Dr. Babasaheb Ambedkar Technological University

Course Structure and Syllabus

For

M. Tech. (Wireless Communication and Computing)

Two Year (Four Semester) Course

(w.e.f. July 2017)

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY,

Lonere-402103, Raigad (MS)

M.Tech. (Wireless Communication and Computing)

Objectives

I. To serve the society and nation, by providing high quality engineering educational programs to the students, engaging in research and innovations that will enhance the skill and knowledge and assisting the economic development of the region, state, and nation through technology transfer.

II. To equip the postgraduate students with the state of the art education through research and collaborative work experience/culture to enable successful, innovative, and life-long careers in Electronics and Telecommunication.

III. To encourage the post-graduates students, to acquire the academic excellence and skills necessary to work as Electronics and Telecommunication professional in a modern, ever-evolving world.

IV. To provide the broad understanding of social, ethical and professional issues of contemporary engineering practice and related technologies, as well as professional, ethical, and societal responsibilities.

V. To inculcate the skills for perusing inventive concept to provide solutions to industrial, social or nation problem.

Outcomes

I. Students of this program will have ability to apply knowledge of mathematics, sciences and engineering to Electronics and Telecommunication problems.

II. Postgraduate students will gain an ability to design and conduct experiments, as well as to analyze and interpret data/results.

III. Learners of this program will built an ability to design and develop a system, components, devices, or process to meet desired needs.

IV. Masters students of this program will have an ability to work on multi-disciplinary teams and also as an individual for solving issues related to Electronics and Telecommunication.

V. Learners of this program will have an ability to identify, formulate, and solve Engineering problems by applying mathematical foundations, algorithmic principles, and Electronics and Telecommunication theory in the modeling and design of electronics systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.

VI. Postgraduate students will have an ability to communicate effectively orally and in writing and also understanding of professional and ethical responsibility.

VII. Postgraduate students will have an ability to use the techniques, skills, and modern engineering EDA tools necessary for Electronics and Telecommunication practices.

VIII. Learners of this program will have an ability to evaluate Electronics and Telecommunication Engineering problems with cost effectiveness, features, and user friendliness to cater needs for innovative product development.

IX. Postgraduate students will have an ability to solve contemporary social and industrial problems by engaging in life-long learning.

Dr. Babasaheb Ambedkar Technological University

Teaching and Examination Scheme for
M.Tech. (Wireless Communication and Computing) w.e.f. July 2017

Sr. No.	Course Code	Name of the course	Hours/Week			Credit	Examination scheme				
							Theory		IA	PR/OR	TOTAL
			L	P	T		TH	Test			
First Semester											
01	MTWCC101	Ad-hoc Wireless Network	03	--	1	04	60	20	20	--	**100**
02	MTWCC102	Wireless Communication Network	03	--	1	04	60	20	20	--	**100**
03	MTWCC103	Mobile Computing	03	--	1	04	60	20	20	--	**100**
04	MTWCE114	Elective-I	03	--	--	03	60	20	20	--	**100**
05	MTWCE125	Elective-II	03	--	--	03	60	20	20	--	**100**
06	MTWCC106	Communication Skills	02	--	--	02	--	--	25	25	**50**
07	MTWCL107	PG Lab-I*	--	03	--	02	--	--	25	25	**50**
		Total for Semester I	**17**	**03**	**03**	**22**	**300**	**100**	**150**	**50**	**600**
Second Semester											
01	MTWCC201	Multimedia Communication	03	--	1	04	60	20	20	--	**100**
02	MTWCC202	Wireless Sensor Network	03	--	1	04	60	20	20	--	**100**
03	MTWCE233	Elective-III	03	--	--	03	60	20	20	--	**100**
04	MTWCE244	Elective- IV	03	--	--	03	60	20	20	--	**100**
05	MTWCE255	Elective-V- (Open to all)	03	--	--	03	60	20	20	--	**100**
06	MTWCS206	Seminar-I	--	04	--	02	--	--	50	50	**100**
07	MTWCP207	Mini-Project	--	04	--	02	--	--	50	50	**100**
		Total for Semester II	**15**	**08**	**02**	**21**	**300**	**100**	**200**	**100**	**700**
Third Semester											
1	MTWCC301	Project Management & Intellectual Property Rights (Self Study)#	--	--	--	02	--	--	50	50	**100**
2	MTWCP302	Project-I	--	--	--	10	--	--	50	50	**100**
		Total for Semester III	**--**	**--**	**-**	**12**	**--**	**--**	**100**	**100**	**200**
Fourth Semester											
1	MTWCP401	Project-II	--	--	--	20	--	--	100	100	**200**
		Total for Semester IV	**--**	**--**	**--**	**20**	**--**	**--**	**100**	**100**	**200**
GRAND TOTAL											**1700**

* PG Lab-I –Practical shall be based on courses of first semester.

Student has to choose this course either from NPTEL/MOOC pool and submission of course completion certificate is mandatory.

Elective-I

A. Telecommunication Network Planning and Management
B. MIMO Wireless Communication Systems
C. CMOS VLSI Design
D. Software Defined Radio
E. Cryptography & Network Security

Elective-II

A. Resource Management In Wireless Communications
B. Ultra Wide Band Communication System
C. VLSI for Wireless Communication
D. Cognitive Radio Communications
E. Distributed Operating System

Elective-III

A. Cloud Computing
B. Mobile Broadband Communication
C. Network Planning and Optimization
D. Cooperative Communications and Networking
E. Soft Computing

Elective-IV

A. Signal Processing and Smart Antennas for Wireless Communication
B. Advanced Digital Image Processing
C. Electromagnetics, Antenna And Prorogation
D. Free Space Optical Communication
E. Advanced Satellite Communication

Elective-V (Open)

A. TCP/IP and Internet
B. High Performance Communication Networks
C. Multirate Signal Processing
D. Research Methodology
E. Internet of Things

AD-HOC WIRELESS NETWORK

Weekly Teaching Hours	TH: 03	Tut: 01		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide advanced research-oriented course designed for graduate students with computer and wireless networks background.
B	To give an exposure to a cutting-edge technology, namely, Wireless Ad Hoc Networks, which include Mobile Ad Hoc Networks (MANETs), Wire-less Sensor Networks (WSNs) and Wireless Mesh Networks (WMNs).
C	To give students the state of art of wireless adhoc networks research, and enhance their potential to do research in this exciting area.

Course Outcomes:

CO1	Learner will be able in-depth networking materials to students in networking research.
CO2	Learner will be able to discuss the challenges in designing routing and transport protocols for wireless Ad-hoc/sensor networks.
CO3	Learner will be able to describe the unique issues in wireless ad-hoc networks.
C04	Learner will be able to describe current technology trends for the implementation and deployment of wireless ad-hoc networks.
C05	Learner will be able to discuss the challenges in designing MAC, routing and transport protocols for wireless ad-hoc networks.

UNIT I

Wireless WANS and MANs: Cellular architecture, Wireless in local loops, Wireless ATM, IEEE 802.16. Wireless internet: Wireless internet, mobile IP, TCP in wireless domain, WAP

UNIT II

Ad hoc wireless networks: Space Cellular and ad hoc wireless networks, Issues in Ad Hoc wireless networks, Issues in designing MAC protocol for Ad Hoc wireless networks, Design goals of MAC protocols for Ad Hoc wireless networks,

UNIT III

Classification of MAC protocols, Contention –Based protocols with reservation and scheduling mechanism, MAC protocols that use directional antennas, Issues in Designing Space MAC Protocol for Ad-Hoc Wireless Networks, MAC Protocol that use directional Antennas.

UNIT IV

Routing protocols for Ad Hoc wireless networks: Designing issues, classification of routing protocols, table driven routing protocols, On demand routing protocol, Hybrid routing protocol, Hierarchical routing protocols. Multicast routing in Ad Hoc wireless networks: Operations and

classification of multicast routing protocols, Tree based multicast routing protocol, Mesh based multicast routing protocol.

UNIT V

Transport layer security protocols for Ad Hoc wireless networks: Designing issues, classification of transport layer solutions, feedback based TCP, TCP bus, Ad Hoc TCP, Security in Ad hoc wireless networks, Issues and challenges in security provisioning, Key management, Secure routing in Ad hoc wireless networks. Quality of Service: Issues and challenges in providing QoS in Ad Hoc wireless networks, classification of QoS solutions.

UNIT VI

Energy management in Ad Hoc wireless networks: Need for energy management, classification of energy management, battery management schemes, transmission power management schemes, system power management schemes. Wireless sensor networks: Sensor network architecture, data dissemination, data gathering, MAC protocol sensor networks, Location discovery.

Textbooks/References:

1. C. Siva Ram Murthy, B.S. Manoj, Ad Hoc Wireless Networks: Architecture and Protocols, Pearson education
2. Anurag Kumar, D. Manjunath, Joy Kuri, Wireless Networks 1/e, Morgan Kaufman (2008)
3. Carlos de Morais Cordeiro and Dharma Prakash Agrawal, Ad Hoc & Sensor Networks: Theory and Applications, 1/e, World Scientific (2007).
4. Houda Labiod, Wireless Ad Hoc and Sensor Networks, John Wiley & Sons, Inc.

WIRELESS COMMUNICATION NETWORKS

Weekly Teaching Hours	TH : 03	Tut: 01		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide in-depth understanding and overview of Wireless Communication networks area and its applications in communication engineering
B	To understand the various terminology, principles, devices, schemes, concepts, algorithms and different methodologies used in Wireless Communication Networks.

Course Outcomes:

CO1	Learner will be able to articulate basics of Wireless Communication Networks.
CO2	Learner will be able to analyze Wireless Communication Networks.
CO3	Learner will be able to simulate wireless networks and analyze the simulation results
CO4	Learner will be able to Understand the techniques of radio spectrum allocation in multi-user systems and their impact on networks capacity.
CO5	Learner will be able to pursue research in the area of wireless communication networks.
CO6	Learner will be able to analyze wireless network and apply the different security measures for the wireless network.

UNIT I

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

UNIT II

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.

UNIT III

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.

UNIT IV

Architecture of a Wireless Wide-Area Network (WWAN) :Introduction, WWAN Subsystem Entities, User Equipment, Radio Station Subsystem, Network and Switching Subsystem, Operation and Maintenance Subsystem (OMSS),Interworking and Interfaces, Logical Channels, Channel and Frame Structure, Basic Signal Characteristics, Speech Processing, Power Levels in Mobile Station, GSM Public Land Mobile Network Services.

UNIT V

Security in Wireless Systems: Introduction, Security and Privacy Needs of a Wireless System, Purpose of Security ,Privacy Definitions ,Privacy Requirements, Theft Resistance Requirements, Radio System Requirements, System Lifetime Requirements, Physical Requirements, Law Enforcement Requirements, Required Features for a Secured Wireless Communications System, Methods of Providing Privacy and Security in Wireless Systems, Wireless Security and Standards, IEEE 802.11 Security, Security in North American Cellular/PCS Systems, Shared Secret Data Update, Global Challenge, Unique Challenge, Security in GSM, GPRS, and UMTS, Security in GSM, Security in GPRS, Security in UMTS, Data Security, Firewalls, Encryption, Secure Socket Layer, IP Security Protocol (IPSec), Authentication Protocols

UNIT VI

Mobile Network and Transport Layer: Introduction, Concept of the Transmission Control Protocol/Internet Protocol, Suite in Internet, Network Layer in the Internet, Internet Addresses, IP Adjunct Protocols, QoS Support in the Internet, TCP/IP Suite, Transmission Control Protocol, TCP Enhancements for Wireless Networks, Implementation of Wireless TCP, Mobile IP (MIP) and Session Initiation Protocol (SIP),Mobile IP, Session Initiation Protocol (SIP),Internet Reference Model.

