MIMO Single-Band UWB, Performance Analysis

OFDM Sytem issues: OFDM concept, OFDM model, Time frequency interpretation, Impairment issues in OFDM systems, Frequency offset, Timing offset, Carrier phase noise, Multipath issues, ISI issues, PAPR, OFDMA, Frequency Hopping OFDMA, OFDMA system description,

Module 2 (13 Hours)

UWB: Multiband OFDM Approach: Overview of Multiband OFDM Approach, IEEE 802.15.3a WPAN Standard Proposal, Physical Layer Design, MAC Layer Design, MIMO Multiband OFDM: MIMO-OFDM Communications, MIMO Multiband OFDM System Model, Performance Analysis,

Module 3 (13 Hours)

Performance Characterization: System Model, Performance Analysis, Analysis for MIMO Multiband OFDM systems, Performance Under Practical Considerations: System Model, Average Signal-to-Noise Ratio, Average Bit Error Rate, Performance Bound, Differential Multiband OFDM, Cooperative UWB Multiband OFDM,

Text Books:

1. OFDM Towards fixed and mobile Broadband Wireless Access by Uma Sankar Jha and Ramjee Prasad. ARTECH House Publication.

2. Ultrawideband communications Systems Multiband OFDM Approach By W.Pam Siriwongpairat and K.J.Ray Liu IEEE Press Publn

EL3. VLSI for Wireless Communication (3-0-0)

MODULE – I (12 hours)

Communication Concepts in terms circuit designer perspective:
Introduction, Overview of Modulation schemes, Clasical Channel, Wireless channel description, Path loss, Multipath fading (channel model and envelope fading, frequency selective).
Receiver Architectures:
Introduction, Receiver front end, Filter design, Rest of receiver front end, Receiver front end,
Low Noise Amplifier:
Introduction, Wideband LNA design, Narrowband LNA (Impedance matching and Core Amplifier)

MODULE – II (12 hours)

Active Mixer:
Introduction, balancing, Qualititative description of Gilbert Mixer, Conversion Gain, Distortion (Low frequency and high frequency case), Noise and a complete active mixer.

Passive Mixer:
Introduction, Switching Mixer, Distortion, Conversion Gain and Noise in Unbalanced Switching Mixer, A practical Unbalanced Switching Mixer, Sampling Mixer, Conversion Gain, Distortion, and noise in Single-Ended Sampling Mixer.

MODULE – III (16 hours)

Analog-to-Digital Converters:
Introduction, Demodulators, A/D Converters used in a Receiver, Low-Pass Sigma- Delta Modulators, Implementation of Low-pass Sigma-Delta Modulators, Bandpass Sigma-Delta Modulators and its implementation,
Frequency Synthesizer: Phase/Frequency-Processing Components
Introduction, PLL based Frequency Synthesizer, Phase Detector/Charge Pump, Dividers, VCO, LCO, Ring Oscillator, Phase noise

Frequency Synthesizer: Loop Filter and System Design
Introduction, Loop Filter (General description and design approaches), A case study of complete synthesizer

Text Book:

1. Bosco Leung, “VLSI for Wireless Communication”, Prentice Hall Electronics and VLSI series, 2002.

EL3. Next Generation Wireless Communication Network (3-0-0)

Module I (13 Hours)

Fundamentals of Wireless Communication: History of Mobile Cellular Systems, 1st Generation, 2nd Generation, 3rdGeneration, Overview of 3G , Proposals for 3G Standard, WCDMA ,Advanced TDMA, Hybrid CDMA/TDMA OFDM, IMT-2000,3GPP,3GPP2, 3G Evolution Paths, Mobile WiMAX & 4G.

Basics of Cellular Communication: Cellular System Fundamentals, Cellular Concept, Channel Reuse, Handover, Cellular Deployments Spectral Efficiency, SIR and User Capacity, Interference Reduction Techniques, Dynamic Resource Allocation,Fundamental Rate Limits.

Path Loss and Shadowing: Radio Wave Propagation, Transmit and Receive Signal Models, Free-Space Path Ray Tracing, Two-Ray , Ten-Ray Model (Dielectric Canyon) General Ray Tracing. Local Mean Received Power, Empirical Path Loss Models, The Okumura Model. Hata Model, COST 231 Extension to Hata Model, Piecewise Linear (Multi-Slope) Model, Indoor Attenuation Factors, Simplified Path Loss Model, Shadow Fading, Combined Path Loss and Shadowing, Outage Probability under Path Loss and Shadowing, Cell Coverage Area

Module II (13 Hours)

Statistical Multipath Channel Models: Time-Varying Channel Impulse Response, Narrowband Fading Models, Wideband Fading Models, Discrete-Time Model, Space-Time Channel Models

Capacity of Wireless Channels: Capacity in AWGN, Capacity of Flat-Fading Channels, Capacity of Frequency-Selective Fading Channels.

