KAMARAJ
COLLEGE OF ENGINEERING & TECHNOLOGY
(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)
S.P.G.Chidambara Nadar - C.Nagammal Campus
S.P.G.C.Nagar, K.Vellakulam - 625 701 (Near Virudhunagar), Madurai District.

M.E COMMUNICATION AND NETWORKING

(Regulations 2020 – Autonomous)

Sl. No	Category of Courses	Credits
1.	Foundation Courses - Humanities and Social Sciences including Management Courses, Basic Science and Engineering Science Courses (HS+BS+ES)	04
2.	Professional Core Courses (PC)	28
3.	Professional Elective Courses (PE)	15
4.	Open Elective Courses (OE)	03
5.	Employability Enhancement Courses (EEC)	19
6.	Online Courses (OC)	03
7.	Audit Courses (AC)	---
8.	Value Added Courses	---
	Total	**72**

M.E – Communication & Networking (Credits Allocation to Individual Semesters)					
Semester	I	II	III	IV	**Total**
Credits	21	21	18	12	**72**

Credit Distribution to Individual Semesters:

S. No.	Category of Courses	Credits	I	II	III	IV
1.	Foundation Courses (FC)	4 credits	4 credit	-	-	-
2.	Professional Core (PC)	28 credits	14 credit	11 credit	3 credit	-
3.	Professional Elective (PE)	15 credits	3 credit	6 credit	6 credit	-
4.	Employability and Enhancement Course (EEC)	19 credits	-	1 credit	6 credit	12 credit
5.	Open Elective (OE)	3 credits	-	-	3 credit	-
6.	Online Course (OC)	3 credits	-	3 credit	-	-
7.	Audit Course (AU) – (may be recommended but not mandatory)	-	-	-	-	-
	Total	**72**	**21**	**21**	**18**	**12**

SEMESTER - I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA1102	Applied Mathematics for Communication Engineers	FC	4	4	0	0	4
2	CN1101	Advanced Digital Communication Techniques	PC	3	3	0	0	3
3	CN1102	Advanced Digital Signal Processing	PC	4	3	0	0	3
4	CN1103	Advanced Wireless Communications Systems	PC	3	3	0	0	3
5	CN1104	Communication Networks Modelling and Simulation	PC	3	3	0	0	3
6		Professional Elective - I	PE	3	3	0	0	3
PRACTICALS								
7	CN1111	Communication Systems Laboratory	PC	4	0	0	4	2
			Total	25	19	0	4	21

SEMESTER - II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	CN1201	Advanced Wireless Networks	PC	3	3	0	0	3
2	CN1202	Cognitive Radio Networks	PC	3	3	0	0	3
3	CN1203	Communication Network Security	PC	3	3	0	0	3
4		Professional Elective - II	PE	3	3	0	0	3
5		Professional Elective - III	PE	3	3	0	0	3
6		Online Course - I	OC	3	3	0	0	3
PRACTICALS								
7	CN1211	Networking Laboratory	PC	4	0	0	4	2
8	CN1221	Term Paper Writing and Seminar	EEC	2	0	0	2	1
			Total	24	18	0	6	21

SEMESTER - III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	CN1301	Internet of Things	PC	3	3	0	0	3
2		Professional Elective - IV	PE	3	3	0	0	3
3		Professional Elective - V	PE	3	3	0	0	3
4		Open Elective - I	OC	3	3	0	0	3
PRACTICALS								
5	CN1321	Project Work Phase - I	EEC	12	0	0	12	6
			Total	24	12	0	12	18

SEMESTER - IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1	CN1421	Project Work Phase - II	EEC	24	0	0	24	12
			Total	24	0	0	24	12

PROFESSIONAL ELECTIVES

SEMESTER - I

PROFESSIONAL ELECTIVE - I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	CN1131	Analysis and Design of CMOS Analog Integrated Circuits	PE	3	3	0	0	3
2	CN1132	MEMS and NEMS	PE	3	3	0	0	3
3	CN1133	Real Time Embedded Systems	PE	3	3	0	0	3
4	CN1134	RF Integrated Circuits	PE	3	3	0	0	3
5	CN1135	Signal Integrity for High Speed Design	PE	3	3	0	0	3
6	CN1136	Soft Computing Techniques	PE	3	3	0	0	3

SEMESTER - II

PROFESSIONAL ELECTIVE - II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	CN1231	Advanced Satellite Communication and Navigation Systems	PE	3	3	0	0	3
2	CN1232	Detection and Estimation Theory	PE	3	3	0	0	3
3	CN1233	Digital Communication Receivers	PE	3	3	0	0	3
4	CN1234	Electromagnetic Interference and Compatibility	PE	3	3	0	0	3
5	CN1235	Parallel Processing	PE	3	3	0	0	3
6	CN1236	VLSI for Wireless Communication	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE - III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	CN1237	Advanced Digital Image Processing	PE	3	3	0	0	3
2	CN1238	Fundamentals of Cloud Computing	PE	3	3	0	0	3
3	CN1239	Network Management	PE	3	3	0	0	3
4	CN1240	Pattern Recognition and Machine Learning	PE	3	3	0	0	3
5	CN1241	Radar Signal Processing	PE	3	3	0	0	3
6	CN1242	Speech Processing and Synthesis	PE	3	3	0	0	3

SEMESTER - III

PROFESSIONAL ELECTIVE - IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	CN1331	Broad Band Wireless Access Technologies	PE	3	3	0	0	3
2	CN1332	DSP Processor Architecture and Programming	PE	3	3	0	0	3
3	CN1333	Network Processors	PE	3	3	0	0	3
4	CN1334	Software Defined Radio	PE	3	3	0	0	3
5	CN1335	Space Time Wireless Communication	PE	3	3	0	0	3
6	CN1336	Wavelet Transforms and its Applications	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE - V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	CN1337	Game theory for Wireless Communication and Networking	PE	3	3	0	0	3
2	CN1338	Multimedia Compression Techniques	PE	3	3	0	0	3
3	CN1339	Network Routing Algorithms	PE	3	3	0	0	3
4	CN1340	Optical Networks	PE	3	3	0	0	3
5	CN1341	Ultra Wide Band Communication	PE	3	3	0	0	3
6	CN1342	Wireless Adhoc and Sensor Networks	PE	3	3	0	0	3

M.E COMMUNICATION AND NETWORKING

Open Electives (Offered to other departments)

SEMESTER - III

OPEN ELECTIVE - I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	OCN151	Biosensors	OE	3	3	0	0	3
2	OCN152	Computer Vision and Applications	OE	3	3	0	0	3
3	OCN153	Machine Learning using Python	OE	3	3	0	0	3
4	OCN154	Medical Image processing	OE	3	3	0	0	3
5	OCN155	Basics of MEMS and NEMS	OE	3	3	0	0	3
6	OCN156	Soft Computing	OE	3	3	0	0	3

Semester - I

MA1102 APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS

L	T	P	C
4	0	0	4

OBJECTIVES:

- To encourage students to develop a working knowledge of the central ideas of Matrix Theory and Numerical Methods that will come in convenient to solve numerically the problems that arise in engineering
- To develop a fundamental understanding of linear programming models and apply the simplex method for solving linear programming problems.
- To analyze the Graph algorithms and understand their applications in Networks and acquire skills in analyzing Queuing Models.

UNIT I MATRIX THEORY **12**

Eigen values using QR transformations – QR factorization – generalized eigenvectors – Canonical forms – singular value decomposition and applications – pseudo inverse – least square approximations --Toeplitz matrices and some applications

UNIT II LINEAR PROGRAMMING **12**

Formulation – Graphical solution – Simplex method – Big M method - Two phase method - Transportation problems - Assignment models.

UNIT III NUMERICAL SOLUTION OF INITIAL AND BOUNDARY VALUE PROBLEMS **12**

Runge - Kutta method of fourth order for system of IVPs – Numerical stability of Runge – Kutta method -–Adams - Bashforth multistep method – BVP: Finite difference method, Numerical solution of Elliptic and Hyperbolic Equations.

UNIT IV GRAPH ALGORITHMS **12**

Graphs – Sub graphs – Complements – Graph isomorphism – Eulerian graphs –Hamiltonian graphs - Planar graphs– Kruskals algorithm – Dijkstras shortest path algorithm, Prims algorithm– Transport Networks.

UNIT V QUEUEING MODELS **12**

Poisson Process – Markovian queues – Single and multi - server models – Little's formula - Machine interference mode - Steady state analysis – Self service queue

Total Periods: 60

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Understand the concepts of decomposition of the matrices into required form.

CO2: Develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.

CO3: Solve Initial and Boundary value problems numerically.

CO4: Apply Graph Theory algorithms in networks.

CO5: Demonstrate the basic characteristic features of a queuing system and using discrete time Markov chains to model computer systems

REFERENCES:

1. Bronson.R & Costa.G.B, 2007, *Linear Algebra*, Academic Press.
2. Taha.H.A, 2016, *Operations Research: An Introduction*, 9th Edition, Pearson Education Asia, New Delhi.
3. Balakrishnan.R & Ranganathan.K, 2012, *A textbook of Graph theory*, 2nd Edition, Springer, New York.
4. Sastry.S.S, 2015, *Introductory Methods of Numerical Analysis*, 5th Edition, PHI Learning.
5. Gross.D, Shortle.J.F, Thompson.J.M & Harris.C.M, 2014, *Fundamentals of Queuing Theory*, 4th Edition, Wiley.