Textbooks/References:

1. William Stallings, Wireless Communications & Networks, , 2nd Edition, 2009, Pearson Education, ISBN 81-7808-560-7
2. V.K. Garg, Wireless communication and Networking , Morgan Kauffman Publisher, 2009, ISBN:9780123735805
3. Iti Saha Misra, Wireless Communication & Network, 3G & beyond, McGrawHill, 2009, ISBN 10:0-07-015140-7

MOBILE COMPUTING

Weekly Teaching Hours	TH: 03	Tut: 01	
Scheme of Marking	TH: 60	Tests: 20 IA: 20	Total: 100

Course Objectives:

A	To introduce wireless communication and networking principles, that support connectivity to cellular networks, wireless internet and sensor devices.
B	To understand the use of transaction and e-commerce principles over such devices to support mobile business concepts.
C	To appreciate the social and ethical issues of mobile computing, including privacy.
D	To provide guidelines, design principles and experience in developing applications for small, mobile devices, including an appreciation of context and location aware services
E	To introduce wireless communication and networking principles, that support connectivity to cellular networks, wireless internet and sensor devices.

Course Outcomes:

CO1	Learner will be able to understand of the characteristics and limitations of mobile hardware devices including their user-interface modalities.
CO2	Learner will be able to develop applications that are mobile-device specific and demonstrate current practice in mobile computing contexts.
CO3	Learner will be able to comprehension and appreciation of the design and development of context-aware solutions for mobile devices.
CO4	Learner will be able to understand the operational characteristics of mobile computing
CO5	Learner will be able to Demonstrate an awareness of professional and ethical issues, in particular those relating to security and privacy of user data and user behavior.

UNIT I

Mobile Computing Introduction

History of Wireless Communications, Types, propagation modes Wireless network architecture, Applications, Security, Concerns and Standards, Benefits, Future. Evolution of mobile computing, What mobile users need, SOC and AOC client, Mobile computing OS, Architecture for mobile computing, Three tier architecture, design considerations for mobile computing, mobile computing through internet, making existing applications Mobile-Enabled.

UNIT II

Mobile Technologies

Bluetooth, Radio frequency identification (RFID),Wireless Broadband, Mobile IP: Introduction, Advertisement, Registration, TCP connections, two level addressing, abstract mobility management model, performance issue, routing in mobile host, Adhoc networks, Mobile transport layer: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, transaction oriented TCP. ,IPv6 Global system for mobile communication, Global system for mobile communication, GSM architecture, GSM entities, call routing in GSM,PLMN interface, GSM addresses and identifiers, network aspects in GSM,GSM frequency allocation, authentication and security, Short message services, Mobile computing over SMS,SMS, value added services through SMS, accessing the SMS bearer

UNIT III

Mobile Network Layer:

Mobile IP (Goals, assumptions, entities and terminology, IP packet delivery, agent advertisement and discovery, registration, tunneling and encapsulation, optimizations), Dynamic Host Configuration Protocol (DHCP).

UNIT IV

Wireless Application Protocol(WAP) WAP,MMS,GPRS application CDMA and 3G Spread-spectrum Technology, CDMA versus GSM, Wireless data, third generation networks, applications in 3G Wireless LAN, Wireless LAN advantages,IEEE802.11 standards ,Wireless LAN architecture, Mobility in Wireless LAN, Deploying Wireless LAN, Deploying Wireless LAN, Mobile ad hoc networks and sensor networks, wireless LAN security, WiFi v/s 3G Voice over Internet protocol and convergence, Voice over IP,H.323 framework for voice over IP,SIP, comparison between H.323 ad SIP, Real time protocols, convergence technologies, call routing, call routing, voice over IP applications, IMS, Mobile VoIP, Security issues in mobile Information security, security techniques and algorithms, security framework for mobile environment

UNIT V

Mobile Transport Layer : Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission /time-out freezing, Selective retransmission, Transaction oriented TCP. Database Issues : Hoarding techniques, caching invalidation mechanisms, client server computing with adaptation, power-aware and context-aware computing, transactional models, query processing, recovery, and quality of service issues.

UNIT VI

Data Dissemination: Communications asymmetry, classification of new data delivery mechanisms, push based mechanisms, pull-based mechanisms, hybrid mechanisms, selective tuning (indexing) techniques.

Textbooks/References:

1. Asoke K Telukder, Roopa R Yavagal, Mobile Computing, Tata Mcgraw hill Publication.
2. James Edward Keogh, The complete reference J2ME, Tata Mcgraw hill Publication.
3. G. T. Thampi, Programming for Mobile and Remote Computers, , Dreamtech Publication
4. Ivan Stojmenovic, Handbook of Wireless Networks and Mobile Computing, ,Wiley Publication.
5. Hansmann, Merk, Nicklous and Stober, Principles of Mobile Computing, Springer Publication
6. Jochen Schiller,"Mobile Communications",Addison-Wesley.,second edition, 2004.
7. Stojmenovic and Cacute, "Handbook of Wireless Networks and Mobile Computing", Wiley, 2002, ISBN 0471419028.
8. Raj Kamal, Mobile Computing, , Oxford Publication
9. Shane Conder, Lauren Darcey, Android Wireless Application Development, Pearson
10. Professional Android 2 Application development, Reto Meier, Wrox, Wiley India

ELECTIVE I
TELECOMMUNICATION NETWORK PLANNING AND MANAGEMENT

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand the general concepts and architecture behind standards based network management
B	To understand advanced information processing techniques such as distributed object technologies, software agents and internet technologies used for network management.
C	To provide an advanced technical knowledge of applied telecommunications integrated with a solid grounding in business management techniques.
D	To impart professional knowledge in creating cost models for new technology implementations, calculating return on investment, and in the organizational and user implications of networking systems.

Course Outcomes:

CO1	Learner will be able to analyze modern large-scale networks into their component networks
CO2	Learner will be able to develop a network strategy for upgrading an existing network or the build of a new network, taking due consideration of the company's objectives, service, and operational requirements
CO3	Learner will be able to select the appropriate technology for broadband deployment in the access Network
CO4	Learner will be able to outline the process and techniques for planning the deployment of a mobile network, including coverage and capacity planning
CO5	Learner will be able to describe the principles of design and dimensioning of circuit-switched networks, and the core transmission network

UNIT I

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.

UNIT II

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.

UNIT III

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.

UNIT IV

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

UNIT V

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.

UNIT VI

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

Textbooks/References:

1. Sharon Evans, Telecommunications network modeling, Planning and Design, The institute of Engineering and technology, London, UK, 2003.
2. Mani Subramanian, Network Management: Principles and Practice, Addison-Wesley Prentice Hall, ISBN-10: 0201357429
3. Sansò, Brunilde, Soriano, Patrick, Telecommunications network planning, Springer Publication.

ELECTIVE I

MIMO WIRELESS COMMUNICATION SYSTEMS

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand the MIMO wireless communications systems and its importance.
B	To understand the different encoding and decoding technique used for the MIMO wireless communication system.
C	To understand the importance of the multiple antenna and multicarrier communication system for delivering the high data rate.
D	To understand the importance of the MIMO systems for implementing the mobile broadband communication system.

Course Outcomes:

CO1	Learner will be able to explain and differentiate the SISO and MIMO wireless communication system
CO2	Learner will be able to explain and differentiate the single carrier and multicarrier communication system.
CO3	Learner will be able to model and simulate the MIMO communications system to demonstrate its efficiency.
CO4	Learner will be able to demonstrate how to improve the throughput and efficiency of the MIMO system over SISO system using different coding techniques.

UNIT I

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.

UNIT II

Preceding Design: Transmit channel side information, Information - theoretic foundation for exploiting CSIT, A transmitter structure, Preceding 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.

UNIT III

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.

UNIT IV

Forward Error Correction Coding: Linear Block Codes, Convolutional Codes, Soft-Output Decoding of Binary Codes, Performance Evaluation of Linear Codes, Concatenated Codes, Low Density Parity Check (LDPC) Codes.

UNIT V

Space-time coding: Space-time coding introduction, Space-time code design criteria, Orthogonal space-time block codes, Space-time trellis codes.

UNIT VI

Spatial multiplexing: Overview of spatial multiplexing, BLAST encoding architectures, Demultiplexing methods for H-BLAST and V-BLAST, Multi-group space-time coded modulation (MGSTC)

Textbooks/References:

1. E.Biglieri, R. Calderbank, A.Constantinides, Andrea Goldsmith, A. Paulraj & H. V. Poor, MIMO Wireless Communications ,Cambridge University Press, ISBN: 9780521873284
2. Jerry R. Hampton, Introduction to MIMO Communications, Cambridge University Press.
3. Volker Kuhn, Wireless Communications over MIMO Channels Applications to CDMA and Multiple Antenna Systems, John Wiley & Sons, 2006.
4. David Tse and Pramod Viswanath, Fundamentals of Wireless Communication , Cambridge University Press, 2005

ELECTIVE I

CMOS VLSI DESIGN

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand the concept behind ASIC (Application Specific Integrated Circuits) design and the different implementation approaches used in industry.
B	To understand the concept behind ASIC (Application Specific Integrated Circuits) design and the different implementation approaches used in industry
C	To design digital systems for a variety of applications, including microcomputers and special purpose computing systems,
D	To understand the static and dynamic behavior of MOSFETs (Metal Oxide Semiconductor Field Effect Transistors) and the secondary effects of the MOS transistor model.

Course Outcomes:

CO1	Learner will be able to use different analysis and verification tools, implementation and synthesis methodologies and testability techniques that will enable them to design high performance and efficient digital systems.
CO2	Learner will be able to prepare Layout, Stick diagrams, Fabrication of digital system, and learn Static and Switching characteristics of inverters
CO3	Learner will be able to synthesis of digital VLSI systems from register-transfer or higher level descriptions in hardware design languages and demonstrate the MOS transistor as a switch and its capacitance.
CO4	Learner will be able to design high performance digital systems with operating speed in the multiple hundreds of MHZ and even the GHz range using BiCMOS, ECL and Gallium Arsenide design techniques.

UNIT I

Basics of CMOS :VLSI Design: History, Trends, Principles, Metrics, CMOS transistors (n-channel and p-channel), The CMOS Switch model, CMOS Inverter mode, Logic devices and interconnect, CMOS circuit analysis: transistors, inverters, interconnect modeling, CMOS parasitic, CMOS Process and Layout, CMOS Devices: SPICE and deep sub-micron issues.

UNIT II

CMOS: Design Issues: Design of FSM, Moore & Mealy machines, Metastability, Solutions to metastability, Synchronization methods, VHDL codes for complex sequential machines,

Hazards, Types of hazards, Method to eliminate hazards, case studies. Design calculations for different logic circuits, Calculations for Area on chip, Power dissipation, PDP, Transmission gate, Domino logic, NORA logic, CMOS layout techniques, Transient response, Advance trends of elements & Alloys for ultra-fast logic clock, CMOS Inverter: speed, power and scaling, Static CMOS Gates, Dynamic CMOS Gates, Power Estimation and Optimization

UNIT III

Modeling: Analytical modeling: Ellmore Delay, Transmission models, RC, RLC lumped parameter models, Layout for custom logic: Sea of Gates (SoG) model, Design rules, Circuit fabrication methods for CMOS, Levels of abstraction.

UNIT IV

Circuits to Systems: VLSI circuits to systems, Circuit modeling and layout (demo using standard tools), CMOS design and layout tools, Nano-electronics circuits versus CMOS microelectronics circuits, Nano-computing techniques and device platforms

UNIT V

Digital IC Design: Digital CMOS IC design: Sequential Logic Circuits, Implementation Strategies for Digital ICs, Interconnects, Timing and Clocking, data path design, Memory Design, Capacitive parasitics, Resistive parasitics, Inductive parasitic

UNIT VI

Timing issues for Digital CMOS circuits: Timing Issues, Clock skew, clocking styles, Self-timed circuit design, Case study of Kitchen timer chip. ultra-fast VLSI circuits and systems with GaAs system

Textbooks/References:

1. N.H.E. Weste and K. Eshraghian, “Principles of CMOS VLSI Design”, New York: Addison-Wesley, 1993.
2. Christopher Saint and Judy Saint, “IC Layout Basics”, McGraw Hill Publications.
3. Weste and Harris, “CMOS VLSI Design, a Circuits and Systems Perspective” (3 rd edition)
4. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, Digital Integrated Circuits (2nd Edition) Prentice Hall, 2003.
5. Douglas Holberg, “CMOS Analog circuit design”, Oxford Publication.
6. Rabey, Chandrakasan, “Digital IC Design”. Artech House Publications
7. Ken Martin “Digital Integrated Circuit Design” Oxford Press 2000
8. Pucknell and Kamran “Basic VLSI Design” EEE PHI 3rd Edition
9. Allen and Holberg “CMOS Analog Circuit Design”. Oxford Pub. (2nd Edn.)