Principles of CDMA: Radio-Channel Access Schemes, Spread Spectrum, RAKE Receiver, Power Control, Handovers, Soft Handover Relocation Hard Handover, Intersystem Handovers, Multiuser Detection.

Module III (14 Hours)

Theory of OFDMA & MIMO : Principles of OFDM, A simple OFDM system, CSMA-OFDM TDMA-OFDM, FDMA-OFDM, MC-CDMA, SDMA-OFDM Multiple Antenna Systems, SC-FDMA

Coding: Block Coding, Reed-Solomon Coding, Convolution Coding, Concatenated Coding, Trellis Coding Turbo Coding, Synchronization, Detection and Channel Estimation, Equalization: ZF: Zero Forcing Equalizer, MMSE, DFE, Adaptive Equalizers, MLSE: Maximum Likelihood

Sequence Estimation, Viterbi Equalizer, Turbo Equalizer, Equalization in OFDM, Time and Frequency Domain Equalization.

Diversity: Realization of Independent Fading Paths, Receiver Diversity, Transmitter Diversity, Moment Generating Functions in Diversity Analysis

Multiple Antenna Systems: Spatial Diversity, Basics of MIMO, SIMO, MISO, Space-Time Coding, Cooperative MIMO.

TEXT BOOKS:

1. WIRELESS COMMUNICATIONS by Andrea Goldsmith, Cambridge University Press.
2. Introduction to 3G Mobile Communications by Juha Korhonen ,2nd edition, Artech House

REFERENCE BOOKS:

1. Mobile Broadband Including WiMAX and LTE by Mustafa Ergen, Springer

EL3.Network Optimization

Module – I (12 hr)

2G NETWORK PLANNING AND OPTIMISATION (GSM)
Radio Network Planning and Optimisation: Radio Network Detailed Planning, Radio Network Optimisation
Transmission Network Planning and Optimisation: Pre-planning in Transmission Network, Detailed Transmission Network Planning, Transmission Network Optimisation.
Core Network Planning and Optimisation: Core Network Planning Process, Core Network Optimisation

Module – II (14 hr)

2.5-GENERATION NETWORK PLANNING AND OPTIMISATION (GPRS AND EDGE)
GPRS: Network Planning and Optimisation: GPRS Network Planning, Network Optimisation. EDGE: Network Planning and Optimisation: EDGE Network Planning, Network Optimisation

THIRD-GENERATION NETWORK PLANNING AND OPTIMISATION (WCDMA)
3G Radio Network Planning and Optimisation: Radio Network Planning Process, WCDMA Radio Network Optimisation. 3G Transmission Network Planning and Optimisation: Basics of Transmission Network Planning, Transmission Network Planning Process, Dimensioning, Microwave Link Planning, Detailed Planning, Transmission Network Optimisation.

Module – II (14 hr)

3G Transmission Network Planning and Optimisation: Basics of Transmission Network Planning, Transmission Network Planning Process, Dimensioning, Microwave Link Planning, Detailed Planning, Transmission Network Optimisation.

3G Core Network Planning and Optimisation: Basics of Core Network Planning, Detailed Network Planning, Core Network Optimisation

Text book:

1. Fundamentals of Cellular Network Planning and Optimisation 2G/2.5G/3G... Evolution to 4G, Ajay R. Mishra, John Wiley & Sons, Ltd

Reference:

1. Evolved Cellular Network Planning and Optimization for UMTS and LTE, By Lingyang Song, Jia Shen, CRC Press, ISBN**:** 9781439806494

EL-3 SATELLITE COMMUNICATION System

Module – I (12 hrs)

Basic Principles of Satellite Communication:
Origin, Overview, Types, Satellite orbits and orbital errors, Communications via satellite, characteristic features of communication satellites, Message security, Coverage area and satellite networks, Geometric distances, Swath width, Communication time, and satellite visibility.