CN1101	**ADVANCED DIGITAL COMMUNICATION TECHNIQUES**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of signal-space analysis and digital transmission.
- To understand the coherent and noncoherent receivers and its impact on different channel characteristics.
- To understand the different Equalizers
- To understand the different block coded and convolutional coded digital communication systems.
- To understand the basics of Multicarrier and Multiuser Communications

UNIT I COHERENT AND NON-COHERENT COMMUNICATION **9**

Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation – Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; M-DPSK-BER Performance Analysis. Carrier Synchronization- Bit synchronization.

UNIT II EQUALIZATION TECHNIQUES **9**

Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Equalization algorithms – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

UNIT III BLOCK CODED DIGITAL COMMUNICATION **9**

Architecture and performance – Binary block codes; Orthogonal; Biorthogonal; Transorthogonal – Shannon's channel coding theorem; Channel capacity; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hammning; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes.

UNIT IV CONVOLUTIONAL CODED DIGITAL COMMUNICATION **9**

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram – Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods – Error probability performance for BPSK and Viterbi algorithm, Turbo Coding.

UNIT V MULTICARRIER AND MULTIUSER COMMUNICATIONS **9**

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation. Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Interpret the concept of signal space analysis for coherent and non-coherent receivers.

CO2: Demonstrate the different equalization techniques for controlling ISI effect.

CO3: Construct the concept of source coding technique for calculating capacity of the system & linear coding for error controlling.

CO4: Solve the error detection and error correction problem by cyclic coding during data transmission.

CO5: Infer about the generation of OFDM signals and the techniques of multiuser detection.

REFERENCES:

1. Bernard Sklar, 2001, *Digital Communications*, Second Edition, Pearson Education, University of California, Los Angeles.
2. John G. Proakis, 2008, *Digital Communication*, Fifth Edition, Mc Graw Hill Publication.
3. Simon.M.K, Hinedi.S.M & Lindsey.W.C, 1995, *Digital communication techniques; Signal Design and Detection*, Prentice Hall of India, New Delhi.
4. Richard Van Nee & Ramjee Prasad, 2001, *OFDM for Multimedia Communications*, Artech House Publication.
5. Simon Haykin, 1998, *Digital communications*, John Wiley and sons.
6. Stephen G. Wilson, 2003, *Digital Modulation and Coding*, First Indian Reprint, Pearson Education.
7. Theodore S.Rappaport, 2002, *Wireless Communications*, Second edition, Pearson Education.

CN1102 ADVANCED DIGITAL SIGNAL PROCESSING L T P C

3 0 0 3

OBJECTIVES:

- To learn and understand the concepts of stationary and non-stationary random signals and analysis & characterization of discrete-time random processes
- To enunciate the significance of estimation of power spectral density of random processes
- To introduce the principles of optimum filters such as Wiener and Kalman filters
- To introduce the principles of adaptive filters and their applications to communication engineering
- To introduce the concepts of multi rate digital signal processing

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9

Wide sense stationary process – Ergodic process – Mean – Variance - Auto-correlation and Auto-correlation matrix - Properties - Weiner Khitchine relation - Power spectral density – filtering random process, Spectral Factorization Theorem–Finite Data records, Simulation of uniformly distributed/Gaussian distributed white noise – Simulation of Sine wave mixed with Additive White Gaussian Noise.

UNIT II SPECTRUM ESTIMATION – NON PARAMETRIC METHODS 9

Bias and Consistency of estimators - Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Welch estimation.

UNIT III SPECTRUM ESTIMATION – PARAMETRIC METHODS 9

Model based approach - AR, MA, ARMA Signal modeling - Parameter estimation using Yule-Walker method - Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion – Wiener filter - Discrete Wiener Hoff equations – Mean square error.

UNIT IV LINEAR ESTIMATION AND PREDICTION 9

Recursive estimators - Kalman filter - Linear prediction – Forward prediction and Backward prediction, Prediction error - Whitening filter, Inverse filter - Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.

UNIT V ADAPTIVE FILTERS 9

FIR Adaptive filters - Newton's steepest descent method - Adaptive filters based on steepest descent method - Widrow Hoff LMS Adaptive algorithm - Adaptive channel equalization - Adaptive echo canceller - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS – Sliding window RLS - Simplified IIR LMS Adaptive filter.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Apply the concepts of random process in practical applications.

CO2: Demonstrate spectrum estimation using non parametric methods.

CO3: Demonstrate spectrum estimation using parametric methods.

CO4: Model linear estimation and prediction for a given communication application.

CO5: Apply appropriate adaptive algorithm for processing non-stationary signals

REFERENCES:

1. John G. Proakis & Dimitris G. Manolakis, 2005, *Digital Signal Processing*, Prentice Hall of India, New Delhi.
2. Monson H. Hayes, 2006, *Statistical Digital Signal Processing and Modeling*, John Wiley and Sons Inc., New York.
3. Vaidyanathan.P.P, 1992, *Multirate Systems and Filter Banks*, Prentice Hall.
4. Sophoncles J. Orfanidis, 2000, *Optimum Signal Processing*, McGraw Hill.
5. Simon Haykin, 1986, *Adaptive Filter Theory*, Prentice Hall, Englehood Cliffs,
6. Kay.S, 1988, *Modern spectrum Estimation theory and application*, Prentice Hall, Englehood Cliffs.

CN1103	ADVANCED WIRELESS COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the MIMO System model
- To understand Concepts of MIMO diversity and spatial multiplexing.
- To learn Massive MIMO system
- To know millimeter wave communication
- T0 discuss about Software Define Radio & Cognitive Radio

UNIT I INFORMATION THEORETIC ASPECTS OF MIMO **10**

Review of SISO fading communication channels, MIMO Channel models, Classical i.i.d. and extended channels, Frequency selective and correlated channels models, Capacity of MIMO channels, Erogodic and outage capacity, capacity bounds and influence of channel properties on the capacity

UNIT II MIMO DIVERSITY AND SPATIAL MULTIPLEXING **10**

Sources and types of diversity, analysis under Rayleigh fading, Diversity and channel knowledge. Alamouti space time code. MIMO spatial multiplexing: Space time receivers, ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade - off.

UNIT III MASSIVE MIMO SYSTEM **9**

Introduction - MIMO for LTE, capacity of massive MIMO, Pilot Design for massive MIMO, Resource allocation and transceivers design, Base band and RF implementation, Channel Models.

UNIT IV MILLIMETER WAVE COMMUNICATION **8**

Spectrum regulation, Channel propagation, Hardware technology for mmW systems, architecture and mobility, Beam forming techniques, Beam finding, Physical layer techniques - Duplex scheme and Transmission Scheme.

UNIT V SOFTWRE DEFINED RADIO AND COGNITIVE RADIO **8**

SDR - Definition, Origin, key characteristic, hardware and software architecture, waveforms. Cognitive Radio - Definitions, Cognitive theories, architectures, Cognitive radio as self controlling system, Ontology based cognitive radio.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Infer about the channel model, ergodic and outage capacity of MIMO.

CO2: Outline the diversity techniques, spatial multiplexing & receiver techniques used in MIMO.

CO3: Interpret the theoretical aspects of massive MIMO.

CO4: Summarize the different channel, spectrum & architecture of millimeter wave communication.

CO5: Demonstrate the architecture, design issues & Challenges of software defined radio & cognitive radio.

REFERENCES:

1. David Tse & Pramod Viswanath, 2005, *Fundamentals of Wireless Communication*, Cambridge University Press.
2. Hamid Jafarkhani, 2005, *Space - Time Coding: Theory and Practices*, Cambridge University Press.
3. Mischa Dohler & Jose F. Monserrat Afif Osseiran, 2016, *5G Mobile and Wireless Communication Technology*, Cambridge University Press.
4. Mieczyslaw.M.Kokar & Lezek Lechowicz, 2016, *Cognitive Radio Interoperability through Waveform Reconfiguration*, ARTECH House.

CN1104	**COMMUNICATION NETWORKS MODELING AND SIMULATION**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn Modeling and Simulation
- To understand Monte Carlo Simulation
- To study Channel Modeling and Mobility Modeling

UNIT I INTRODUCTION TO MODELING AND SIMULATION **9**

Introduction, Discrete-event Simulation, Modeling for Computer Simulation, Tools and Methods for Network Simulation, The Simulation Platform, Simulation Framework, Tools and Modeling Approaches for Simulating Hardware.

UNIT II MONTE CARLO SIMULATION **9**

Fundamental concepts, Application to communication systems, Monte Carlo integration, Semi analytic techniques, Case study: Performance estimation of a wireless system.

UNIT III LOWER LAYER & LINK LAYER WIRELESS MODELING **9**

Physical Layer Modeling, Description of the Main Components of the PHY Layer, Accurate Simulation of Physical Layers, Physical Layer Modeling for Network Simulations, Link Layer Modeling, Medium Access Control (MAC) Protocols, Logical Link Control, Forward Error Detection and Correction, Backward Error Detection and Correction, Queueing and Processing Delay.

UNIT IV CHANNEL MODELING & MOBILITY MODELING **9**

Channel Modeling: The Physics of Radiation, The Nature of Electromagnetic Radiation, Classification of Propagation Models, Deterministic Approaches by Classical Field Theory, Deterministic Geometric Optical Approaches, Empirical Path Loss Approaches, Stochastic Shadowing Models, Stochastic Fading Models, MIMO Channel Models. Mobility modeling: Categorization of Mobility Models, Mobility Models, Random Walk Model, Random Waypoint Model, Random Direction Model, Gauss-Markov Model, Manhattan Model, Column Model , Pursue Model, Nomadic Community Model, Selection of Appropriate Mobility Models.