ELECTIVE I

SOFTWARE DEFINED RADIO

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand the fundamental and state-of the art concepts in software defined radio
B	To understand the Software radio, Software defined radio and software defined networking.
C	To understand the Evolution of the software Defined Radio.
D	To develop the model for the SDR and simulate using different simulation tools such as GNU radio and MATLAB

Course Outcomes:

CO1	Learner will be able to make system-level decisions for software defined radio technology and products.
CO2	Learner will be able to explain analog RF components as front end block in implementation of SDR.
CO3	Learner will be able to design circuits at different multi-rate signaling technique for frequency conversion and sampling issues.
CO4	Learner will be able to demonstrate the software development methods for embedded wireless systems and understand the use of ADC and DAC in the implementation of SDR.

UNIT I

SDR concepts & history, Benefits of SDR, SDR Forum, Ideal SDR architecture, SDR Based End to-End Communication, Worldwide frequency band plans, Aim and requirements of the SCA.

UNIT II

Architecture Overview, Functional View, Networking Overview, Core Framework, Real Time Operating Systems, Common Object Request Broker Architecture (CORBA), SCA and JTRS compliance.

UNIT III

Radio Frequency design, Baseband Signal Processing, Radios with intelligence, Smart antennas, Adaptive techniques, Phased array antennas, Applying SDR principles to antenna systems, Smart antenna architectures.

UNIT IV

Low Cost SDR Platform, Requirements and system architecture, Convergence between military and commercial systems, The Future for Software Defined Radio, Cognitive Radio.

UNIT V

Software Radio platforms: GNU radio- Python introduction, developing GNU Radio, signal processing blocks, scheduler, Basic GR development flow, case study- any application, Open source SCA implementations-Embedded , All other software radio framework- Microsoft research software radio, Frontend for Software radio- Sound card front ends, Universal Software radio peripherals (USRP), SDR front end for Navigation applications, Network based front ends.

UNIT VI

Development tools and flow: Requirement capture, System simulation, Firmware development: Electronics System level design, Block based system design, and Final Implementation, Software development: Real-time versus Non Real-time software, Optimization, and Automatic Code generation.

Textbooks/References:

1. Dillinger, Madani, Alonistioti (Eds.): Software Defined Radio, Architectures, Systems and Functions, Wiley 2003.
2. Jefree Reed: Software Radio, Pearson Education.
3. Paul Burns, Software Defined Radio for 3G, 2002, Artech Publication.
4.Tafazolli (Ed.): Technologies for the Wireless Future, Wiley 2005
5. Bard, Kovarik: Software Defined Radio, The Software Communications Architecture, Wiley 2007
6. Eugene Grayver, Implementing Software Defined Radio, Springer
7. Cory Clark, Software Defined Radio: With GNU Radio and USRP, McGraw-Hill Companies, Incorporated, 29-Nov-2008

ELECTIVE I
CRYPTOGRAPHY AND NETWORK SECURITY

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand lossless and lossy compression techniques for different types of data.
B	To understand data encryption techniques.
C	To understand Network security and ethical hacking.

Course Outcomes:

CO1	Learner will be able to implement text, audio and video compression techniques.
CO2	Learner will be able to understand symmetric and asymmetric key cryptography schemes.
CO3	Learner will be able to understand network security and ethical hacking.
CO4	Learner will be able to implement Digital Signature and Authentication Protocol.
CO5	Learner will be able to understand Electronic Mail Security.

UNIT I

Overview: Services, Mechanisms and attacks, OS1 security architecture, Model for network security.

UNIT II

Classical Encryption Techniques: Symmetric cipher model, Substitution techniques, Transposition techniques, Rotor machine, Steganography, Problems

UNIT III

DES (Data Encryption Standards): Simplified DBS, Block cipher principles, DES, Strength of DES, Block cipher design principles, Block cipher modes of operation, Problems

UNIT IV

Public Key Cryptography and RSA: Principles of public key cryptosystems, RSA algorithm, Problems. Other Public Key Crypto Systems and Key Management: Key management, Diffie Hellman key exchange, Elliptic curve arithmetic, Elliptic curve cryptography, Problems.

UNIT V

Digital Signature and Authentication Protocol: Digital signature, Authentication protocols, Digital signature standard. Authentication Applications: Kerberos, X.509 authentication service, Kerberos encryption technique, Problems. Message Authentication and Hash Functions: Authentication requirements, Authentication functions, Message authentication codes, Hash functions, Security of Hash functions and MAC's, Problems

UNIT VI

Electronic Mail Security: Pretty good privacy, S/MIME, Data compression using ZIP, Radix-64 conversion, PGP random number generator. IP Security: Overview, IP security architecture, Authentication header, ESP (encapsulating security pay load), Security associations, Key

management, Problems.) Firewalls: Firewall design principles; trusted systems, Problems. Wireless Security Issues: The Unique Security Environment of Wireless, "Notable Security Failures with Wi-Fi and GSM, Authentication, Authorization and Accounting, IEEE 802.1 1 (Wi-Fi) Solutions; Initial and Revised Virtual Private Networks.

Textbooks/References:

1. William Stallings, "Cryptography and Network Security," 3rd edition, Pearson Education (Asia) Pte. Ltd./ Prentice Hall of India, 2003.
2. C. Kaufman, R. Perlman, and M. Speciner, "Network Security: Private Communication in a Public World," 2nd edition, Pearson Education (Asia) Pte. Ltd.

ELECTIVE II

RESOURCE MANAGEMENT IN WIRELESS COMMUNICATIONS

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand Analysis, model and design of radio resource management mechanisms for wireless communications systems, with a focus on mobile communications.
B	To develop the concepts for designing and operating a mobile communication network, including the planning and dimensioning processes.
C	To understand different strategies for radio resource management and network optimization, including advanced concepts for automated network optimization
D	To develop models and strategies for managing the network and the spectrum.

Course Outcomes:

CO1	Learner will be able to model, design and evaluate strategies and mechanisms for the management of the radio resources and the flexible use of the spectrum in wireless networks
CO2	Learner will be able to deployment and resource management options for heterogeneous networks
CO3	Learner will be able to understand flexible spectrum management concepts: regulation, spectrum management components, spectrum sharing, dynamic spectrum access and cognitive radio
CO4	Learner will be able to understand heterogeneous networks, including deployment, interference management, load control and use of multiple radio interfaces.
CO5	Learner will be able to analyze, model and evaluate advanced resource management and optimization techniques for wireless networks.

UNIT I

Resource Management: Call admission control in wireless LANs, Activity Scheduling in Bluetooth Sensor Networks, Traffic aware routing for RTC in wireless Multi-hop Networks, Reliable multicast for Wireless LAN, Wireless Network Tele-traffic modeling with Lossy Link.

UNIT II

Heterogeneous Wireless Networks: Optimal resource management and QoS Provisioning, Medium Access Control in Wireless Ad Hoc Networks, A Cost-Controlled Bandwidth

Adaptation Algorithm for Multimedia Wireless Networks, Advanced Radio resource management for future Mobile Networks

UNIT III

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.

UNIT IV

Location management in Wireless Networks: Issues and Technologies, Network Topologies, Time based location update. Network Mobility

UNIT V

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.

UNIT VI

Localization in Wireless Ad Hoc Networks: What Are Ad Hoc Networks ,Why Localization in Ad Hoc Networks, Designing Localization Algorithms for Ad Hoc Networks, How Node Localization Works: Range-based Methods, Connectivity-based Approach, Localization Techniques in Infrastructure, Systems Localization Algorithms for Ad Hoc Networks: Range-based Algorithms, Connectivity-based Algorithms , Comparing Ad Hoc Localization Algorithms

Textbooks/References:

1. Yan Zhang, Masayuki Fujise, Resource, mobility, and security management in wireless networks and mobile communications, Auerbach Publications, 2007, Taylor and Francis group, ISBN: 0849380367.
2. Mihaela Cardei, Ionut Cardei, Dingzhu Du, Resource management in wireless Networking, Springer, 2005, ISBN:0387238077

ELECTIVE II

ULTRA WIDE BAND COMMUNICATION SYSTEM

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand the Ultra-wideband (UWB) Communication Technology.
B	To understand the role of Ultra-wideband (UWB) in next generation wireless communications systems.
C	To study working principle of MIMO-OFDM Communications, MIMO Multiband OFDM System for UWB.

Course Outcomes:

CO1	Learner will be able to understand the operational characteristics of UWB.
CO2	Learner will be able to understand the working principle UWB technologies.
CO3	Learner will be able to model and simulate Ultra Wide Band Wireless Channels
CO4	Learner will be able to model UWB interference and performance characterization.

UNIT I

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

UNIT II

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,

UNIT III

Ultra Wide Band Wireless Channels: Impulse Response Modeling of UWB Wireless Channels, Distribution of Amplitude Fading, Distribution of Time of Arrival, Path Loss, Power-Delay Profiles , RMS Delay Spread, Modified Impulse Response Method, The IEEE UWB Channel Model ,Frequency Modeling of UWB Channels, Comparison of Time and Frequency Models

UNIT IV

UWB Interference: An Example: IEEE802-11.a Interference, General Method of Signal to Interference Ratio Calculation, Interference of UWB to Existing OFDM System, Interference of UWB to Narrowband Systems, Interference to WiMax, Interference Reduction, Interference Mitigation of Wideband System on UWB Using Multicarrier Templates**.**

UNIT V

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.

UNIT VI

UWB Wireless Locationing : Position Locationing Methods, Received Signal Strength (RSS), Angle of Arrival (AOA), Time of Arrival (TOA) ,Time of Arrival Estimation, Inverse Filtering Technique, ESPRIT Technique, CLEAN Technique, Super-Resolution Technique, Non-Coherent Technique, NLOS Location Error, Locationing with OFDM

Textbooks/References:

1. Uma Sankar Jha and Ramjee Prasad, OFDM Towards fixed and mobile Broadband Wireless Access , ARTECH House Publication.
2. W.Pam Siriwongpairat and K. J. Ray Liu, Ultrawideband communications Systems Multiband OFDM Approach, IEEE Press Publication.
3. Homayoun Nikookar, Ramjee Prasad, Introduction to Ultra Wideband for Wireless Communications, ARTECH House Publication.

ELECTIVE II

VLSI FOR WIRELESS COMMUNICATION

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand the RF front end and various types of mixers designed for wireless communication.
B	To introduce students to the fundamentals of VLSI signal processing and expose them to examples of applications.
C	To understand design and optimization of VLSI architectures for basic DSP algorithms for wireless communications.
D	To understand algorithm, architecture, and circuit design tradeoffs to jointly optimize for power, performance, and area.

Course Outcomes:

CO1	Learner will be able to understand VLSI design methodology for signal processing systems.
CO2	Learner will be able to understand VLSI algorithms for DUC, DDC and Filter bank.
CO3	Learner will be able to understand scaling and round-off noise issues and their impact on performance of the system.
CO4	Learner will be able to implement basic architectures for wireless communication system blocks using CAD tools.

UNIT I

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)

UNIT II

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

UNIT III

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

UNIT IV

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.

UNIT V

Frequency Synthesizer: Phase/Frequency-Processing Components Introduction, PLL based Frequency Synthesizer, Phase Detector/Charge Pump, Dividers, VCO, LCO, Ring Oscillator, Phase noise

UNIT VI

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

Textbooks/References:

1. Bosco Leung, VLSI for Wireless Communication, Prentice Hall Electronics and VLSI series, 2002.
2. Emad N. Farag, Mohamed I. Elmasry, Mixed Signal VLSI Wireless Design Circuits And Systems, Kluwer Academic Publishers, 2007.

ELECTIVE II

COGNITIVE RADIO COMMUNICATIONS

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand the use of the SDR
B	To understand the stages of the evolution of SDR.
C	To study the applications of the Cognitive Radio.
D	To develop the system model for the spectrum sensing and spectrum access techniques in CR.