System design procedure: Mission requirement, system specifications, System design: Bus, Electrical and Mechanical, System reliability and Availability analysis, Antennas, Satellite power systems

Chap:1.1 -1.4, 2.1 – 2.8(# 2),

Module - II (14 hrs)

Satellite Links: Link equations
Satellite Link design : Introduction, Basic transmission theory, System Noise temperature and G/T ratio, Noise temperature, calculation of System Noise Temperature, G/T ration earth stations, Design of downlink: Link budgets, Satellite systems using small earth stations: Direct broadcast TV, Uplink design: Design for specified C/N: Combining C/N and C/I values in satellite links, System design examples

Chap: 4.1 (#2), 4.1 – 4.8 (#1)

Module - III (14 hrs)

Propagation Effects and their Impact on Satellite-Earth Links: Introduction, Attenuation and Depolarization, Atmospheric attenuation, Cloud attenuation, Rain and Ice effects, Prediction of rain attenuation, Prediction of XPD, Propagation impairment countermeasures

VSAT Systems: Overview, Network architecture, Access control protocols, Basic technique, system design procedure

Mobile Satellite System services: Overview, Mobile satellite system architecture, the internet and satellite.
Chap: 8.1 – 8.7 (#1), 9.1- 9.8 (#1), 8.1 - 8.3 (#2)

Text book:

1. Satellite Communication by T. Pratt, C. Bostian, J. Allnutt, 2nd edition ,Wiley Publication, 2008, ISBN: 978-81-265-0833-4
2. Satellite Communication Engineering by M.O. Kolawole, Signal processing and communication series, Marcel Dekker, 2009, ISBN: 0-8247-0777-X

EL4. Adaptive Techniques in Signal Processing (3-0-0)

Unit-I : (12 hours)

Introduction : Adaptive systems, Definition and characteristics, areas of application, general properties, Open-loop and closed-loop adaptation, the adaptive linear combiner. Properties of the quadratic performance surface.

Unit-II: (14 hours)

Adaptive Algorithms and structures:
Basics of Wiener filtering, Widrow-Hopf Equation, Derivation of Least mean square algorithm, convergence of the weight vector, learning curve, performance, Recursive least square algorithm, variants of LMS algorithm: FX-LMS, Fast LMS, N-LMS, PN-LMS.

Unit-III : (14 hours)

Applications of adaptive signal processing
Design of Adaptive FIR & IIR filters, Adaptive modeling of a multipath communication channel, System identification using adaptive filters, inverse adaptive modeling, deconvolution and Channel equalization, adaptive noise cancellation, adaptive line enhancer.

Text Book:

1. Adaptive Signal Processing, by - B. Widrow and S.D. Stearns, Pearson Education, 2006.

Reference Books:

1. Digital Signal Processing, by- Sanjit K Mitra, new edition, TMH,2009.
2. Digital Signal Processing, by -Salivanan, new edition, TMH, 2009.

EL4. Embedded S/W Design for Communication Network (3-0-0)

Module – I (12 hr)

Introduction :OSI Reference Model, Communication Devices, Types of Software Components: *The Communications Ecosystem,* Design Consideration
Software Consideration in Communications Systems: Host-Based Communication, Embedded Communications Software: *Host Operating Systems versus RTOSes*
Software Partitioning: Limitations of Strict Layering, Tasks and Modules, Module and task Decomposition, 3.4 Partitioning Case Study – Layer 2 Switch: *Optimization of Reception*, Layer 3 Switch/Router, Module and Task Interfaces

Module – II (14 hr)
Protocol Software: Protocol Implementation: Management Types, Debugging Protocols
Tables and Other Data Structures: Tables, Partitioning the Structures/Tables: *Design Decisions,* Implementation, Speeding up Access, *Over Engineering Assumptions, Engineering Assumptions,* Table Resizing, Table Access Routines
Buffer and Timer Management: Buffer Management: Third-Party Protocol Libraries, Timer Management
Management Software: Device Management, Management Schemes, Router Management, Management Subsystem Architecture, Agent-to-Protocol Interface: *Legacy Systems,* Device-to-Manager Communication, System Setup and Configuration, Saving & Restoring the Configuration

Module – III (14 hr)