UNIT V HIGHER LAYER MODELING & MODELING THE NETWORK TOPOLOGY **9**

Higher Layer Modeling: Modeling the Network Layer and Routing Protocols, Components of a Routing Protocol, Metrics, Virtual Routing on Overlays, Modeling Transport Layer Protocols, Modeling Application Traffic. Modeling the Network Topology: Abstraction of Network Topologies by Graphs, Characterizing Graphs, Common Topology Models, Geometric Random Graphs – The Waxman Model, Hierarchical Topologies, Preferential Linking – The Barabási-Albert Model, Modeling the Internet.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Illustrate the concept of modeling and simulation.

CO2: Make use of Monte Carlo simulation.

CO3: Explain the Lower Layer and Link Layer Wireless Modeling.

CO4: Outline the Channel Modeling and Mobility Modeling.

CO5: Illustrate the concept of Higher Layer Modeling & Modeling the network topology

REFERENCES:

1. Wehrie.K.Gunes & Gross.J, 2010, *Modeling and Tools for Network Simulation*, Springer.
2. William.H.Tranter, K.Sam Shanmugam, Theodore.S.Rappaport & Kurt.L.Kosbar, 2004, *Principles of Communication Systems Simulation*, Pearson Education Pvt. Ltd., Singapore.
3. Irene Karzela, 1998, *Modeling and Simulating Communications Networks*, Prentice Hall India.

4. Jeruchim.M.C, Balaban.P & Sam Shanmugam.K, 2001, *Simulation of Communication Systems: Modeling, Methodology and Techniques*, Plenum Press, New York.
5. Nejat Bragg & Arnold, 2007, *Recent Advances in Modeling and Simulation Tools for Communication Networks and Services*, Springer.
6. https://www.nsnam.org/docs/release/3.18/tutorial/ns-3-tutorial.pdf

CN1111 COMMUNICATION SYSTEMS LABORATORY L T P C

0 0 4 2

OBJECTIVES:

- To understand the functioning of various modulation & coding techniques in Wireless Environment.
- To understand the functioning of adaptive filters and equalizers
- To understand wireless channel simulation and path loss measurements
- To understand about the OFDM, MIMO and STBC.

LIST OF EXPERIMENTS

1. Simulation of Modulation and Coding in a AWGN/ wireless Communication Channel using SDR kit / Simulation Packages.
2. Implementation of Linear and Cyclic Codes
3. Implementation of Adaptive Filters, periodogram & multistage multirate system in DSP Processor
4. Simulation of QMF using Simulation Packages.
5. Wireless Channel simulation and characterization
6. Path loss Measurement and Characterization of Wireless Channels
7. Wireless Channel equalizer design (ZF / LMS / RLS) using Simulation Packages.
8. OFDM transceiver design using Simulation Packages.
9. Simulation of MIMO systems using Simulation Packages.
10. Implementation of STBC using Simulation Packages

Total Periods: 60

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Design various modulation and coding techniques for wireless environment

CO2: Design various filters for wireless environment

CO3: Design various equalizers for wireless environment

CO4: Analyze the OFDM signals

CO5: Design MIMO system with STBC

Semester – II

CN1201	ADVANCED WIRELESS NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study about advanced wireless network, LTE, 4G and Evolutions from LTE to LTE.
- To study about wireless IP architecture, Packet Data Protocol and LTE network architecture
- To study about adaptive link layer, hybrid ARQ and graphs routing protocol.
- To study about mobility management, cellular network and micro cellular networks

UNIT I INTRODUCTION **9**

Introduction to 1G/2G/3G/4G Terminology. Evolution of Public Mobile Services -Motivation for IP Based Wireless Networks -Requirements and Targets for Long Term Evolution (LTE) - Technologies for LTE- 4G Advanced Features and Roadmap Evolutions from LTE to LTE-A - Wireless Standards. Network Model-Network Connectivity-Wireless Network Design with Small World Properties

UNIT II WIRELESS IP NETWORK ARCHITECTURES **9**

3GPP Packet Data Networks - Network Architecture - Packet Data Protocol (PDP) Context - Configuring PDP Addresses on Mobile Stations - Accessing IP Networks through PS Domain – LTE network Architecture - Roaming Architecture- Protocol Architecture- Bearer Establishment Procedure -Inter-Working with other RATs.

UNIT III ADAPTIVE LINK AND NETWORK LAYER **9**

Link Layer Capacity of Adaptive Air Interfaces-Adaptive Transmission in Ad Hoc Networks-Adaptive Hybrid ARQ Schemes for Wireless Links-Stochastic Learning Link Layer Protocol-Infrared Link Access Protocol-Graphs and Routing Protocols-Graph Theory-Routing with Topology Aggregation-Network and Aggregation Models.

UNIT IV MOBILITY MANAGEMENT **9**

Cellular Networks-Cellular Systems with Prioritized Handoff-Cell Residing Time Distribution-Mobility Prediction in Pico- and Micro-Cellular Networks

UNIT V QUALITY OF SERVICE **9**

QoS Challenges in Wireless IP Networks - QoS in 3GPP - QoS Architecture, Management and Classes -QoS Attributes - Management of End-to-End IP QoS - EPS Bearers and QoS in LTE networks.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Interpret the latest 4G networks and LTE.

CO2: Explain about the wireless IP architecture and LTE network architecture.

CO3: Outline the adaptive link layer and network layer graphs and protocol.

CO4: Understand about the mobility management and cellular network.

CO5: Explain about the wireless sensor network architecture and its QoS parameters.

REFERENCES:

1. Ayman El-Nashar, Mohamed El-Saidny & Mahmoud Sherif, 2014, *Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach*, John Wiley & Sons.
2. Yi-Bil Ling & Ai-Chun Pang, 2005, *Wireless and Mobile All-IP Networks*, Wiley Publication.
3. Jyh-Cheng Chen & Tao Zhang, 2006, *IP-Based Next-Generation Wireless Networks Systems, Architectures, and Protocols*, John Wiley & Sons Inc. Publication.
4. Minoru Etoh, 2005, *Next Generation Mobile Systems 3G and Beyond*, Wiley Publications.
5. Stefania Sesia, Issam Toufik & Matthew Baker, 2011, *LTE – The UMTS Long Term Evolution From Theory to Practice*, Second Edition , John Wiley & Sons, Inc. Publication.
6. SavoGlisic, 2016, *Advanced wireless networks-technology and business models*, Third Edition, John Wiley & Sons Ltd.
7. Savo Glisic, 2006, *Advanced Wireless Networks-4G Technologies*, John Wiley & Sons Ltd.

CN1202 COGNITIVE RADIO NETWORKS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the concepts of cognitive radio
- To learn spectrum sensing and dynamic spectrum access
- To compare MAC and network layer design for cognitive radio

UNIT I INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO 9

Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

UNIT II COGNITIVE RADIO ARCHITECTURE 9

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

UNIT III SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS 9

Introduction – Primary user detection techniques – energy detection, feature detection, matched filtering, cooperative detection , Bayesian Approach, Neyman Pearson fusion rule for spectrum sensing, Optimum spectrum sensing – Kullback Leibler Divergence and other approaches, Fundamental Tradeoffs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.

UNIT IV MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO 9

MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques.

UNIT V ADVANCED TOPICS IN COGNITIVE RADIO 9

Cognitive radio for Internet of Things - Features and applications – Enabling technologies and protocols – M2M technologies - Data storage and analysis techniques - Requirement and challenges of IoT – Energy efficiency– MIMO Cognitive Radio – Power allocation algorithms.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1 : Explain Software Defined Radio and Cognitive Radio

CO2 : Understand the concepts of cognitive radio

CO3 : Describe the various Spectrum Sensing Techniques

CO4: Compare MAC and network layer design for cognitive radio

CO5 : Discuss cognitive radio for Internet of Things and M2M technologies

REFERENCES:

1. Alexander M. Wyglinski, Maziar Nekovee & Thomas Hou, 2010, *Cognitive Radio Communications and Networks*, Academic Press, Elsevier.
2. Bruce Fette, 2006, *Cognitive Radio Technology*, Newnes.
3. Huseyin Arslan (Ed.), 2007, *Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems*, Springer.
4. Kwang Cheng Chen & Ramjee Prasad, 2009, *Cognitive Radio Networks*, John Wiley and Sons.
5. Shanmugavel.S, Bhagyaveni.M.A & Kalidoss.R, 2017*, Cognitive Radio-An Enabler for Internet of things*, River Publishers.

CN1203 COMMUNICATION NETWORK SECURITY L T P C

3 0 0 3

OBJECTIVES:

- To learn security mechanisms and techniques to provide security services.
- To be exposed to symmetric & asymmetric key algorithms and key management aspects.
- To be aware of the need for security in different layers and wireless network security.

UNIT I INTRODUCTION AND NUMBER THEORY 9

Introduction to Information Security, Computer Security & Network Security. Need For Security. Security – Goals, Attacks, Security Services and Mechanisms, and Techniques. Number Theory and Mathematics for Symmetric Cryptography- Finite Arithmetic, Congruence Arithmetic-Linear Congruence and Quadratic Congruence. Mathematics for Asymmetric-Key Cryptography: Fermat's Theorem and Euler's Theorem, Primes, Primality Testing, Factorization, CRT, Exponentiation. Classical Symmetric-Key Ciphers –Substitution Ciphers, Transposition Ciphers.