Course Outcomes:

CO1	Learner will be able to differentiate between SDR and CR
CO2	Learner will be able to evaluate the different spectrum sensing techniques for the cognitive radio.
CO3	Learner will be able to develop the system model for single carrier and multicarrier cognitive radio system.
CO4	Learner will be able to evaluate the different spectrum management techniques for cognitive radio system.
C05	Learner will be able to simulate and analyze the SDR and Cognitive radio systems

UNIT I

Software Defined Radio Architecture - Digital Signal Processor and SDR Baseband Architecture, Reconfigurable Wireless Communication Systems, Unified Communication Algorithm , Reconfigurable OFDM Implementation, Reconfigurable OFDM and CDMA, Digital Radio Processing , Conventional RF, Digital Radio Processing (DRP) Based System Architecture

UNIT II

Cooperative Communications and Networks - Information Theory for Cooperative Communications, Fundamental Network Information, Multiple-access Channel with Cooperative Diversity, Cooperative Communications, Three-Node Cooperative Communications ,Multiple-Node Relay Network,Cooperative Wireless Networks, Benefits of Cooperation in Wireless Networks , Cooperation in Cluster-Based Ad-hoc Networks

UNIT III

Cognitive Radio Communications **:** Cognitive Radios and Dynamic Spectrum Access,The Capability of Cognitive Radios, Cognitive Radio cycle, Spectrum Sharing Models of DSA,

Opportunistic Spectrum Access: Basic Components , Networking The Cognitive Radios, Analytical Approach and Algorithms for Dynamic Spectrum Access, Dynamic Spectrum Access in Open Spectrum ,Opportunistic Spectrum Access , Opportunistic Power Control ,Fundamental Limits of Cognitive Radios, Mathematical Models Toward Networking Cognitive Radios, CR Link Model, Overlay CR Systems, Rate-Distance Nature .

UNIT IV

Spectrum Sensing: Primary Signal Detection such as Energy Detector, Cyclostationary Feature Detector ,Matched Filter, Cooperative Sensing etc., Spectrum Sensing to Detect Specific Primary System , conventional Spectrum Sensing, Power Control , Power-Scaling Power Control ,Cooperative Spectrum Sensing , Spectrum Sensing for Cognitive OFDMA Systems , Discrimination of States of the Primary System, Spectrum Sensing Procedure, Spectrum Sensing for Cognitive Multi-Radio Networks , Multiple System Sensing , Radio Resource Sensing.

UNIT V

Cognitive Radio Networks: Network Coding for Cognitive Radio Relay Networks , System Model, Network Capacity Analysis on Fundamental CRRN Topologies, Link Allocation , Numerical Results, Cognitive Radio Networks Architecture , Network Architecture ,Links in CRN , IP Mobility Management in CRN ,Terminal Architecture of CRN, Cognitive Radio Device Architecture , Re-configurable MAC ,Radio Access Network Selection ,QoS Provisional Diversity Radio Access Networks , Cooperative/Collaborative Diversity and Efficient Protocols , Statistical QoS Guarantees over Wireless Asymmetry Collaborative Relay Networks.

UNIT VI

Spectrum access and sharing: Unlicensed Spectrum Sharing, Licensed Spectrum Sharing , Secondary(SSA) Spectrum Access ,Non-Real-Time SSA, Real-Time SSA, Negotiated Access , Is Quality of Service Provisioning Possible in a Shared Band, Opportunistic Access ,Overlay Approach , Underlay Approach

Textbooks/References:

1. Kwang-Cheng Chen, Ramjee Prasad, Cognitive Radio Networks, John Wiley & Sons Ltd.
2. Alexander M. Wyglinski, Maziar Nekovee, Y. Thomas Hou, Cognitive Radio Communications and Networks Principles and Practice, Elsevier publication.
3. Qusay H. Mahmoud, Cognitive Networks, John Wiley & Sons Ltd.

ELECTIVE II
DISTRIBUTED OPERATING SYSTEM

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To learn the fundamentals of Operating Systems.
B	To gain knowledge on Distributed operating system concepts that includes architecture, Mutual exclusion algorithms, Deadlock detection algorithms and agreement protocols.
C	To gain insight on to the distributed resource management components viz. the algorithms for implementation of distributed shared memory, recovery and commit protocols.
D	To know the components and management aspects of Real time, Mobile operating Systems.

Course Outcomes:

CO1	Learner will be able demonstrate the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system.
CO2	Learner will be able to learn the various resource management techniques for distributed systems
CO3	Learner will be able to Identify the different features of real time and mobile operating systems.
CO4	Learner will be able to Modify existing open source kernels in terms of functionality or features used.

UNIT I

Architectures of Distributed Systems: Issues in Distributed operating System, Communication Networks, Communication Primitives, Limitations of Distributed Systems

UNIT II

Physical and Logical Clocks, Lamport's Logical Clock, Vector Clocks, Casual Ordering of Messages, Global State, Cuts of Distributed Computation

UNIT III

Distributed Mutual Exclusion: Classification, Preliminaries, A Simple Solution to Distributed Mutual Exclusion, Non-Token-Based Algorithms, The Ricart Agrawala Algorithm, A Generalized Non-Token-Based Algorithms, Token-Based Algorithms, SuzukiKasami's Broadcast Algorithm, Raymond's Tree-Based Algorithm, A Comparative Performance Analysis, Distributed Deadlock Detection: Preliminaries, Deadlock Handling Strategies in

Distributed System, Issues in Deadlock Detection & Resolution, Control Organizations for Distributed Deadlock Detection, Centralized Deadlock Detection Algorithms, Distributed Deadlock Detection Algorithms, Hierarchical Distributed Deadlock Detection

UNIT IV

Agreement Protocols: The System Model, A Classification of Agreement Problems, Solution to the Byzantine Agreement Problem, Applications of Agreement Algorithms. Distributed File Systems: Architecture, Mechanism for Building Distributed File System, Design Issues, Case Studies, Log-Structured File Systems.

UNIT V

Distributed Shared Memory: Architecture & Motivation, Algorithm for Implementing DSM, Memory Coherence, Coherence Protocols, Design Issues, and Case Studies. Distributed Scheduling: Motivation, Issues in Load Distributing, Components of a Load Distributing Algorithm, Stability, Load Distributing Algorithms, Performance Comparison, Selecting Suitable Load Sharing Algorithm, Requirements of Load Distribution, Load Sharing Policies: Case Studies Task Migration, Issues in Task Migration

UNIT VI

Recovery: Introduction, Classification of Failures, Backward & Forward Error Recovery, Recovery in Concurrent Systems, Consistence Set of Checkpoints, Synchronous Checkpoint & Recovery, Asynchronous Checkpoint & Recovery, Checkpointing for Distributed Database Systems, Recovery in Replicated Distributed Database Systems. Fault Tolerance: Issues, Atomic Actions & Committing, Commit Protocols, Nonblocking Commit Protocols, Voting Protocols, Dynamic Voting Protocols, The Majority Based Dynamic Voting Protocols, Dynamic Vote Reassignment Protocols, Failure Resilient Processes, Reliable Communication, Case Studies. Recent Trends in Distributed OS.

Textbooks/References:

1. Mukesh Singhal & Niranjan Shivratri, Advanced Concepts in Operating Systems, McGraw-Hill, 1994.
2. Andrew S. Tanenbaum, Distributed Operating Systems, Pearson Education 2008.

COMMUNICATION SKILLS

Weekly Teaching Hours TH: 02 Practical: --

Scheme of Marking TH: -- IA: 25 PR/OR: 25 Total: 50

Course Objectives:

A	To become more effective confident speakers and deliver persuasive presentations
B	To develop greater awareness and sensitivity to some important considerations in interpersonal communication and learn techniques to ensure smoother interpersonal relations

Course Outcomes:

CO1	Learner will be able to understand the fundamental principles of effective business communication
CO2	Learner will be able to apply the critical and creative thinking abilities necessary for effective communication in today's business world
CO3	Learner will be able to organize and express ideas in writing and speaking to produce messages suitably tailored for the topic, objective, audience, communication medium and context
CO4	Learner will be able to demonstrate clarity, precision, conciseness and coherence in your use of language
CO5	Learner will be able to become more effective confident speakers and deliver persuasive presentations

UNIT I

Introduction to communication, Necessity of communication skills, Features of good communication, Speaking skills, Feedback & questioning technique, Objectivity in argument

UNIT II

Verbal and Non-verbal Communication, Use and importance of non-verbal communication while using a language, Study of different pictorial expressions of non-verbal communication and their analysis

UNIT III

Academic writing, Different types of academic writing, Writing Assignments and Research Papers, Writing dissertations and project reports

UNIT IV

Presentation Skills: Designing an effective Presentation, Contents, appearance, themes in a presentation; Tone and Language in a presentation, Role and Importance of different tools for effective presentation

UNIT V

Motivation/ Inspiration: Ability to shape and direct working methods according to self-defined criteria;Ability to think for oneself, Apply oneself to a task independently with self-motivation, Motivation techniques: Motivation techniques based on needs and field situations

UNIT VI

Self-management, Self-evaluation, Self-discipline, Self-criticism, Recognition of one's own limits and deficiencies, dependency etc. Self-awareness, Identifying one's strengths and weaknesses, Planning & Goal setting, Managing self-emotions, ego, pride leadership & Team dynamics

Textbooks/References:

1. Mitra, Barun, Personality Development and Soft Skills, Oxford University Press, 2016.
2. Ramesh, Gopalswamy, The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education, 2013.
3. Covey, Stephen R., Seven Habits of Highly Effective People: Powerful Lessons in Personal Change, Simon and Schuster, 09-Nov-2004
4. Rosenberg Marshall B., Nonviolent Communication: A Language of Life, PuddleDancer Press, 01-Sep-2003

PG LAB-I

Weekly Teaching Hours	TH: --		Practical: 03	
Scheme of Marking	TH: --	IA: 25	PR/OR: 25	Total: 50

Practical's of the Lab - I shall be based on the courses of first semester. The lab work shall consists of hands on experiments on the different software and hardware platforms related to the syllabus.

MULTIMEDIA COMMUNICATION

Weekly Teaching Hours	TH : 03	Tut: 01		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand the multimedia communications systems, application and basic principles
B	To provide in-depth understanding for multimedia communication standards and compression techniques
C	To provide in-depth understanding for representation of image, video.
D	To understand the basics of analog and digital video: video representation and transmission and perform the analysis of the multimedia streaming,

Course Outcomes:

CO1	Learner will be able to understand different multimedia communication devices.
CO2	Learner will be able to analyze different multimedia compression techniques.
CO3	Learner will be able to analyze fundamental concepts of multimedia building blocks.
CO4	Learner will be able to demonstrate a diverse portfolio that reflects multimedia aesthetic proficiency.
CO5	Learner will be able to demonstrate a set of professional skills and competencies in their practice of multimedia communication.

UNIT I

Introduction to Multimedia, Multimedia Information, Multimedia Objects, Multimedia in business and work. Convergence of Computer, Communication and Entertainment products Stages of Multimedia Projects Multimedia hardware, Memory & storage devices, Communication devices, Multimedia software's, presentation tools, tools for object generations, video, sound, image capturing, authoring tools, card and page based authoring tools.

UNIT II

Multimedia Building Blocks Text, Sound MIDI, Digital Audio, audio file formats, MIDI under windows environment Audio & Video Capture.

UNIT III

Data Compression Huffman Coding, Shannon Fano Algorithm, Huffman Algorithms, Adaptive Coding, Arithmetic Coding Higher Order Modelling. Finite Context Modelling, Dictionary based Compression, Sliding Window Compression, LZ77, LZW compression, Compression, Compression ratio loss less & lossy compression.

UNIT IV

Speech Compression & Synthesis Digital Audio concepts, Sampling Variables, Loss less compression of sound, loss compression & silence compression.

UNIT V

Images Multiple monitors, bitmaps, Vector drawing, lossy graphic compression, image file format, animations Images standards, JPEG Compression, Zig Zag Coding, Multimedia Database, Content based retrieval for text and images, Video: Video representation, Colors, Video Compression, MPEG standards, MHEG Standard Video Streaming on net, Video Conferencing, Multimedia Broadcast Services, Indexing and retrieval of Video Database, recent development in Multimedia.

UNIT VI

Multimedia Operating Systems: Process Management, Inter-process Communication and Synchronization, Memory Management, Device Management, System Architecture.