Multi-Board Communications Software Design: Common Architectures for Communications Equipment, Multi-Board Architectures, Single Control Card + Multiple Line Card Architectures, RTOS Support for Distribution, Data Structure Changes for Distribution, State machine Changes for Distribution, Management Interfaces for Multi-Board Software, Multiple Line Card, Fully Distributed Architecture, Failures and Fault Tolerance in Multi-Board Systems
Development : Product Development Steps, Hardware-Independent Steps: *ACE OSAL*, Development Environments and Tools, 5 Test Tools and Equipment
Examples from Commercial Systems: Juniper Networks M-Series Routers, Cisco Systems 12000-series Routers

Text Book:

1. Designing Embedded Communications Software, By T. Sridhar, CMP publisher, Kindle Edition, Jan 2003.ISBN: 157820125X

Reference:

1. Embedded Systems: Architecture, Programming and Design, By Raj Kamal, 2003, TMH, ISBN: 0-07- 049470-3

EL4. Wireless Optical Communication (3-0-0)

Unit 1 (13 Hours)
Introduction
Technology Overview System Configurations Evolution of Infrared Communication Systems The Optical Wireless Channel Design Fundamentals Power Budget Considerations. ATMOSPHERIC TRANSMISSION LIMITATIONS: Introduction to Atmospheric Propagation Important Definitions Atmospheric Transmission effect of fog, Rain, and Mist Scintillation.

DATA TRANSMISSION LIMITATIONS AND EYE SAFETY: Data Transmission Limitations Eye Safety Extended vs. Collimated Sources Holographic Diffusers

Unit 2 (13 Hours)
LEDs vs. LDs Special Considerations for Outdoor Systems
OPTICAL CONCENTRATORS: Overview of Optical Concentrators Wireless IR Receiver Requirements Optical Filters Optical Concentrators DTIRC Characteristics Comparison of Concentrators Practical Issues Other Shapes of DTIRC.

Optical Wireless Transmitter Design: Introduction to Optical Wireless Transmitter Design Transmitter Design Considerations Optical Source Characteristics Types of Optical Modulation Driver Circuit Design Concepts Current Steering Output Circuit Back Termination Circuit Predriver Data Retiming Automatic Power Control Transmitters Linearization Techniques

Unit 3 (14 Hours)
Optical Wireless Receiver Design:
Receiver Design Considerations Photo detection in Reverse-biased Diodes Choosing the Photo detector Receiver Noise Consideration Bit Error Rate and Sensitivity Bandwidth Signal Amplification Techniques Receiver Main Amplifier (RMA) Transceiver Circuit Implementation Technologies: Hybrid and Monolithic Integration

MODULATION, CODING, AND MULTIPLE ACCESS
Introduction to Modulation and Multiple Access Techniques Modulation Techniques Comparison Modulation Schemes in the Presence of Noise Modulation Schemes in the Presence of multipath Distortion Multiple Access Techniques
WIRELESS IR NETWORKING. Introduction to Wireless IR Networking Network Architecture Optical Wireless Network Specifications. The Ad Hoc Network Quality of Service (QoS) Future Infrared Networking

Text Books

1. Optical wireless communication: IR for Wireless Connectivity Roberto Ramirez-Iniguez, Sevia M. Idrus, Skudai Johor; Ziran Sun ,CRC Press

2. Optical and wireless communications, Next Generation Networks, Matthew W.O.Sadiku.Prairie View A&M University, Texas, USA

EL5. Mobile Computing (3-0-0)

Module-1 (12 Hours)

Issues in Mobile computing, Overview of wireless telephony, Introduction to Personal Communications Services (PCS): PCS Architecture, mobility management, Networks signaling, Global system for Mobile Communication (GSM) System overview: GSM architecture, Mobility management, Network signaling. General Packet Radio Services (GPRS): GPRS Architecture, GPRS Network Nodes, Mobile Data Communication; Cellular digital packet data (CDPD) Networks, WLANs (Wireless LANs) - IEEE 802.II standard, Blue tooth, Mobile IP.

Module-II (10 hours)

Wireless Application Protocol (WAP): The Mobile Internet standard, WAP Gateway and Protocols, Wireless mark up Languages (WML), 3G Mobile Services: Introduction to international Mobile Telecommunications 2000 (IMT 2000) Vision, Ultra Wideband Code division Multiple Access (UW-CDMA), Introduction to 4G Mobile Services, Quality of services in 4G.

Module-III (8 hours)

Wireless Enterprise Networks: Introduction to Virtual Networks. Data management issues – Data replication for mobile computers, Adaptive clustering for mobile wireless networks, Coda file system, Mobile computing with Rover toolkit, Transaction processing in mobile computing environment, Disconnected operations-Mobile agents.