UNIT II SYMMETRIC AND ASYMMETRIC CRYPTO SYSTEMS 9

Modern Symmetric-Key Cipher - Block Ciphers (DES, 3DES, AES and its mode of operations), Stream Ciphers, Asymmetric-Key Cryptosystem- RSA, ElGamal, ECC, Key Management - Diffie-Hellman (DH) Mechanism, Kerberos – Needham Schroeder Protocol.

UNIT III AUTHENTICATION, DIGITAL SIGNATURE AND CERTIFICATES 9

Message Integrity & Message Authentication - Message Authentication Code (MAC), Cryptographic Hash Functions – Birthday Attacks, Digital Signatures - Digital Signature Standards (FIPS 186-2), DSA (ANSI X9.30), RSA (ANSI X9.31) – Public Key Distribution – RSA schemes, Digital Certificates - PKI Certificates, PKI Life Cycle Management .

UNIT IV NETWORK SECURITY, FIREWALLS AND WEB SECURITY 9

Introduction on Firewalls, Types of Firewalls, Firewall Configuration and Limitation of Firewall. IP Security Overview, IP security Architecture, authentication Header, Security payload, security associations, Key Management. Web security requirement, secure sockets layer, transport layer security, secure electronic transaction, dual signature.

UNIT V WIRELESS NETWORK SECURITY 9

Security Attack issues specific to Wireless systems: Worm hole, Tunnelling, DoS. WEP for Wi-Fi network, Security for 4G networks: Secure Ad hoc Network, Secure Sensor Network.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Identify and differentiate security attacks.

CO2: Apply the different cryptographic operations of private and public key cryptography.

CO3: Apply the various authentication schemes to simulate different applications.

CO4: Configure firewalls based on the security requirements and secure the perimeter and provide security services at different layers for various network architectures.

CO5: Show with different general purpose and application specific Security Protocols and Techniques.

REFERENCES:

1. Behrouz A. Forouzan & Debdeep Mukhopadhyay, 2011, *Cryptography and Network security*, Second Edition, Tata McGraw Hill.
2. William Stallings, 2013, *Cryptography and Network security: Principles and Practice*, Sixth Edition, Prentice Hall of India, New Delhi.
3. AtulKahate, 2008, *Cryptography and Network security*, Third Edition, Tata McGraw Hill.
4. Nichols.R.K. & Lekkas.P.C, 2006, *Wireless Security Models, Threats and Solutions*, First Edition, Tata McGraw- Hill.
5. Yang.H, 2004, *Security in Mobile Ad Hoc Networks: Challenges and Solution*, IEEE Wireless Communications.
6. Zhou.L & Haas.Z. J, 1999, *Securing Ad Hoc Networks*, vol. 13, no. 6, pp. 24-30, IEEE Network Magazine.
7. David Boyle & Thomas Newe, 2008, *Securing Wireless Sensor Networks – Security Architecture*, Vol.3. No. 1. pp. 65 -76, Journal of networks.
8. Perrig.A, Stankovic.J & Wagner.D, 2004, *Security in Wireless Sensor Networks*, Vol. No.47, Issue. 6, pp 53-57, Communications of the ACM.

CN1211	**NETWORKING LABORATORY**	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To understand the functioning of various protocols in Wireless Environment.
- To understand the functioning of IP network
- To understand about the mobile ad hoc network
- To understand about the wireless routing protocol, Wi-Fi network and sensor protocol

LIST OF EXPERIMENTS

1. Implement wireless to wireless communication using wireless protocol
2. Implement and test Wireless Network Design with Small World Properties.

3. Implement Packet Data Protocol wireless communication.
4. Implement IP Networks protocol.
5. Simulating a Mobile Adhoc Network.
6. Simulating a Wi-Fi Network.
7. Simulating a Wireless Sensor Network.
8. Implement Transport Control Protocol in Sensor Network.
9. Implement applications using TCP & UDP sockets like (i) DNS (ii) SNMP (iii) File Transfer
10. Implement different routing protocols to select the network path with its optimum energy and cost during data transfer (i) Link state routing (ii) Flooding (iii) Distance vector

Total Periods: 60

OUTCOMES:

Upon successful completion of the course, the students will be able to
CO1: Demonstrate the functioning of wireless protocols in the networking environment.
CO2: Illustrate the functioning of IP networks protocol.
CO3: Apply the wireless protocols in the Mobile Adhoc Networks.
CO4: Apply the wireless protocols in the Wireless Sensor Networks.
CO5: Demonstrate the functioning of routing protocols in the communication networks

CN1221	**TERM PAPER WRITING AND SEMINAR**	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To develop student's scientific and technical reading and writing skills that they need to understand and construct research articles

LIST OF STEPS

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (at least 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Total Periods: 30

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Identify research problem.

CO2: Survey the existing research literature.

CO3: Model the research problem.

CO4: Summarize the research findings.

CO5: Organize the research ideas and prepare article for publication.

REFERENCES:

1. Kothari.C.R & GauravGarg, Research Methodology, Latest Edition, New Age International Publishers, Bangalore

Semester - III

CN1301	INTERNET OF THINGS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamentals of Internet of Things
- To learn about the basics of IOT protocols
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real world scenario.

UNIT I INTRODUCTION TO IOT **9**

Internet of Things-Physical Design-Logical Design-IoT Enabling Technologies-IoT Levels & Deployment Templates-Domain Specific IoTs-IoT and M2M-IoT System Management with NETCONF-YANG-IoT Platforms Design Methodology.

UNIT II IOT ARCHITECTURE **9**

M2M high-level ETSI architecture -IETF architecture for IoT -OGC architecture - IoT reference model -Domain model -information model -functional model - communication model -IoT reference architecture .

UNIT III IOT PROTOCOLS **9**

Protocol Standardization for IoT –Efforts –M2M and WSN Protocols –SCADA and RFID Protocols –Unified Data Standards –Protocols –IEEE 802.15.4 –BACNet Protocol –Modbus–Zigbee Architecture –Network layer –6LowPAN -CoAP – Security.

UNIT IV BUILDING IOT WITH RASPBERRY PI & ARDUINO **9**

Building IOT with RASPERRY PI-IoT Systems -Logical Design using Python–IoT Physical Devices & Endpoints-IoT Device-Building blocks -Raspberry Pi -Board-Linux on Raspberry Pi-Raspberry Pi Interfaces-Programming Raspberry Pi with Python-Other IoT Platforms –Arduino.

UNIT V CASE STUDIES AND REAL-WORLD APPLICATIONS **9**

Real world design constraints -Applications -Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing -Data Analytics for IoT –Software &Management Tools for IoT Cloud Storage Models & Communication APIs-Cloud for IoT-Amazon Web Services for IoT.

Total Periods: 45

Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Analyze various protocols for IoT.

CO2: Develop web services to access/control IoT devices.

CO3: Design a portable IoT using Rasperry Pi.

CO4: Deploy an IoT application and connect to the cloud.

CO5: Analyze applications of IoT in real time scenario.

REFERENCES:

1. Arshdeep Bahga & Vijay Madisetti, 2015, *Internet of Things – A hands-on approach*, Universities Press.
2. Dieter Uckelmann, Mark Harrison, Michahelles & Florian (Eds), 2011, *Architecting the Internet of Things*, Springer.
3. Honbo Zhou, 2012, *The Internet of Things in the Cloud: A Middleware Perspective*, CRC Press.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand & David Boyle, 2014, *From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence*, Elsevier.
5. Olivier Hersent, David Boswarthick & Omar Elloumi, 2012, *The Internet of Things – Key applications and Protocols*, Wiley.

Professional Electives
Professional Elective - I (Semester - I)

CN1131	ANALYSIS AND DESIGN OF CMOS ANALOG INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the different biasing circuits for amplifiers.
- To study the different types of current mirrors
- To know the concepts of voltage and current reference circuits.

UNIT I SINGLE STAGE AMPLIFIERS **9**

MOS physics, Large signal and Small signal analysis of Common source stage, Source follower, Common gate stage, Cascode stage. Single ended and differential operation of differential amplifier, Basic differential pair, Differential pair with MOS loads

UNIT II BIASING CIRCUITS **9**

Basic current mirrors, cascode current mirrors, active current mirrors, voltage references, supply independent biasing, temperature independent references, PTAT current generation, Constant-Gm Biasing.

UNIT III FREQUENCY RESPONSE AND NOISE ANALYSIS **9**

Miller effect, Association of poles with nodes, frequency response of common source stage, Source followers, Common gate stage, zero value time constant model, Cascode stage, Differential pair amplifier, PSRR+, PSRR-, CMRR measurement of differential amplifier, Statistical characteristics of noise, noise in single stage amplifiers, noise in differential amplifiers.

UNIT IV OPERATIONAL AMPLIFIERS **9**

Concept of negative feedback, Effect of loading in feedback networks, return ratio analysis of differential amplifier operational amplifier performance parameters, One-stage Op Amps, Two-stage Op Amps, Input range limitations, Gain boosting, slew rate, power supply rejection, noise in Op Amps.

UNIT V STABILITY AND FREQUENCY COMPENSATION **9**

General considerations, Multipole systems, Phase Margin, Frequency Compensation, and Compensation of two stage Op Amps, Slewing in two stage Op Amps, and Other compensation techniques.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Extend the concepts of different configurations of single stage amplifier.

CO2: Construct the different types of biasing circuits and current mirror circuits.

CO3: Outline the characteristics of frequency response of the amplifier and its noise.