Textbooks/References:

1. Tay Vaughan, "Multimedia, Making IT Work", McGraw Hill.
2. John F. Koegel Buford, "Multimedia Systems", Addison Wesley.
3. Mark Nelson, "Data Compression Hand Book", BPB Publication.
4. Steinmetz, Ralf, Nahrstedt, Klara, "Multimedia System", Springer Publications.

WIRELESS SENSOR NETWORK

Weekly Teaching Hours	TH : 03	Tut: 01		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand the use of wireless sensor network for sensor data transmission.
B	To interpret and get familiarity to the different wireless transmission and reception technologies and topologies for sensor data.
C	To illustrate the different wireless protocols for the wireless sensor nodes.
D	To understand the different tiny OS and also able to choose the appropriate tiny OS for the sensor node.

Course Outcomes:

CO1	Learner will be able to identify the appropriate wireless trans-receiver for the different sensor data transmission and reception.
CO2	Learner will be able to design, develop and deploy the wireless sensor node.
CO3	Learner will be able to implement the tiny operating system on the sensor node.
CO4	Learner will be able to identify the energy consumption of the nose and to provide appropriate solution for energy optimization.

UNIT I

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.

UNIT II

Software (OS): tinyOS, MANTIS, Contiki, MagnetOS, OSPM, PicOS, SenOS, and RetOS. Programming tools: C, OMNET++, NS-2, J-Sim, GloMoSim, 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.

UNIT III

Medium Access Control Protocols for Wireless Sensor Networks: Fundamentals of MAC Protocols, Performance Requirements, Common Protocols,MAC Protocols for WSNs,Schedule-Based Protocols,Random Access-Based Protocols,Sensor-MAC Case Study, Protocol Overview, Periodic Listen and Sleep Operations, Schedule Selection and Coordination, Schedule Synchronization, Adaptive Listening, Access Control and Data

Exchange, Message Passing, IEEE 802.15.4 LR-WPANs Standard Case Study, PHY Layer, MAC Layer.

UNIT IV

Routing Protocols for Wireless Sensor Networks :Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless, Sensor Networks, Network Scale and Time-Varying Characteristics, Resource Constraints, Sensor Applications Data Models, Routing Strategies in Wireless Sensor Networks, WSN Routing Techniques, Flooding and Its Variants, Sensor Protocols for Information via Negotiation, Low-Energy Adaptive Clustering Hierarchy, Power-Efficient Gathering in Sensor Information Systems, Directed Diffusion, Geographical Routing,

UNIT V

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;

UNIT VI

Network Management for Wireless Sensor Networks: Network Management Requirements, Traditional Network Management Models, Simple Network Management Protocol, Telecom Operation Map, Network Management Design Issues, Example of Management Architecture: MANNA, Other Issues Related to Network Management, Naming, Localization.

Textbooks/References:

1. H. Karl and A. Willig. John, Protocols and Architectures for Wireless Sensor Networks. Wiley & Sons, June 2005
2. K. Sohraby, D. Minoli, and T. Znati, Wireless Sensor Networks: Technology, Protocols, and Applications, John Wiley & Sons, March 2007.
3. C. S. Raghavendra, K. M. Sivalingam, and T. Znati , Wireless Sensor Networks, Springer Verlag, Sep. 2006.
4. E. H. Callaway, Wireless Sensor Networks: Architectures and Protocols, Jr. AUERBACH, Aug. 2003.
5. B. Krishnamachari. Networking Wireless Sensors, Cambridge University Press, Dec. 2005.
6. F. Zhao and L. Guibas, Wireless Sensor Networks: An Information Processing Approach, Morgan Kaufmann, Jul. 2004.
7. N. P. Mahalik , Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications, Springer Verlag, Nov. 2006.
8. N. Bulusu and S. Jha, Wireless Sensor Networks: A Systems Perspective, Editors, Artech House, August 2005.

ELECTIVE III

CLOUD COMPUTING

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To analyze the components of cloud computing showing how business agility in an organization can be created.
B	To evaluate the deployment of web services from cloud architecture.
C	To evaluate the consistency of services deployed from a cloud architecture.
D	To compare and contrast the economic benefits delivered by various cloud models based on application requirements, economic constraints and business requirements.

Course Outcomes:

CO1	Learner will be able to analyze the trade-offs between deploying applications in the cloud and over the local infrastructure.
CO2	Learner will be able to compare the advantages and disadvantages of various cloud computing platforms.
CO3	Learner will be able to deploy applications over commercial cloud computing infrastructures such as Amazon Web Services, Windows Azure, and Google App Engine.
CO4	Learner will be able to analyze the performance, scalability, and availability of the underlying cloud technologies and software.
CO5	Learner will be able to solve a real-world problem using cloud computing through group collaboration.

UNIT I

Cloud Computing Fundamental: Cloud computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public vs private clouds, role of virtualization in enabling the cloud; Business Agility: Benefits and challenges to Cloud architecture. Application availability, performance, security and disaster recovery; next generation Cloud Applications.

UNIT II

Cloud Applications: Technologies and the processes required when deploying web services; Deploying a web service from inside and outside a cloud architecture, advantages and disadvantages

UNIT III

Cloud Services Management: Reliability, availability and security of services deployed from the cloud. Performance and scalability of services, tools and technologies used to manage cloud services deployment;

UNIT IV

Cloud Economics: Cloud computing infrastructures available for implementing cloud based services. Economics of choosing a Cloud platform for an organization, based on application requirements, economic constraints and business needs (e.g Amazon, Microsoft and Google, Salesforce.com, Ubuntu and Redhat)

UNIT V

Application Development: Service creation environments to develop cloud based applications. Development environments for service development; Amazon, Azure, Google App.

UNIT VI

Best Practice Cloud IT Model: Analysis of Case Studies when deciding to adopt cloud computing architecture. How to decide if the cloud is right for your requirements. Cloud based service, applications and development platform deployment so as to improve the total cost of ownership (TCO)

Textbooks/References:

1. Gautam Shroff, Enterprise Cloud Computing Technology Architecture Applications [ISBN: 978-0521137355]
2. Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach [ISBN: 0071626948]
3. Dimitris N. Chorafas, Cloud Computing Strategies [ISBN: 1439834539]

ELECTIVE III

MOBILE BROADBAND COMMUNICATION

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To study the different components of high speed wireless communication system.
B	To understand the design and development methodology for WiMAX network.
C	To understand the concept of the All-IP Networking.
D	To understand the Fundamental Constraints of the Higher Data Rates in wireless Communications.

Course Outcomes:

CO1	Learner will be able to understand the different concept of the high speed wireless communication systems.
CO2	Learner will be able to work with IPv4 and IPv6 addressing and the IP transmission protocols.
CO3	Learner will be able to understand the 4G, LTE, LTE advanced and its evolution toward 5G.
CO4	Learner will be able to understand the use of multimedia broadcast/multicast services and its architecture.

UNIT I

Introduction to Mobile Broadband: Introduction, Before 3G and Broadband, Cellular Communication, Broadband and WLAN/WiFi, 3G and Broadband Wireless, 3GPP2 Family, Broadband Wireless Access, Mobile WiMAX and 4G.

UNIT II

Basics of All-IP Networking: Introduction, IP Protocol ,IP Address Assignment, IPv6, IP Transmission, IP Routing Protocols, RIP Version 2, OSPF, BGP Version 4, Multicast IP, QoS for All-IP Network, Diff Serv: Differentiated Services, IntServ: Integrated Services, RSVP: Resource Reservation Protocol, MPLS: Multiprotocol Label Switching, DPI: Deep Packet Inspection, IP Header Compression, IP Security, Security Associations ,IP Tunneling, PPP: Point-to-Point Protocol, LCP Link Establishment, PPP Authentication, AAA, RADIUS, DIAMETER .EAP: Extensible Authentication Protocol. EAP-TLS, EAP-TTLS, EAP-AKA, Mobile IP, Route Optimization, Reverse Tunneling, PMIPv4: Proxy Mobile IPv4, Mobile IP for IPv6, PMIPv6: Proxy Mobile IPv6, SIP: Session Initiated Protocol, IMS: IP Multimedia Subsystem.

UNIT III

High Data Rates in Mobile Communication: High Data Rates: Fundamental Constraints, Higher Data Rates within a Limited Bandwidth: Higher-Order Modulation, Variations in Instantaneous Transmit Power, Wider Bandwidth Including Multi-Carrier Transmission

UNIT IV

LTE Radio Access: An Overview: Basic Principles, LTE Release 9, LTE Release 10 and IMT-Advanced, Terminal Capabilities, Radio-Interface Architecture, Overall System Architecture, Radio Protocol Architecture, Control-Plane Protocols, Physical Transmission Resources, Overall Time–Frequency Structure, Normal Sub frames and Mbsfn Sub frames, Carrier Aggregation, Frequency-Domain Location Of LTE Carriers, Duplex Schemes

UNIT V

Downlink Physical-Layer Processing: Transport-Channel Processing, Downlink Reference Signals, Multi-Antenna Transmission, Downlink L1/L2 Control Signaling, Uplink Physical-Layer Processing: Transport-Channel Processing, Uplink Reference Signals, Uplink Multi-Antenna Transmission, Uplink L1/L2 Control Signaling, Uplink Timing Alignment. Retransmission Protocols: Hybrid ARQ with Soft Combining, Radio-Link Control.

UNIT VI

Multimedia Broadcast/Multicast Services: Architecture, Overall Channel Structure and Physical-Layer Processing, Scheduling of MBMS Services Relaying: Relays in LTE, Overall Architecture, Backhaul Design for In band Relaying Spectrum and RF Characteristics: Spectrum for LTE, Flexible Spectrum USE, Flexible Channel Bandwidth Operation, Carrier Aggregation for LTE, Multi-Standard Radio Base Stations, Overview of RF Requirements for LTE, Output Power Level Requirements, Transmitted Signal Quality, Unwanted Emissions Requirements, Sensitivity and Dynamic Range, Receiver Susceptibility to Interfering Signal

Textbooks/References:

1. Mustafa Ergen, Mobile Broadband Including WiMAX and LTE, Springer Publication.
2. Erik Dahlman, Stefan Parkvall Johan Skold, 4G: LTE/LTE-Advanced for Mobile Broadband, 1/e, ISBN: 978012385489, Elsevier Publication.

ELECTIVE III

NETWORK PLANNING AND OPTIMIZATION

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To understand the need of the Radio Network Planning and Optimization.
B	To study the transmission network planning and optimization for cellular communication and adhoc networks.
C	To study the 3G and WCDMA network planning and deployment stages.

Course Outcomes:

CO1	Learner will be able to analyze the need of the network planning and able to optimize the required resources.
CO2	Learner will be able to prepare the optimized plan for the 2G wireless network.
CO3	Learner will be able to prepare the optimized plan for the 3G wireless network.

UNIT I

Radio Network Planning and Optimization: Radio Network Detailed Planning, Radio Network Optimization

UNIT II

Transmission Network Planning and Optimization: Pre-planning in Transmission Network, Detailed Transmission Network Planning, Transmission Network Optimization. Core Network Planning and Optimization: Core Network Planning Process, Core Network Optimization.

UNIT III

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.

UNIT IV

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

UNIT V

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

UNIT VI

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

Textbooks/References:

1. Ajay R. Mishra, Fundamentals of Cellular Network Planning and Optimisation 2G/2.5G/3G... Evolution to 4G, John Wiley & Sons, Ltd.
2. Lingyang Song, Jia She, Evolved Cellular Network Planning and Optimization for UMTS and LTE, CRC Press, ISBN: 9781439806494

ELECTIVE III

COOPERATIVE COMMUNICATIONS AND NETWORKING

Weekly Teaching Hours	TH: 03	Tut: --		
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:

A	To study the need of the cooperative communication networks.
B	To understand the different techniques for the cooperative communication.
C	To study and understand the energy consumption in the network and energy efficiency improvement using cooperative communication.

Course Outcomes:

CO1	Learner will be able to analyze the requirements of the cooperative communication systems.
CO2	Learner will be able to prepare the model for the multi-node cooperative communication.
CO3	Learner will be able to understand the differential modulation for cooperative communications.

UNIT I

Relay channels and protocols: Cooperative communications, Cooperation protocols, Hierarchical cooperation, Cooperative communications with single relay: System model, SER analysis for DF protocol, SER analysis for AF protocol, Comparison of DF and AF cooperation gains, Trans-modulation in relay communications.