Module-IV (10 hours)
Server-side programming in Java, Pervasive web application architecture, Device independent example application. Adhoc Network – Routing protocol, Global state routing (GSR), Dynamic state routing (DSR), Fisheye state routing (FSR), Adhoc on demand distance vector (AODV), Destination sequenced Distance-vector routing (DSDV).

Text Books:

1. Mobile Computing, - by A. K. Talukder and R.R. Yavagal, 13th reprint,TMH, 2010.
2. Mobile Communications, - by J. Schiller, 2nd reprint, Pearson education, 2009.

Reference Books:

1. Pervasive Computing , - by Burkhardt, Pearson education, 2009.
2. The Wireless Application Protocol, - by Sandeep Singhal, Pearson education, 2009.
3. Wireless communications, by T.S. Rapaport, 2nd edition, Pearson education, 2010.

EL5. High Speed Telecom Switching Architecture (3-0-0)

MODULE I (13 Hours)

Switching Concepts - Hierarchy of switching networks - Switching in telecommunication networks, Evolution of networks - Introduction to B-ISDN. ATM Standards, ATM adaptation layers.

MODULE II (14 Hours)

Switch Forwarding Techniques, Switch Path Control, LAN Switching, Cut through Forwarding, Store and forward, Virtual LANs. Switching architectures - Issues and performance analysis - Banyan and knockout switches - Single & Multistage networks - Shuffle switch tandem banyan. Signaling - SS7 Signaling - Traffic and queueing models - Performance analysis of Input, Output & Multiple shared Queueing.

MODULE III (13 Hours)

Addressing Model, IP switching types, Flow driven and topology driven solutions, IP over ATM, Address and next hop resolution Multicasting, IPV6 over ATM.

TEXT BOOKS

1. Achille Pattavina, Switching Theory Architectures and performance in Broadband ATM networks, John wiley & sons Ltd. New York, 1998
2. Christopher Y Metz, Switching protocols & Architectures, McGraw Hill Professional Publishing, New York, 1998
3. Ranier Handel. Manfred N Huber, Stefab Schrodder, ATM Networks - Concepts, Protocols, Applications, 3rd edition, Adisson Wesley, New York 1999
4. Thiggarajan Viswanathan, "Tele Communication Switching System and Networks", Prentice Hall of India, Pvt.Ltd., New Delhi, 1995

EL5. Wireless Sensor Network (3-0-0)

Module 1 (13 Hours)

Introduction and overview: Overview of the course; overview of sensor network protocols, architecture, and applications; simulation and experimental platforms; main features of WSNs; research issues and trends. Enabling technologies Fundamentals of 802.15.4, Bluetooth, and UWB; Physical and MAC layers.

Sensor node hardware and Software, Hardware: mica2, mica Z, telosB, cricket, Imote2, tmote, btnode, and Sun SPOT.

Module 2 (13 Hours)

Software (OS): tinyOS, MANTIS, Contiki, and RetOS. Programming tools: C, nesC, Mate

Localization, connectivity, and topology: Sensor deployment mechanisms; coverage issues; node discovery protocols. Network layer protocols Data dissemination and processing; multi-hop and cluster based protocols; routing.

Module 3 (14 Hours)

Middleware and application layers: Data dissemination; data storage; query processing; sensor Web; sensor Grid. Open issues for future research Energy preservation and efficiency; security challenges; fault-tolerance;

Textbook:

1. Protocols and Architectures for Wireless Sensor Networks. H. Karl and A. Willig. John Wiley & Sons, June 2005.
2. Wireless Sensor Networks: Technology, Protocols, and Applications. K. Sohraby, D. Minoli, and T. Znati. John Wiley & Sons, March 2007.

References:

1. Wireless Sensor Networks. C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors. Springer Verlag, Sep. 2006.
2. Wireless Sensor Networks: Architectures and Protocols. E. H. Callaway, Jr. AUERBACH, Aug. 2003.
3. Networking Wireless Sensors. B. Krishnamachari. Cambridge University Press, Dec. 2005.
4. Wireless Sensor Networks: An Information Processing Approach. F. Zhao and L. Guibas. Morgan Kaufmann, Jul. 2004.
5. Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications. N. P. Mahalik. Springer Verlag, Nov. 2006.
6. Wireless Sensor Networks: A Systems Perspective, N. Bulusu and S. Jha, Editors, Artech House, August 2005.