CO4: Demonstrate the performance of the stability and frequency compensation techniques of Op-amp circuits.

CO5: Construct the various compensation techniques for Op-amp circuits.

REFERENCES:

1. BehzadRazavi, 2001, *Design of Analog CMOS Integrated Circuits*, Tata McGraw Hill.

2. Grebene, 2003, *Bipolar and MOS Analog Integrated circuit design*, John Wiley & sons.

3. Paul R.Gray, Paul J.Hurst, Stephen H.Lewis & Robert G.Meyer, 2009, *Analysis and Design of Analog Integrated Circuits*, 5th Edition, Wiley.

4. Phillip E.Allen & Douglas R.Holberg, 2002, *CMOS Analog Circuit Design*, Second edition, Oxford University Press.

5. Willey M.C. Sansen, 2006, *Analog design essentials*, Springer.

CN1132	**MEMS AND NEMS**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concepts of micro electro mechanical devices.
- To know the fabrication process of Microsystems.
- To know the design concepts of micro sensors and micro actuators.
- To familiarize concepts of quantum mechanics and nano systems.

UNIT I OVERVIEW **9**

New trends in Engineering and Science: Micro and Nanoscale systems, Introduction to Design of MEMS and NEMS, MEMS and NEMS Applications, Devices and structures. Materials for MEMS: Silicon, silicon compounds, polymers, metals.

UNIT II MEMS FABRICATION TECHNOLOGIES **9**

Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials.

UNIT III MICRO SENSORS **9**

MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Microsensors. Case study: Piezo-resistive pressure sensor.

UNIT IV MICRO ACTUATORS **9**

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators.

UNIT V NANOSYSTEMS AND QUANTUM MECHANICS **9**

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wavefunction Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Summarize the concept of scaling, applications of MEMS and the materials used for MEMS.

CO2: Illustrate different techniques involved in MEMS fabrication and Packaging.

CO3: Apply the Concept of various sensor design and its engineering mechanisms.

CO4: Understand the design concepts of micro actuators.

CO5: Understand the concepts of Nano systems and quantum Mechanics.

REFERENCES:

1. Chang Liu, 2006, *Foundations of MEMS*, Pearson education India limited.
2. Vijay K Varadhan & K.J.Vinoy, 2003, *RF MEMS and their Applications*, John Wiley & Sons.
3. Marc Madou, 1997, *Fundamentals of Microfabrication*, CRC press.
4. Stephen.D.Senturia, 2001, *Micro system Design*, Kluwer Academic Publishers.
5. Sergey Edward Lyshevski, 2002, *MEMS and NEMS: Systems, Devices, and Structures,* CRC Press.
6. Tai Ran Hsu, 2002, *MEMS and Microsystems Design and Manufacture*, Tata Mcraw Hill.

CN1133 REAL TIME EMBEDDED SYSTEMS L T P C

3 0 0 3

OBJECTIVES:

- To study the basic concepts of ARM processors
- To understand the computing platform and design analysis of ARM processors
- To study the concepts of Operating systems in ARM
- To study the concept of embedded networks
- To understand case studies related to embedded systems

UNIT I INTRODUCTION TO ARM PROCESSORS 9

Fundamentals of ARM, ARM Instruction set, Thumb Instruction set, ARM assembly language programming, Digital Signal Processing in ARM, Exceptions & Interrupt Handling.

UNIT II COMPUTING PLATFORM AND DESIGN ANALYSIS 9

CPU buses – Memory devices – I/O devices – Memory Protection Units – Memory Management Units– Component interfacing – Design with microprocessors – Development and Debugging – Program design – Model of programs – Assembly and Linking – Basic compilation techniques – Analysis and optimization of execution time, power, energy, program size – Program validation and testing.

UNIT III PROCESS AND OPERATING SYSTEMS 9

Multiple tasks and multi processes – Processes – Context Switching – Scheduling policies - Multiprocessor – Inter Process Communication mechanisms – Evaluating operating system Performance – Power optimization strategies for processes – Firmware and Operating Systems for ARM processor.

UNIT IV HARDWARE ACCELERATES & NETWORKS 9

Accelerators – Accelerated system design – Distributed Embedded Architecture – Networks for Embedded Systems – Network based design – Internet enabled systems.

UNIT V CASE STUDY 9

Hardware and software co-design - Data Compressor - Software Modem – Personal Digital Assistants– Set–Top–Box. – System-on-Silicon – FOSS Tools for embedded system development.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Illustrate the ARM Architecture and its programming.

CO2: Develop various embedded computing platforms.

CO3: Solve problems related operating systems and scheduling policy.

CO4: Explain the basics about accelerators and system design.

CO5: Describe different applications of embedded system.

REFERENCES:

1. Andrew N Sloss, Dominic Symes & Chris Wright, 2004, *ARM system developer's guide – Designing and Optimizing System Software*, Morgan Kaufmann publishers.
2. David E-Simon, 2007, *An Embedded Software Primer*, Pearson Education.
3. K.V.K.K.Prasad, 2005, *Embedded Real-Time Systems: Concepts, Design & Programming*", DreamtechPress,.
4. Tim Wilmshurst, 2004, *An Introduction to the Design of Small Scale Embedded Systems*, Pal grave Publisher.
5. Wayne Wolf, 2006, *Computers as Components - Principles of Embedded Computer System Design*, Morgan Kaufmann Publisher.

CN1134	**RF INTEGRATED CIRCUITS**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamentals of integrated circuits operating at microwave frequencies.
- To learn RFIC design techniques, including system architecture, key building blocks and design methodologies in CMOS technology.

UNIT I BASIC RF IC COMPONENTS **9**

Skin effect, Resistors, Capacitor, Inductor and Transformers at high frequency, Interconnect options. S-parameters with Smith chart, Impedance matching networks, Transmission lines, finite length effects, MOSFET characteristics, Noise: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, RF System characterization, Transceiver Architectures.

UNIT II RECEIVERS ARCHITECTURE AND LOW NOISE AMPLIFIERS **9**

Homodyne Receiver, Heterodyne Receiver, Image reject, Low IF Receiver Architectures Direct up conversion Transmitter, Two step up conversion Transmitter, CMOS amplifiers, Single ended and Differential LNAs terminated with Resistors and Source Degeneration LNAs, OC Time constants in bandwidth estimation and enhancement, Power match and Noise match, Design of LNA using EDA tools.

UNIT III FEEDBACK SYSTEMS AND POWER AMPLIFIERS **9**

Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations , Compensation, General model – Class A, AB, B, C, D, E and F amplifiers, Power amplifier Linearization Techniques, Efficiency boosting techniques.

UNIT IV PLL AND FREQUENCY SYNTHESIZERS **9**

Linearised PLL Model, Noise properties, Phase detectors, Loop filters and Charge pumps, PLL Design examples. Integer-N frequency synthesizers, Direct Digital Frequency synthesizers.

UNIT V MIXERS AND OSCILLATORS **9**

Mixer characteristics, Non-linear mixers, Multiplier based mixers, Single balanced and double balanced mixers, sub sampling mixers, Oscillators describing Functions, Resonators, Phase noise, Chip Design Examples: GPS Receiver, WLAN receiver.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to
CO1: Understand the fundamentals of RF integrated circuits components.
CO2: Understand the architecture of receiver and low noise amplifier
CO3: Discuss the various feedback system and amplifier.
CO4: Understand the design of PLL and frequency synthesizers.
CO5: Discuss the various types of mixer and oscillator.

REFERENCES:

1. Behzad Razavi, Reprint 2012, *RF Microelectronics*, Second Edition, Prentice Hall.
2. Thomas. H. Lee, 2004, *The Design of CMOS Radio Frequency Integrated Circuits*, Cambridge University Press.
3. Devendra.K. Misra, 2004, Radio *Frequency and Microwave Communication Circuits – Analysis and Design*, John Wiley and Sons.
4. John W.M.Rogers & Calvin Plett, 2010, *Radio Frequency Integrated Circuit Design*, Second Edition, Artech House, Norwood.
5. Matthew M. Radmanesh,2007, *RF and Microwave Design Essentials*, Author House, Bloomington.

CN1135 SIGNAL INTEGRITY FOR HIGH SPEED DESIGN

L	T	P	C
3	0	0	3

OBJECTIVES:

- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics
- To know about power consideration and system design
- To be aware of clock distribution and clock oscillators.

UNIT I SIGNAL PROPAGATION ON TRANSMISSION LINES **9**

Transmission line equations, wave solution, wave *vs*. circuits, initial wave, delay time, Characteristic impedance , wave propagation, reflection, and bounce diagrams Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion

UNIT II MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK 9

Multi-conductor transmission-lines, coupling physics, per unit length parameters, Near and far-end cross-talk, minimizing cross-talk (stripline and microstrip) Differential signalling, termination, balanced circuits, S-parameters, Lossy and Lossless models, Characteristics of CPW transmission line.

UNIT III NON-IDEAL EFFECTS 9

Non-ideal signal return paths – gaps, BGA fields, via transitions, Parasitic inductance and capacitance, Transmission line losses – Rs, tanδ, routing parasitic, Common-mode current, differential-mode current , Connectors

UNIT IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9

SSN/SSO, DC power bus design, layer stack up, SMT decoupling, Logic families, power consumption and system power delivery, Logic families and speed Package types and parasitic, SPICE, IBIS models, Bit streams, PRBS and filtering functions of link-path components, Eye diagrams, jitter, inter-symbol interference Bit-error rate, Timing analysis

UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, cancelling parasitic capacitance, Clock jitter.