UNIT II

Multi-node cooperative communications: Multi-node decode-and-forward protocol, Multi-node amplify-and-forward protocol, Distributed space–time and space–frequency coding: Distributed space–time coding (DSTC), Distributed space–frequency coding (DSFC), Relay selection: Motivation and relay-selection protocol, Performance analysis, Multi-node scenario Optimum power allocation

UNIT III

Differential modulation for cooperative communications: Differential modulation, Differential modulations for DF cooperative communications, Differential modulation for AF cooperative communications, Energy efficiency in cooperative sensor networks: System model, Performance analysis and optimum power allocation, Multi-relay scenario.

UNIT IV

Cognitive multiple access via cooperation: System model, Cooperative cognitive multiple access (CCMA) protocols, Stability analysis, Throughput, Delay analysis, Content-aware cooperative multiple access: System model, Content-aware cooperative multiple access protocol, Dynamic state model, Performance analysis, Access contention–cooperation tradeoff

UNIT V

Distributed cooperative routing : Network model and transmission modes , Link analysis , Cooperation-based routing algorithms , Simulation examples, Source–channel coding with cooperation: Joint source–channel coding bit rate allocation, Joint source–channel coding with user cooperation, The Source–channel–cooperation tradeoff problem, Source codec, Channel codec, Analysis of source–channel–cooperation performance , Validation of D-SNR characterization , Effects of source–channel–cooperation tradeoffs

UNIT VI

Asymptotic performance of distortion exponents: Systems setup for source–channel diversity, Multi-hop channels, Relay channels , Coverage expansion with cooperation: System model, Relay assignment: protocols and analysis , Relay assignment algorithms , Numerical results, Broadband cooperative communications : System model, Cooperative protocol and relay-assignment scheme, Performance analysis, Performance lower bound, Optimum relay location, Network lifetime maximization via cooperation: Introduction , System models, Lifetime maximization by employing a cooperative node , Deploying relays to improve device lifetime

Textbooks/References:

1. K.J.Rayliu, Ahmed K. Sadek, Weifeng Su, Andres Kwasinski, Cooperative Communications and Networking, CAMBRIDGE UNIVERSITY PRESS
2. Gerhard Kramer, Ivana Maric´, and Roy D. Yates, Cooperative Communications, now Publishers Inc.USA.
3. Zhengguo Sheng , Chi Harold Liu, Energy Efficient Cooperative Wireless Communication and Networks, CRC Press

ELECTIVE III
SOFT COMPUTING

Weekly Teaching Hours	TH: 03	Tut: --	
Scheme of Marking	TH: 60	Tests: 20 IA: 20	Total: 100

Course Objectives:

A	To provide in-depth understanding of fundamental theory and concepts of computational intelligence methods
B	To understand the fundamental theory and concepts of neural networks, neuro-modeling, several neural network paradigms and its applications.

Course Outcomes:

CO1	Learner will be able to articulate analogy of human neural network for understanding of artificial learning algorithms.
CO2	Learner will be able to analyze radial basis function network.
CO3	Learner will be able to analyze neural network architecture & basic learning algorithms.
CO4	Learner will be able to understand mathematical modeling of neurons, neural networks.
CO5	Learner will be able to analyze training, verification and validation of neural network models
CO6	Learner will be able to design Engineering applications that can learn using neural networks

UNIT I

Neural Networks: Introduction to Biological Neural Networks: Neuron physiology, Neuronal diversity, specification of the brain, the eye's Neural Network. Artificial Neural Network Concepts: Neural attributes, modeling learning in ANN, characteristics of ANN, ANN topologies, learning algorithm.

UNIT II

Neural Network Paradigm: MeCulloch-Pitts, Model, the perception, Back-propagation networks. Associative Memory, Adaptive Resonance (ART) paradigm, Hopfield Model, Competitive learning Model, Kohonen Self-Organizing Network.

UNIT III

Fuzzy Logic: Introduction to Fuzzy sets: Fuzzy set theory Vs Probability Theory, classical set theory, properties of Fuzzy sets, Operation on Fuzzy sets. Fuzzy relations, Operations of Fuzzy relation, the extension principle. Fuzzy Arithmetic, Approximate reasoning: Introduction, linguistic variables, Fuzzy proposition, Fuzzy if-then rules. Fuzzy Reasoning

UNIT IV

Fuzzy Inference Systems – Mamdani Fuzzy Models – Sugeno Fuzzy Models –Tsukamoto Fuzzy Models –Input Space Partitioning and Fuzzy Modeling

UNIT V

Genetic Algorithms: Fundamentals of Genetic Algorithms. Encoding, Fitness function, Reproduction, Genetic modeling: Cross over, Inversion & Deletion, Mutation Operator, Bit wise Operators, Convergence of Genetic Algorithm

UNIT VI

Swarm Intelligence: Introduction to swarm intelligence and key principles (e.g. self organization, stigmergy), neural and artificial examples, Computational and embedded SI, Foraging, trail lying, Open space, multi-source foraging experiments: biological data, microscopic experiments. Recent trends in soft computing

Textbooks/References:

1. George J Klir, B. Yuan, Fuzzy sets & fuzzy logic, Prentice Hall of India 1995.
2. E. Bonabeau, M. Dorigo, and G. Theraulaz, Swarm Intelligence: From Natural to Artificial Systems, Santa Fe Sciences of Complexity, Oxford University Press 1999.
3. Jacek M. Zurada, Introduction to Artificial Neural Systems Jaico Publishing House 1992.

ELECTIVE IV

SIGNAL PROCESSING AND SMART ANTENNAS FOR WIRELESS COMMUNICATION

Weekly Teaching Hours	TH: 03	Tut: --	
Scheme of Marking	TH: 60	Tests: 20 IA: 20	Total: 100

Course Objectives:

A	To instill research skills and bring in optimal solutions and novel products to Signal processing and allied application areas using modern technology and tools that are technically sound, economically feasible and socially acceptable.
B	To enable the graduates to engage in Signal processing and its broad range of applications to understand the challenges of the rapidly changing environment and adapt their skills through reflective and continuous learning.
C	To provide graduates strong mathematical skills and in depth knowledge in signal theory to analyze and solve complex problems in the domain of emerging wireless systems.
D	To get an understanding of signal processing techniques for emerging wireless systems.

Course Outcomes:

CO1	Learner will be able to discuss the wireless signaling environment and Performance issues.
CO2	Learner will be able to analyze the channel modeling and multiuser detection.
CO3	Learner will be able to analyze the Adaptive array processing and turbo coded CDMA.
CO4	Learner will be able to analyze Linear and nonlinear predictive techniques.
CO5	Learner will be able to analyze the Signal Processing Techniques for wireless reception.

UNIT I

Overview of wireless and mobile: Cellular system concepts, standards and Evolution of mobile & wireless communication technologies.

UNIT II

Wireless channel characterization: Attenuation, Shadowing, Fading, Doppler Shift, Delya Spread, Co-channel, Adjacent Channel and other forms of interferences. Modulation techniques: QAM, Multitone, MSK, OMSK, CPM, TFM and OFDM.

UNIT III

Receiver architecture and algorithms: Digital IF receivers, Sub-sampling digital receivers, I & Q channel sampling, Noncoherent and Coherent techniques, Rake receiver. Equalization and Synchronization: MLSE, Adaptive Equalization: LMS, RLS & Blind adjustment, Timing recovery and carrier

UNIT IV

Smart Antennas systems: Generalized array signal processing, Beam forming concepts: DOB, TRB & SSBF, Switched beam antennas, spatial diversity, and fully adaptive antennas for enhanced coverage, range extension & improvement in frequency refuse, interference Nulling for LOS & Multipath systems.

UNIT V

SDMA concepts and Smart antennas implementation issues.

UNIT VI

RF Ics: LNA, IQ Lodulator, Mixers, DSPs & Micro-controllers in wireless communications, ASICs and FPGAs.

Textbooks/References:

1. T.S. Rappaport, Wireless Communication: Principles & Practices, 2/e, 2002, Prentice Hall.
2. J. Liberti & T.S. Rappaport, Smart Antennas for Wireless Communication: IS-95 and Third Generation CDMS applications, 1999, Prentice Hall.
3. B. Pattan, Robust Modulation Methods and Smart Antennas in Wireless communications, 2000, Prentice Hall.e Lin, “Essential Issues in SOC Design, Designing Complex Systems-on-Chip”, Springer publication.

ELECTIVE IV

ADVANCE DIGITAL IMAGE PROCESSING

Weekly Teaching Hours	TH: 03	Tut: --	
Scheme of Marking	TH: 60	Tests: 20 IA: 20	Total: 100

Course Objectives:

A	To instill research skills and bring in optimal solutions and novel products to Image processing and allied application areas using modern technology and tools that are technically sound, economically feasible and socially acceptable.
B	To enable the graduates to engage in Image processing and its broad range of applications to understand the challenges of the rapidly changing environment and adapt their skills through reflective and continuous learning.
C	To provide graduates strong mathematical skills and in depth knowledge in image theory to analyze and solve complex problems in the domain of Image processing.
D	To design, analyze and implement algorithms for advanced image analysis like image compression, image segmentation etc.

Course Outcomes:

CO1	Learner will be able to develop and implement algorithms for digital image processing.
CO2	Learner will be able to examine various types of images, intensity transformations and applying various filtering techniques.
CO3	Learner will be able to develop critical thinking about shortcomings of the state of the art in image processing.
CO4	Learner will be able to identify the suitable image enhancement and restoration techniques based upon the application.
CO5	Learner will be able to show how higher-level image concepts such as edge detection, segmentation, representation can be implemented and used.
CO6	Learner will be able to manipulate both binary and grayscale digital images using morphological filters and operators to achieve a desired result.

UNIT I

Digital Image Fundamentals: Simple image model, Fundamentals Steps in Image Processing, Elements of visual perception, image sensing and acquisition, Image Sampling and Quantization, Basic relationships like Neighbors, Connectivity, Distance Measures between pixels, Linear and Non Linear Operations, Introduction to 2D Fourier Transform and Liner Algebra. Fundamental operations of image processing using image processing tool. **Passive**

UNIT II

Intensity Transformations and Filtering: Spatial intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing filters, sharpening filters, fuzzy techniques for intensity transformations and spatial filtering. Frequency domain filtering sampling and Fourier transform of sampled functions, Discrete Fourier transform, properties of DFT, smoothing and sharpening in frequency domain.

UNIT III

Color Image Processing and Wavelets: Color models, intensity slicing, color transformations, fundamentals of wavelets- image pyramids, subband coding, Harr transform, multi-resolution expansion- series scaling and wavelet functions, 1D wavelet transform-wavelet series expansion, discrete wavelet transform, continuous wavelet transform, fast wavelet transform, 2D wavelet transform, wavelet packets

UNIT IV

Image Compression fundamentals- coding redundancy, spatial and temporal redundancy, image compression models, image formats and compression standards, compression methods- Huffman coding, Golomb coding, Arithmetic coding, LZW, Run Length coding, wavelet coding, digital image watermarking

UNIT V

Morphological operations- dilation, erosion, duality, opening, closing, hit/miss transformation, boundary extraction, hole filling, extraction of connected components, thinning, thickening, skeletons, pruning.

UNIT VI

Image Segmentation and Object Recognition: fundamentals, detection of isolated point, line and edge detection, edge linking and boundary detection, global thresholding basics, multiple thresholds, variable thresholding, multivariable thresholding, region growing, region splitting and merging, morphological watersheds- dam construction, watershed segmentation algorithm, markers, segmentation using motion- spatial techniques, frequency domain techniques. Patterns and patterns classes, matching, optimal statistical classifier, neural network, matching shape numbers, string matching.

Textbooks/Reference:

1. Rafael C. Gonzalez & Richard E. Woods, “Digital Image Processing”, 2nd edition, Pearson Education.
2. A. K. Jain, “Fundamental of Digital Image Processing”, PHI.
3. William Pratt, “Digital Image Processing”, 4th Edition, Wiley India Edition.