Total Periods: 45

OUTCOMES:

Upon Successful Completion of this course, the students will be able to
CO1: Understand the Signal Propagation On Transmission Lines
CO2: Discuss the various multi-Conductor Transmission Lines and Cross-Talk
CO3: Discuss the Non-Ideal Effects of basic RF components
CO4: Explain the Power Considerations and System Design of logic families.
CO5: Understand the Clock distribution and Clock Oscillators

REFERENCES:

1. Douglas Brooks, 2003, *Signal Integrity Issues and Printed Circuit Board Design*, Prentice Hall PTR.
2. Eric Bogatin, 2003, *Signal Integrity – Simplified*, Prentice Hall PTR.
3. Johnson.H.W & Graham.M, 1993, *High-Speed Digital Design: A Handbook of Black Magic*, Prentice Hall.
4. Hall.S, Hall.G & McCall.J, 2000, *High-Speed Digital System Design: A hand book of Interconnect Theory and Design Practices*, Wiley-Interscience.

CN1136 **SOFT COMPUTING TECHNIQUES** L T P C

3 0 0 3

OBJECTIVES:

- To know the basics of artificial neural networks
- To provide adequate knowledge about feed forward /feedback neural networks
- To apply the concept of fuzzy logic in various systems.
- To have the idea about genetic algorithm
- To provide adequate knowledge about the applications of Soft Computing.

UNIT I ARTIFICIAL NEURAL NETWORK **9**

Introduction-Basic concepts of Neural Network-Model of an Artificial Neuron-Characteristics of Neural Network-Learning Methods-Backpropagation Network Architecture-Backpropagation Learning-Counter Propagation Network-Hopfield/Recurrent Network-Adaptive Resonance Theory.

UNIT II FUZZY LOGIC **9**

Basic concepts of Fuzzy Logic-Fuzzy Sets and Crisp Sets-Fuzzy Set Theory and Operations-Properties of Fuzzy Sets-Fuzzy and Crisp relations, Fuzzy to Crisp Conversion-Membership Functions-Interference in Fuzzy Logic-Fuzzy if-then Rules, Fuzzy implications and Fuzzy Algorithms, Fuzzification & Defuzzification-Fuzzy Controller.

UNIT III NEURO-FUZZY MODELLING **9**

ANFIS Architecture-Classification and Regression Trees-Data Clustering algorithms-Rulebase Structure Identification.

UNIT IV GENETIC ALGORITHMS **9**

Basic concepts-Working Principle-Inheritance Operators-Cross Over-Inversion & Deletion-Mutation Operator-Generation Cycle.

UNIT V APPLICATIONS OF SOFTCOMPUTING **9**

Genetic Algorithm Application- Bagley and Adaptive Game-Playing Program- Greg Viols Fuzzy Cruise Controller-Air Conditioner Controller-Application of Back Propagation Neural Network.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Make use of Neural Network architecture to design different learning networks and its application.

CO2: Utilize Fuzzy logic to analyze the various fuzzy rules and fuzzy controllers

CO3: Develop Neuro-Fuzzy model for a various problems.

CO4: Explain the concepts of genetic algorithms.

CO5: Apply the soft computing techniques in real time problems.

REFERENCES:

1. George J.Klir & Bo Yuan, 2002, *Fuzzy Sets and Fuzzy Logic Theory and Applications*, Printice Hall of India.
2. Jang.J.S.R, Sun. C.T & E.Mizutani, 2004, *Neuro-Fuzzy and Soft Computing*, PHI, Pearson Education.
3. Laurene Fausett, 2006, *Fundamentals of Neural Networks: Architectures, Algorithms and Applications*, Pearson Education India.
4. Rajasekaran.S & Pa.G.A.V, 2010, *Neural Networks, Fuzzy Logic and Genetic Algorithms*, Printice Hall of India.
5. Timothy J Ross, 2009, *Fuzzy logic with Engineering Applications*, John Wiley and Sons.
6. Zimmermann H.J, 2011, *Fuzzy Set Theory and Its Application,* Springer International Edition.

Professional Elective - II (Semester - II)

CN1231	ADVANCED SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn M2M developments and satellite applications
- To understand Satellite Communication In Ipv6 Environment

UNIT I OVERVIEW OF SATELLITE COMMUNICATION 9

Overview of satellite communication and orbital mechanics Link budget Parameters, Link budget calculations, Auxiliary Equations, Performance Calculations.

UNIT II M2M DEVELOPMENTS AND SATELLITE APPLICATIONS 9

Overview of the Internet of Things and M2M- M2M Applications Examples and Satellite Support- Satellite Roles Context and Applications- Antennas for Satellite M2M Applications- M2M Market Opportunities for Satellite Operators- Ultra HD Video/TV and Satellite Implications- High Throughput Satellites (HTS) and Ka/Ku Spot Beam Technologies- Aeronautical, Maritime and other Mobility Services.

UNIT III SATELLITE COMMUNICATION IN IPV6 ENVIRONMENT 9

Overview of IPv6 and its benefits for Satellite Networks - Migration and Coexistence-Implementation scenarios and support- Preparations for IPv6 in Satellite communication- Satellite specific Protocol issues in IPv6 – Impact of IPv6 on Satellite Network architecture and services-Detailed transitional plan- IPv6 demonstration over satellites - Key results and recommendations.

UNIT IV SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM 9

Over view of Radio and Satellite Navigation, GPS Principles, Signal model and Codes, Satellite Signal Acquisition, Mathematical model of GPS observables, Methods of processing GPS data , GPS Receiver Operation and Differential GPS. IRNSS, GAGAN, GLONASS and Galileo.

UNIT V DEEP SPACE NETWORKS AND INTER PLANETARY MISSIONS 9

Introduction – Functional description - Design procedure and performance criterion-Mars exploration Rover- Mission and space craft summary-Telecommunication subsystem overview-Ground Subsystem-Telecom subsystem and Link performance Telecom subsystem Hardware and software Chandrayaan-1 Mission - Mission and space craft summary-Telecommunication subsystem overview-Ground Subsystem-Telecom subsystem and Link performance. Mangalyaan Mission - Mission and space craft summary-Telecommunication subsystem overview- Ground Subsystem-Telecom subsystem and Link performance.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Describe the satellite orbital mechanics and link budget parameters of satellite communications.

CO2: Explain the M2M developments and various satellite applications.

CO3: Summarize the role of satellite communications in the IPv6 environment.

CO4: Outline the principles and concepts involved in the navigation and global positioning systems.

CO5: Explain the various subsystems of deep space networks and inter planetary missions

REFERENCES:

1. Adimurthy.V, 2015, *Concept design and planning of India's first interplanetary mission,* VOL. 109, NO. 6, Current Science.
2. Anil K. Maini & Varsha Agrawal, 2014, *Satellite Technology: Principles and Applications*, Third Edition, Wiley.
3. Daniel Minoli, 2015, *Innovations in Satellite Communication and Satellite Technology,* Wiley.
4. Daniel Minoli, 2009, *Satellite Systems Engineering in an IPv6 Environment*, First Edition, CRC Press.
5. Hofmann Wellenhof B, Lichtenegger H & Elmar Wasle, 2008, *Global Navigational Satellite Systems,* Springer-Verlag.
6. Jim Taylor, 2016, *Deep Space Communications,* John Wiley & Sons.
7. Ippolito, L.J., 2017, *Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance*, Second Edition, Wiley.
8. http://www.isro.gov.in/pslv-c25-mars-orbiter-mission
9. https://en.wikipedia.org/wiki/Mars_Orbiter_Mission
10. https://en.wikipedia.org/wiki/Chandrayaan-1

CN1232 DETECTION AND ESTIMATION THEORY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the concepts of detection and estimation.
- To learn the basics of multi-user detection theory
- To understand the theory behind various estimation techniques.
- To understand Wiener filter and Kalman filter in detail.

UNIT I REVEIW OF PROBABILITY AND STOCHASTIC PROCESS **9**

Conditional Probability, Bayes' Theorem , Random Variables, Conditional Distributions and Densities, moments and distribution of random variables., Stationary Processes Cyclostationary Processes Averages and Ergodicity Autocorrelation Function Power Spectral Density Discrete Time Stochastic Processes, Spatial Stochastic Processes, Random Signals, Relationship of Power Spectral Density and Autocorrelation Function.

UNIT II SINGLE AND MULTIPLE SAMPLE DETECTION **9**

Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson Criterion, Sequential Detection, The Optimum Digital Detector in Additive Gaussian Noise, Performance of Binary Receivers in AWGN.

UNIT III FUNDAMENTALS OF ESTIMATION THEORY **9**

Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems, Properties of Estimators, Bayes estimation, Minimax Estimation, Maximum-Likelihood Estimation, Comparison of Estimators of Parameters

UNIT IV WIENER AND KALMAN FILTERS **9**

Orthogonality Principle, Autoregressive Techniques, Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations , Linear Least-Squares Methods, Minimum-Variance Weighted Least-Squares Methods, Minimum-Variance, Least Squares, Kalman Algorithm - Computational Considerations, Signal Estimation, Continuous Kalman Filter, Extended Kalman Filter.

UNIT V APPLICATIONS **9**

Detector Structures in Non-Gaussian Noise , Examples of Noise Models, Receiver Structures, and Error-Rate Performance, Estimation of Non-Gaussian Noise Parameters Fading Multipath Channel Models, Receiver Structures with Known Channel Parameters, Receiver Structures without Knowledge of Phase, Receiver Structures without Knowledge of Amplitude or Phase, Receiver Structures and Performance with No Channel Knowledge.

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Illustrate the axiomatic formulation of modern Probability Theory for the analysis of random phenomena.

CO2: Characterize probability models and function of random variables based on single and multiples random variables.

CO3: Apply probability and stochastic process concepts in detection and estimation.

CO4: Design Wiener and Kalman filters to solve linear estimation problems.

CO5: Apply detection and estimation theory to solve communication problems.

REFERENCES:

1. Harry L. & Van Trees, 2004, *Detection, Estimation and Modulation Theory*, Part I John Wiley and Sons, New York.
2. Ludeman & Lonnie.C, 2003, *Random processes: filtering, estimation, and detection*, John Wiley & Sons, Inc.
3. Steven M. & Kay, 1993, *Fundamentals of Statistical Processing*, *Volume I: Estimation Theory*, Prentice Hall Signal Processing Series, Prentice Hall, PTR, New Jersy.
4. Sergio Verdu , 1998, *Multi User Detection*, Cambridge University Press.
5. Thomas Schonhoff, 2007, *Detection and Estimation Theory*, Prentice Hall, New Jersy.

CN1233	DIGITAL COMMUNICATION RECEIVERS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic principles of digital communication techniques.
- To gain knowledge about receivers for AWGN channel and Fading channels.
- To understand the concepts of synchronization and adaptive equalization techniques.

UNIT I REVIEW OF DIGITAL COMMUNICATION TECHNIQUES **9**

Base band communication; signal space representation, linear and nonlinear modulation techniques, Error tracking and Spectral characteristics of digital modulation.

UNIT II OPTIMUM RECEIVERS FOR AWGN CHANNEL **9**

Correlation demodulator, matched filter, maximum likelihood sequence detector, optimum receiver for CPM signals, optimum receivers for signals with random phase in AWGN channel, envelope detection of M-ary orthogonal signals and correlated binary signals.

UNIT III RECEIVERS FOR FADING CHANNELS **9**

Characterization of fading multiple channels, statistical models, flat and frequency selective fading, diversity technique, parameter synchronization for flat fading channels, digital signalling over a frequency selective and slowly fading channel, coded waveform for fading channel.

UNIT IV SYNCHRONIZATION TECHNIQUES **9**

Carrier and signal synchronization, carrier phase estimation-PLL, Decision directed loops, symbol timing estimation, maximum likelihood and non-decision directed timing estimation, joint estimation.

UNIT V ADAPTIVE EQUALIZATION **9**

Zero forcing algorithm, LMS algorithm, adaptive decision-feedback equalizer and Equalization of Trellis-coded signals. Kalman algorithm, blind equalizers and stochastic gradient algorithm.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Explain the basic principles of digital communication techniques.

CO2: Compare the various optimum receivers for AWGN channel.

CO3: Elucidate the concepts and techniques involved in receiver design for fading channels.

CO4: Describe symbol time, carrier frequency and carrier phase synchronization techniques.

CO5: Explain adaptive equalization algorithms for wireless channels.

REFERENCES:

1. Heinrich Meyer, Mare Moeneclacy & Stefan.A.Fechtel, 1997, *Digital communication receivers*, Vol I & Vol II, John Wiley, New York.
2. H.Meyr & G.Ascheid, 1990, *Synchronization in Digital Communications*, John Wiley.
3. John.G.Proakis, 2001, *Digital communication*, 4th Edition, McGraw-Hill, New York.
4. R.G. Gallager, 2008, *Principles of Digital Communication*, Cambridge University Press, Newyork.
5. Simon Marvin, 2000, *Digital communication over fading channel; An unified approach to performance Analysis*, John Wiley, New York.
6. U.Mengali & A.N.D.Andrea, 1997, *Synchronization Techniques for Digital Receivers*, Kluwer.

CN1234 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce EMI sources.
- To introduce EMI problems.
- To introduce Solution methods in PCB.
- To introduce Measurements techniques for emission.
- To introduce Measurement techniques for immunity.

UNIT I BASIC THEORY **9**

Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories EMC Engineering Application

UNIT II COUPLING MECHANISM **9**

Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radioactive coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients

UNIT III EMI MITIGATION TECHNIQUES **9**

Working principle of Shielding and Murphy's Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient Protection.

UNIT IV STANDARD AND REGULATION **9**

Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC. Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards

UNIT V EMI TEST METHODS AND INSTRUMENTATION **9**

Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber , Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Interpret the basics theories of EMI and EMC and explain the various issues, testing categories and engineering application of EMI and EMC

CO2: Identify the different coupling mechanism used in EMI and EMC.

CO3: Identify the type of EMI and Choose appropriate mitigation techniques.

CO4: Explain the different standards and regulation.

CO5: Illustrate the EMI testing methods and its instrumentation.

REFERENCES:

1. Prasad.V Kodali, 2001, *Engineering Electromagnetic Compatibility*, IEEE Press, Newyork.
2. Bemhard Keiser, 1986, *Principles of Electromagnetic Compatibility*, 3rd Ed, Artech house, Norwood.
3. Clayton Paul, 2006, *Introduction to Electromagnetic Compatibility*, Wiley Interscience.
4. Daryl Gerke & William Kimmel, 2002, *EDN's Designer's Guide to Electromagnetic Compatibility*, Elsevier Science & Technology Books
5. Dr Kenneth L Kaiser, 2005, *The Electromagnetic Compatibility Handbook*, CRC Press.

6. Norman Violette, 2013, *Electromagnetic Compatibility*, Springer.
7. Donald R. J. White, 2007, *Electromagnetic Interference and Compatibility: Electrical noise and EMI specifications Volume 1 of A Handbook Series on Electromagnetic Interference and Compatibility*, Don white consultants Original from the University of Michigan.
8. Henry W.Ott, 2009, *Electromagnetic Compatibility Engineering*, John Wiley & Sons Inc, Newyork.
9. Scott W Bennett, 1997, *Control and Measurement of Unintentional Electromagnetic Radiation*, John Wiley & Sons Inc., (Wiley Interscience Series).

CN1235 PARALLEL PROCESSING L T P C

3 0 0 3

OBJECTIVES:

- To understand the architectures for parallel processing.
- To learn the concepts of pipelining and multithreading.

UNIT I THEORY OF PARALLELISM **9**

Parallel computer models- the state of computing, Multiprocessors and multi computers and multivectors and SIMD computers, PRAM and VLSI models, Architecture development tracks Program and network properties.

UNIT II PARALLEL PROCESSING APPLICATIONS **9**

Conditions of parallelism, Program partitioning and scheduling, Program flow mechanisms, system interconnect architectures. Principles of scalable performance, performance metrics and measures, Data Flow Machine Language- Architecture of Data Flow Machines.

UNIT III HARDWARE TECHNOLOGIES **9**

Processor and memory hierarchy- advanced processor technology, superscalar and vector processors, memory hierarchy technology, virtual memory technology, bus cache and shared memory, backplane bus systems, cache memory organizations, shared memory Organizations, sequential and weak consistency models.

UNIT IV INSTRUCTION LEVEL PARALLEL PROCESSING **9**

Pipelining in processing elements- delays in Pipeline execution- difficulties in Pipelining- Superscalar Processors- Vector Processor – Very Long Instruction Word Processor (VLIW)- Commercial Processor-Power PC 620 RISC Processor- Two Instruction Superscalar RISC Processor- Multithreaded Processors- Future Processor Architecture- Trace Processor, Multiscalar Processor, Super flow Architecture.

UNIT V PARALLEL ALGORITHMS **9**

Classification of Parallel Algorithms: Synchronized and Asynchronized parallel algorithms, Performance of Parallel algorithms- Elementary parallel algorithms: Searching, Sorting, Matrix Operations

Total Periods: 45

OUTCOMES:

Upon successful completion of this course, the students will be able to

CO1: Illustrate the theory of parallelism on Multiprocessors and multi computers.
CO2: Develop the problem solving techniques in parallel computing.
CO3: Solve problems related to memory management.
CO4: Describe different parallel architectures and pipeline processing.
CO5: Design efficient parallel algorithms with its performance measure

REFERENCES:

1. Hwang.K & Briggs F.A., 1985, *Computer Architecture and Parallel Processing*, Tata McGraw Hill.
2. Kai Hwang & Naresh Jotwani, 2016, *Advanced Computer Architecture*, Second Edition, Tata McGraw Hill.
3. Quinn M.J., 2003, *Designing Efficient Algorithm for Parallel Computers*, McGraw Hill.
4. Rajaraman,V & Siva Ram Murthy.C, 2006, *Parallel Computers*, *Architecture and Programming*, Prentice Hall of India Private Limited.
5. William Stallings, 2010, *Computer Organization and Architecture*, Indian Edition, Pearson Education.

CN1236 **VLSI FOR WIRELESS COMMUNICATION** L T P C

3 0 0 3

OBJECTIVES:

- To understand the concepts of basic wireless communication concepts.
- To study the parameters in receiver and low noise amplifier design.
- To study the various types of mixers designed for wireless communication.
- To study and design PLL and VCO.
- To understand the concepts of transmitters and power amplifiers in wireless communication.

UNIT I COMMUNICATION CONCEPTS **9**

Introduction –Overview of Wireless systems –Standards –Access Methods – Modulation schemes –Classical channel –Wireless channel description –Path loss – Multipath fading –Standard Translation.