ELECTIVE IV

ELECTROMAGNETICS, ANTENNA AND PROROGATION

Weekly Teaching Hours	TH: 03	Tut: --		
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:

A	To provide in-depth understanding of the electromagnetics concepts such as Stoke's theorem, Coulomb's Laws, Gauss's Law, Poisson's and Laplace's Equations, Biot-Savart Law, Ampere's Circuital Law, with their applications.
B	To provide an insight into various aspects of the radiation and antenna theory.
C	To provide in-depth understanding, construction & working of various microwave antennas, Identify and study the various parameters of microwave antenna.

Course Outcomes:

CO1	Learner will be able to analyze concept of electromagnetics.
CO2	Learner will be able to Identify and study the various design and performance parameters of microwave antenna.
CO3	Learner will be able to design microwave antennas for given specifications at RF and Millimeter wave frequencies.
CO4	Learner will be able to analyze and design the planer antennas.
CO5	Learner will be able to analyze the antenna arrays.
C06	Learner will be able to understand special antennas such as frequency independent and broad band antennas

UNIT I

Introduction, Vector Analysis, Coordiante systems and Transformations, Line, surface and volume integrals, Divergence Theorem, Stoke's theorem, Coulomb's Law, Electric Field, Electric flux density, Gauss's Law with Application, Electrostatic Potential and Equipotential Surfaces, Boundary conditions for Electrostatic fields, Capacitance and Capacitors, Electrostatic Energy and Energy Density, Poisson's and Laplace's Equations, Uniqueness Theorem, Method of Images, Electrostatic boundary value problem

UNIT II

Introduction, Current Density and Ohm's Law, Electromagnetic force and Kirchoff's Voltage Law, Continuity Equation and Kirchoff's Current Law, Power Dissipation and Joule's law, Biot- Savart Law and its Applications, Ampere's Circuital Law and its Applications, Magnetic Flux Density, Magnetic Scalar and Vector Potentials, Boundary Condition for Magnetic Fields, Inductance and Inductor, Energy stored in Magnetic Field, Faraday's Law of electromagnetic Induction, Maxwell's Equation, Boundary Conditions for Electromagnetic fields, Time

Harmonic Fields, The Helmhotz Equation, Plane waves in Lossless medium, Plane waves in a lossy medium, Poynting Vector and Power Flow in Electromagnetic Fields, Polarisation of plane wave, Behaviour of Plane waves at the inteface of two media

UNIT III

Introduction, Fundamentals of Radiation, Radiated field of an Herzian dipole, Basic Antenna Parameters, Half Wave Dipole Antenna, Quarter Wave Monopole Antenna, Small Loop Antennas, Introduction to Antenna Arrays, Finite difference Method, Basic Concepts of the Method of Moments, Method of Moment for Wire Antennas and Wire Scatterers

UNIT IV

Planar Antennas – Microstrip rectangular and circular patch antennas- Analysis and Design , feeding methods; circularly polarized microstrip antennas, broadbanding techniques. Printed slot antennas.

Array theory- linear array: broad side and end fire arrays; self and mutual impedance of between linear elements, grating lobe considerations.

UNIT V

Planar Array- array factor, beam width, directivity. Example of microstrip patch arrays and feed networks electronics scanning.

Broadband antennas- folded dipole, sleeve dipole, Biconical antenna – Analysis, characteristics, matching techniques. Yagi array of linear elements and printed version, Log-Periodic dipole array.

UNIT VI

Frequency Independent Antennas- planar spiral antennas, log periodic dipole array. Aperture antennas- field equivalence principle, Babinet's principle. Rectangular waveguide horn antenna, parabolic reflector antenna.

Antennas for mobile communication- handset antennas, base station antennas. Beam-steering and antennas for MIMO applications. Active and smart microstrip antennas. Design and analysis of microstrip antennas arrays.

Textbooks/References:

1. C. A. Balanis, Antenna Theory and design, John Wiley and sons, 1997.
2. J. D. Kraus, antennas, Mc-Graw-Hill, 1988.
3. R. A. Sainathi, CAD of microstrip antennas for wireless applications, Artech House, 1996.

ELECTIVE IV

FREE SPACE OPTICAL COMMUNICATION

Weekly Teaching Hours	TH: 03	Tut: --		
Scheme of Marking	TH: 60	Tests: 20	IA: 20	Total: 100

Course Objectives:

A	To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.
B	To provide an in-depth understanding needed to perform fiber-optic communication system engineering calculations, identify system tradeoffs, and apply this knowledge to modern fiber optic systems.

Course Outcomes:

CO1	Learner will be able to recognize and classify the structures of Optical fiber and types.
CO2	Learner will be able to demonstrate electromagnetic and mathematical analysis of light wave propagation.
CO3	Learner will be able to analyze fabrication techniques of different optical fibers.
CO4	Learner will be able to interpret behavior of pulse signal and various loss mechanism.
CO5	Learner will be able to interpret Dispersion compensation mechanism, Scattering effects and modulation techniques.
CO6	Learner will be able to interpret working of Fiber based devices.

UNIT I

Fundamentals of FSO Technology: Introduction – Maxwell's Equations – Electromagnetic wave propagation in free space - alternate bandwidth technologies – Fiber Vs FSO- Fiber Access – Overview of FSO Optical Transmitters – Receivers – Subsystems – Pointing, Acquisition and Tracking – Line of sight analysis.

UNIT II

FSO Networks: The Role of FSO in the network – factors affecting FSO – line of Sight (LOS) – selecting transmission wave integration of FSO in Optical networks – installation of FSO systems – moving towards edge – and residential areas.

UNIT III

Long Distance FSO Communication: The FSO model – Applications – System descriptions and design – Introduction to Laser Satellite Communications – Characteristics, Modulation Techniques and Radiation effects – Laser Sources.

UNIT IV

Optical Components for FSO: Optical waveguides – Optical Filters, Couplers, Amplifiers, Switches, Antennas, Interconnecting Equipment's, etc. – Optical integrated circuits – semiconductor integrated optic devices,

UNIT V

Optical Signal Processing: Analog and Discrete systems – Noise and Stochastic processes – Filters – Power spectra estimation – Ambiguity function, Wigner distribution function and triple correlations.

UNIT VI

Advance trends and technologies in free space optical communication.

Textbooks/References:

1. Willebrand, Heinz; Ghuman, Baksheesh, Free Space Optics: Enabling Optical Connectivity in Today's Networks, Sams Publishing, Indianapolis (2001)
2. Morris Katzman, Laser Satellite Communication, Englewood Cliffs, NJ, Prentice-Hall, Inc., 1987.
3. Hiroshi Nishihara, Masamitsu Haruna, Toshiaki Suhara, Optical Integrated Circuits, McGraw Hill Professional, 1989.
4. Pankaj K. Das, Optical signal processing: fundamentals, Springer publications.

ELECTIVE IV

ADVANCED SATELLITE COMMUNICATION

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide students with good depth of knowledge in radar and Satellite communication.
B	To prepare mathematical background for satellite communication signal analysis.
C	To provide the students for further studies and research knowledge of modern applications in Satellite communication.

Course Outcomes:

CO1	Learner will be able to apply knowledge of theory and practice related to Satellite communication
CO2	Learner will be able to identify, formulate and solve engineering problems related to radar and Satellite communication.
CO3	Learner will be able to analyze the various aspects of establishing a geo-stationary satellite communication link. etc.
CO4	Learner will be able to acquired knowledge about Satellite Navigation System.

UNIT I

Satellite Constellations: Introduction, Satellite Orbits, Orbital Mechanics Basics, Satellite Coverage, Space Environment, Eclipse on Satellites, The Sun's Interference, Doppler Effect, Orbital Debris, Summary of Orbital Characteristics, Satellite Constellations, Considerations in Constellation Design, Polar Constellations, Inclined Orbit Constellations , Hybrid Constellations ,Regional Coverage , Constellations for Non-Real-Time Systems, Use of Spot Beams, Availability Considerations for Non-Geostationary Satellites

UNIT II

Radio Link: Introduction, Spectrum Issues, Spectrum Sharing Methods, Spectrum Forecast Methodology, Propagation Characteristics, General Propagation Characteristics, Land Mobile Channel, Maritime Channel, Aeronautical Channel, System Implications, Radio Link Analysis, Fixed Earth Stations and User Terminals: Introduction, Gateways, User Terminals, Environmental Issues

UNIT III

System Architecture: Introduction, Air Interface, System Development, Network Consideration, Satellite Radio Interface Standards: GMR, Satellite Component of UMTS/IMT-2000, Interactive Mobile Broadband Broadcast Standard: DVB-S2/RCS+M

UNIT IV

Operational Considerations: Subscriber and Gateway Commissioning, Radio Resource Management, Radio Frequency Monitoring, Quality of Service, Licensing Issues

UNIT V

Commercial Issues: System Planning, Service Distribution Model, Billing Issues, Regulatory Issues, Traffic Forecast, End-User Perspective – A Case Study

UNIT VI

Mobile Satellite Broadcast Systems: Mobile Broadcast System Requirements, System Configuration, Space Segment, Transmission Technology, OSI Architecture in a Broadcast Context, Prevalent Transmission Systems, Receiver Architecture, DVB-SH System Architecture, Multimedia Broadcast and Multicast Services (MBMS), DBS Reception on Mobile Terminals

Textbooks/References:

1. Madhavendra Richharia, Mobile satellite communications principles and trends, John Wiley & Sons, Ltd, 2014.
2. Timothy Pratt, Charles W. Bostian, "Satellite communication:, John Wiley &sons, f 1986
3. Dennis Roddy, "Satellite Communication", TMH, 3ed, 2001
4. Wilbur L. Pritchard, Henri G. Suyderhoud, Robert A. Nelson, "Satellite Communication Systems Engineering," Prentice Hall, January 1993

ELECTIVE V
TCP/IP AND INTERNET

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH : 60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To provide advanced design, operation, and challenges of the Internet as a global network.
B	To give an exposure to a students with advanced insight into addressing, routing, and performance on the Internet, and understand recent developments such as IPv6 and mobility.
c	To give students research in the area of internet engineering

Course Outcomes:

CO1	Learner will be able describe the architecture of the Internet.
CO2	Learner will be able to describe the advanced functions performed by the Internet Protocol (IP) and supporting protocols (eg. ICMP, UDP).
CO3	Learner will be able to describe IP addressing and are able to design an internetwork with assigned addresses and NAT.
C04	Learner will be able to describe current technology trends for the implementation and deployment of TCP/IP and Internet.

UNIT I

The TCP/IP Architecture, The Internet Protocol: IP Packet, IP Addressing, Subnet Addressing, IP Routing, Classless Inter-Domain Routing (CIDR), Address Resolution, Reverse Address Resolution, Fragmentation and Reassembly, ICMP: Error and Control Messages. IpV6: header format, Network Addressing, Extension Headers

UNIT II

User Datagram Protocol transmission Control Protocol: TCP Reliable Stream Service, TCP Operation, TCP Protocol, DHCP and Mobile IP: Dynamic Host Configuration Protocol, Mobile IP.

UNIT III

Internet Routing Protocols: Routing Information Protocol, Open Shortest' Path First, Border Gateway Protocol .Multicast Routing: Reverse-Path Broadcasting, Internet Group Management Protocol (IGMP), Reverse-Path Multicasting, Distance-Vector Multicast Routing Protocol.

UNIT IV

Security and Cryptographic Algorithms: Applications of Cryptography to Security, Key Distribution. Security Protocols: IPSec, Secure Sockets Layer and Transport Layer Security Cryptographic Algorithms: DES, RSA,

UNIT V

Introduction to Digital Audio, Audio compression, Streaming Audio, Internet Radio, Voice over IP, Introduction to video, Video compression

UNIT VI

Video on demand The Real time transport Protocol: RTP Scenarios and terminology, RTP Packet format, RTP Control Protocol(RTCP) Session control Protocols: Session initiation Protocol, H.323 Multimedia communication systems, Media Gateway Control Protocols.

Textbooks/References:

1. Communication networks, Leon-Gracia & Widjaja,2001, TMH
2. An Engineering approach to computer networking, S. Keshav, Addison Wesley, 2001
3. TCP/IP Illustrated Volume 1: The protocols, 1/e--, W. Richard Stevens,Pearson Education

ELECTIVE V

HIGH PERFOMANCE COMMUNICATION NETWORKS

Weekly Teaching Hours TH : 03 Tut: --

Scheme of Marking TH : 60 Tests : 20 IA: 20 Total : 100

Course Objectives:

A	To understand the different terminologies of the broadband communication.
B	To study the different switching techniques used in the broadband communication system.
c	To understand the different concepts of the ATM and the optical communications.

Course Outcomes:

CO1	Learner will be able to describe the architecture of the Internet.
CO2	Learner will be able to differentiate the different switching techniques and its applications.
CO3	Learner will be able to explain the different functionalities of the ATM network.

UNIT I

Packet switched networks: OSI & IP models – Ethernet (IEEE 802.3) – Token Ring (IEEE 802.5) Wireless LAN (IEEE 802.11), FDDI-DQDB-SMDS: Internetworking with SMDS

UNIT II

ISDN and broadband ISDN: Interfaces and functions- Layers and Services – Signaling System 7- Broadband ISDN architecture and protocols.

UNIT III

ATM and frame relay: Main features, addressing, signaling & routing, ATM header structure adaptation layer management & control ATM switching & transmission. Frame relay Protocols & services, congestion control, internetworking with ATM, Internet and ATM Frame relay via ATM

UNIT IV

Optical networks: Optical Links, WDM system, Optical cross-connects, Optical LANs, Optical paths and networks

UNIT V

Bluetooth technology: Overview, protocol stack, link manager, Host controller interface, Service discovery protocol, WAP Applications, encryption and security, QoS.

UNIT VI

Advanced network architecture: IP forwarding architectures overlay model: Multi-protocol Label switching (MPLS) – integrated services in the Internet – Resource Reservation Protocol (RSVP): Differentiated services, Application Layer Protocols: FTP – File access and transfer, online shared access, sharing by file transfer, The Major view of FTP TFTP, SMTP, and HTTP.

Textbooks/References:

1. Jean Walrand, PravinVaraiya , High performance communication networks,2nd edition, Morgan Kaufmann Publication
2. William Stallings, ISDN and Broadband ISDN with Frame Relay and ATM, 4th Edition, Pearson Education.
3. Jennifer Bray and Charles Sturman, Bluetooth connect without cables, Pearson education Asia, LPE.
4. Leon Gracia, IndraWidjaja, Communication Networks-Fundamental concepts and Key architectures, McGraw Hill Companies.
5. Douglas Comer , Internetworking with TCP/IP – Principles, Protocols and Archtecture, 5th Edition , PHI Learning.
6. Behrouz Forouzan , Data Communications and Networking, 4th Edition , McFraw Hill.

ELECTIVE V
MULTIRATE SIGNAL PROCESSING

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To master the fundamentals of multirate signal processing and demonstrate the ability to solve problems in sample rate conversion, filter banks, and trans-multiplexers.

Course Outcomes:

CO1	Learner will be able to develop efficient realizations for up sampling and down sampling of signals using the polyphase decomposition
CO2	Learner will be able to design and implement Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters to meet specifications
CO3	Learner will be able to design digital filter banks based on the techniques presented
CO4	Learner will be able to analyze fundamental concepts of wavelets.
CO5	Learner will be able to distinguish between wavelets and multirate filter banks, from the point of view of implementation.

UNIT I

Fundamentals of Multirate Systems

Introduction, Basic multirate operations, Interconnection of building blocks, Polyphase representation, Mulstage implementation, Some application of multirate systems, Special filter and filter banks.

UNIT II

Maximally Decimaled Filter Banks

Introduction, Errors created in the QMF bank, A simple alias free QMF system, Power symmetric QMF banks, M-channel filter banks, Polyphase representation, Perfect reconstruction system, alias free filter banks, Tree structured filter banks, Transmultiplexer.

UNIT III

Paranitary Perfect Reconstruction Filter Banks

Introduction, Lossless transfer matrices, Filter banks properties induced by paraunitariness, Two channel FIR paraunitary QMF banks, Two channel paraunitary QMF lattice, M - channel FIR paraunitary filter banks, Tranform coding and LOT.

UNIT IV

Linear Phase and Cosine Modulated Filter Banks

Introduction, Some necessary conditions, Lattice structure for linear phase FIR PR banks, formal synthesis of linear phase FIR PR QMF Lattice. Pseudo QMF banks, Design of the pseudo QMF bank, Efficient polyphase structure, Cosine modulated perfect reconstruction system.

UNIT V

The Wavelet Transform and its Relation to Multirate Filter Banks

Introduction, Background and outline, Short time fourier transform, The Wavelet transform, DT orthonomal Wavelets, Continuous time orthonormal Wavelet basis.

UNIT VI

Multidimensional, Multivariable and Lossless Systems

Introduction, Multidimensional signals, Sampling a multidimensional Signals, Multirate fundamentals. Review of discrete time multi-input multi-output LTI System, ParaUNITary and lossless system.

Textbooks/References:

1. P.P.Vaidyanathan , Multirate System and Filter Banks PTR Prentice Hall, Englewood Cliffs , New Jersey,
2. N.J.Fliege , Multirate Digital Signal Processing, John Wiley & Sons.
3. Raghuveer Rao, Ajit Bopardikar, Wavelet Transforms Introduction to Theory and Application , Pearson Education Asia,
4. C. Sidney Burrus , R.A.Gopianath , Introduction to wavelet and wavelet Transform, Pretice Hall.

ELECTIVE V
INTERNET OF THINGS

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	Students will be explored to the interconnection and integration of the physical world and the cyber space.
B	To provide ability to design and develop IOT devices.

Course Outcomes:

CO1	Learner will be able to understand the meaning of internet in general and IOT in terms of layers, protocols, packets peer to peer communication
CO2	Learner will be able to interpret IOT working at transport layer with the help of various protocols
CO3	Learner will be able to understand IOT concept at data link layer
CO4	Learner will be able to apply the concept of mobile networking to the internet connected devices
CO5	Learner will be able to measure and schedule the performance of networked devices in IOT
CO6	Learner will be able to analyze the challenges involve in developing IOT architecture

UNIT I

Introduction: What is the Internet of Things: History of IoT, about objects/things in the IoT, Overview and motivations, Examples of applications, IoT definitions, IoT Frame work, General observations, ITU-T views, working definitions, and basic nodal capabilities.

UNIT II

Fundamental IoT Mechanisms & Key Technologies : Identification of IoT objects and services, Structural aspects of the IoT, Environment characteristics, Traffic characteristics ,scalability, Interoperability, Security and Privacy, Open architecture, Key IoT Technologies ,Device Intelligence, Communication capabilities, Mobility support, Device Power, Sensor Technology, RFID technology, Satellite Technology.

UNIT III

Radio Frequency Identification Technology: Introduction, Principles of RFID, Components of an RFID system, Reader, RFID tags, RFID middleware, Issue. Wireless Sensor Networks: History and context, node, connecting nodes, networking nodes, securing communication.

UNIT IV

Wireless Technologies For IoT : Layer ½ Connectivity : WPAN Technologies for IoT/M2M, Zigbee /IEEE 802.15.4, Radio Frequency for consumer Electronics (RF4CE), Bluetooth and

its low-energy profile , IEEE 802.15.6 WBANS, IEEE 802.15 WPAN TG4j, MBANS, NFC, dedicated short range communication(DSRC) & related protocols. Comparison of WPAN technologies cellular & mobile network technologies for IoT/M2M.

UNIT V

Governance of The Internet of Things: Introduction, Notion of governance, aspects of governance, Aspects of governance Bodies subject to governing principles, private organizations, International regulation and supervisor, substantive principles for IoT governance, Legitimacy and inclusion of stakeholders, transparency, accountability. IoT infrastructure governance, robustness, availability, reliability, interoperability, access. Future governance issues, practical implications, legal implications.

UNIT VI

Internet of Things Application Examples: Smart Metering, advanced metering infrastructure, e-Health/Body area network, City automation, automotive applications. Home automation, smart cards, Tracking, Over-The-Air passive surveillance/Ring of steel, Control application examples.

Textbooks/References:

1. Hakima Chaouchi, The Internet of Things, Connecting Objects to the Web, Wiley Publications
2. Daniel Minoli, Building the Internet of Things with IPv6 and MIPv6 The Evolving World of M2M Communications, Wiley Publications
3. Bernd Scholz-Reiter, Florian Michahelles, Architecting the Internet of Things, ISBN 978- 3842-19156-5, Springer.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things Key Applications and Protocols, ISBN 978-1-119-99435-0, Wiley Publications.

ELECTIVE V
RESEARCH METHODOLOGY

Weekly Teaching Hours	TH : 03	Tut: --		
Scheme of Marking	TH :60	Tests : 20	IA: 20	Total : 100

Course Objectives:

A	To develop a research orientation among the scholars and to acquaint them with fundamentals of research methods.
B	To develop understanding of the basic framework of research process.
C	To identify various sources of information for literature review and data collection.
D	To understand the components of scholarly writing and evaluate its quality.

Course Outcomes:

CO1	Student will learn the meaning, objective , motivation and type of research
CO2	Student will be able to formulate their research work with the help of literature review
CO3	Student will be able to develop an understanding of various research design and techniques.
CO4	Student will have an overview knowledge of modeling and simulation of research work
CO5	Student will be able to collect the statistical data with different methods related to research work.
CO6	Student will be able to write their own research work with ethics and non-plagiarized way.

UNIT I

Introduction: Defining research, Motivation and Objectives, Types of research

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research

UNIT II

Research Formulation: Formulating The research Problem, Literature Review, Development of Working Hypothesis

UNIT III

Research Design: Important Concept in Research Design, Research Life Cycle, Developing Research Plan

UNIT IV

Overview of Modeling and Simulation: Classification of models, Development of Models, Experimentation, Simulation.

UNIT V

Statistical Aspects: Methods of Data Collection, Sampling Methods, Statistical analysis, Hypothesis testing.

UNIT VI

Research Report: Research Ethics, Plagiarism, Research Proposal, Report Writing and Writing Research Papers.

Textbooks/References:

1. J.P. Holman, Experimental Methods for Engineers, Mcgraw-Hill publication.
2. C.R. Kothari, Research Methodology Methods & Techniques, New Age International publication.

SEMINAR I

Weekly Teaching Hours	TH: -	Practical: 04	
Scheme of Marking	IA: 50	PR/OR: 50	Total: 100

The seminar shall be on the state of the art in the area of the wireless communication and computing and of student's choice approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work duly signed by the concerned guide and head of the Department/Institute.

MINI PROJECT

Weekly Teaching Hours	TH: -	Practical: 04	
Scheme of Marking	IA: 50	PR/OR: 50	Total: 100

The mini project shall be based on the recent trends in the industry, research and open problems from the industry and society. This may include mathematical analysis, modelling, simulation, and hardware implementation of the problem identified. The mini project shall be of the student's choice and approved by the guide. The student has to submit the report of the work carried out in the prescribed format signed by the guide and head of the department/institute.

PROJECT MANAGEMENT AND INTELLECTUAL PROPERTY RIGHTS

Weekly Teaching Hours	TH: -	Practical: -	
Scheme of Marking	IA: 50	PR/OR: 50	Total: 100

The Student has to choose this course either from NPTEL/MOOCs/SWAYAM pool. It is mandatory to get the certification of the prescribed course.

PROJECT-I

Weekly Teaching Hours	TH: -	Practical: -	
Scheme of Marking	IA: 50	PR/OR: 50	Total: 100

Project-I is an integral part of the final project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation that may include mathematical model/SRS/UML/ERD/block diagram/ PERT chart, and layout and design of the proposed system/work. As a part of the progress report of project-I work, the candidate shall deliver a presentation on progress of the work on the selected dissertation topic.

It is desired to publish the paper on the state of the art on the chosen topic in international conference/ journal.

The student shall submit the duly certified progress report of project -I in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.

PROJECT-II

Weekly Teaching Hours	TH: -	Practical: -	
Scheme of Marking	IA: 100	PR/OR: 100	Total: 200

In Project - II, the student shall complete the remaining part of the project which will consist of the simulation/ analysis/ synthesis/ implementation / fabrication of the proposed project work, work station, conducting experiments and taking results, analysis and validation of results and drawing conclusions.

It is mandatory to publish the paper on the state of the art on the chosen topic in international conference/ journal.

The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work duly signed by the concerned guide and head of the department/institute.