UNIT II RECEIVER ARCHITECTURE & LOW NOISE AMPLIFIERS 9

Receiver front end –Filter design –Non-idealities –Design parameters –Noise figure & Input intercept point. LNA Introduction –Wideband LNA design–Narrow band LNA design: Impedance matching & Core amplifier.

UNIT III MIXERS 9

Balancing Mixer -Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion –Noise -A Complete Active Mixer. Switching Mixer –Distortion, Conversion Gain & Noise in Unbalanced Switching Mixer -A Practical Unbalanced Switching Mixer. Sampling Mixer -Conversion Gain, Distortion, Intrinsic & Extrinsic Noise in Single Ended Sampling Mixer

UNIT IV FREQUENCY SYNTHESIZERS 9

PLL –Phase detector –Dividers –Voltage Controlled Oscillators –LC oscillators –Ring Oscillators –Phase noise –Loop filters & design approaches –A complete synthesizer design example (DECT) –Frequency synthesizer with fractional divider

UNIT V TRANSMITTER ARCHITECTURES & POWER AMPLIFIERS 9

Transmitter back end design – Quadrature LO generator –Power amplifier design.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Outline the concepts of basic wireless communication concepts.

CO2: Illustrate the parameters in receiver and low noise amplifier design.

CO3: Interpret the various types of mixers designed for wireless communication.

CO4: Develop a optimized design for PLL and VCO.

CO5: Illustrate the concepts of transmitters and power amplifiers in wireless communication.

REFERENCES:

1. Bosco H Leung, 2002, *VLSI for Wireless Communication*, Pearson Education.
2. Razavi.B, 1998, *RF Microelectronics*, Prentice-Hall.
3. Behzad Razavi, 1999, *Design of Analog CMOS Integrated Circuits,* McGraw-Hill.
4. Emad N Farag & Mohamed I Elmasry, 2000, *Mixed Signal VLSI wireless design – Circuits & Systems*, Kluwer Academic Publishers.
5. Crols.J & Steyaert.M, 1997, *CMOS Wireless Transceiver Design*, Boston, Kluwer Academic Pub.
6. Thomas H.Lee, 2003, *The Design of CMOS Radio –Frequency Integrated Circuits*, Cambridge University Press.

Professional Elective - III (Semester - II)

CN1237	ADVANCED DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the image fundamentals.
- To understand the various image segmentation techniques.
- To extract features for image analysis.
- To introduce the concepts of image registration and image fusion.
- To illustrate 3D image visualization.

UNIT I FUNDAMENTALS OF DIGITAL IMAGE PROCESSING 9

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, SVD. Image enhancement in spatial and frequency domain, Review of Morphological image processing.

UNIT II SEGMENTATION 9

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour models, Texture feature based segmentation, Graph based segmentation, Wavelet based Segmentation - Applications of image segmentation.

UNIT III FEATURE EXTRACTION 9

First and second order edge detection operators, Phase congruency, Localized feature extraction - detecting image curvature, shape features, Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Runlength features, Fractal model based features, Gabor filter, wavelet features.

UNIT IV REGISTRATION AND IMAGE FUSION 9

Registration - Preprocessing, Feature selection - points, lines, regions and templates Feature correspondence - Point pattern matching, Line matching, Region matching, Template matching. Transformation functions - Similarity transformation and Affine Transformation. Resampling – Nearest Neighbour and Cubic Splines. Image Fusion - Overview of image fusion, pixel fusion, wavelet based fusion -region based fusion.

UNIT V 3D IMAGE VISUALIZATION 9

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiple connected surfaces, Image processing in 3D, Measurements on 3D images.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Explain the basic fundamentals of digital image processing, enhancement techniques, Morphological processing and 2D-transforms.

CO2: Utilize various concepts of image segmentation techniques for image analysis.

CO3: Summarize different feature extraction techniques for image analysis and recognition.

CO4: Make use of the image registration and fusion of different image processing methods.

CO5: Illustrate 3D image visualization methods.

REFERENCES:

1. Ardeshir Goshtasby, 2005, *2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications*, John Wiley and Sons.
2. Anil K. Jain, 2002, *Fundamentals of Digital Image Processing*, Pearson Education Inc.
3. John C.Russ, 2007, *The Image Processing Handbook*, CRC Press.
4. Mark Nixon, Alberto Aguado, 2008, *Feature Extraction and Image Processing*, Academic Press.
5. Rafael C.Gonzalez & Richard E.Woods, 2004, *Digital Image Processing,* Pearson Education Inc.
6. Rick S.Blum & Zheng Liu, 2006, *Multisensor image fusion and its Applications*, Taylor & Francis.

CN1238	**FUNDAMENTALS OF CLOUD COMPUTING**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Build custom made clouds.
- Develop remote access applications, alert generation using cloud.
- Work with commercial cloud packages.

UNIT I INTRODUCTION TO CLOUD **9**

Cloud Computing – History, Architecture, Storage, Advantages, Disadvantages, Services, Server Virtualization- Parallel Processing, Vector Processing, Symmetric Multiprocessing Systems and Massively Parallel Processing Systems.

UNIT II CLOUD BASED WEB SERVICES **9**

Understanding Private and Public cloud environments – Communication as a Service (CaaS)-Infrastructure as a Service (IaaS) – On-demand, Amazon"s Elastic, Amazon EC2, Mosso– Monitoring as a Service (MaaS) –Platform as a Service (PaaS) – On-Premises model, new cloud model –Software as a Service (SaaS) –implementation issues, characteristics, SaaS model.

UNIT III CLOUD COMPUTING FOR EVERYONE **9**

Centralizing Email Communications – Collaborating on Schedules – Collaborating on To-Do Lists – Collaborating Contact Lists – Cloud Computing for the Community – Collaborating on Group Projects and Events – Cloud Computing for the Corporation

UNIT IV USING CLOUD SERVICES **9**

Collaborating on Calendars, Schedules and Task Management – Exploring Online Scheduling Applications – Exploring Online Planning and Task Management – Collaborating on Event Management – Collaborating on Contact Management – Collaborating on Project Management – Collaborating on Word Processing - Collaborating on Databases – Storing and Sharing Files

UNIT V FUTURE DIRECTIONSTOCLOUD **9**

Collaborating on Calendars, Schedules and Task Management – Exploring Online Scheduling Applications – Exploring Online Planning and Task Management – Collaborating on Event Management – Collaborating on Contact Management – Collaborating on Project Management – Collaborating on Word Processing - Collaborating on Databases – Storing and Sharing Files

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Illustrate the concept of virtualization and processing.
CO2: Summarize the various cloud-based web services .
CO3: Explain the collaboration mechanism in cloud computing.
CO4: Outline the usage of cloud services.
CO5: Illustrate the various standards in cloud security

REFERENCES:

1. Barrie Sosinsky, 2011, *Cloud Computing –Bible*, Indian Edition, Wiley.
2. John W.Rittinghouse & James F.Ransome, 2012, *Cloud Computing – Implementation, Management and Security*, CRC press.
3. Michael Miller, 2008, *Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online*, Pearson.

CN1239	**NETWORK MANAGEMENT**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To appreciate the need for interoperable network management as a typical distributed application.
- To familiarize concepts and terminology associated with SNMP.
- To be aware of current trends in network management technologies.

UNIT I OSI NETWORK MANAGEMENT **9**

OSI Network management model - Organizational model - Information model, Communication model. Abstract Syntax Notation - Encoding Structure, Macros Functional Model CMIP/CMIS

UNIT II BROADBAND NETWORK MANAGEMENT **9**

Broadband networks and services, ATM Technology - VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN, ATM Network Management - ATM Network reference model, Integrated local Management Interface. ATM Management Information base, Role of SNMP and ILMI in ATM Management, M1, M2, M3, M4 interface. ATM Digital Exchange Interface Management

UNIT III SIMPLE NETWORK MANAGEMENT PROTOCOL **9**

SNMPv1 Network Management: Communication and Functional Models. The SNMP Communication Model, Functional model. SNMP Management SNMPv2: Major Changes in SNMPv2, SNMPv2 System Architecture, SNMPv2 Structure of Management Information, The SNMPv2 Management Information Base,SNMPv2 Protocol, Compatibility With SNMPv1.Configuration management, Fault management, Performance management, Event Correlation Techniques 168 security management, Accounting management, Report Management, Policy Based Management, Services Level Management.

UNIT IV NETWORK MANAGEMENT SYSTEMS **9**

Network Management Tools, Network Statistics Measurement Systems, History of Enterprise Management, Commercial Network management Systems, System Management and Enterprise Management Solutions.

UNIT V WEB-BASED MANAGEMENT **9**

NMS with Web Interface and Web-Based Management, Web Interface to SNMP Management, Embedded Web-Based Management, Desktop management Interface, Web Based Enterprise Management(WBEM),Windows Management Instrumentation, Java management Extensions, Management of a Storage Area Network.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Identify problems and make minor repairs to computer networks using appropriate diagnostics software.

CO2: Demonstrate how to correctly maintain LAN computer systems.

CO3: Make use of Simple Network Management Protocol to maintain the security management.

CO4: Apply Network Management Systems for various applications.

CO5: Apply network management tools for various windows management.

REFERENCES:

1. Lakshmi G Raman, 1999, *Fundamentals of Telecommunication Network Management*, Eastern Economy Edition, IEEE Press, New Delhi.
2. Mani Subramanian, 2010, *Network Management - Principles and Practice*, Second edition, Pearson Education.
3. Mani Subramanian, 2010, *Network Management Principles and Practice*, Second edition, Addison Wesley.
4. Mark Burges, 2000, *Principles of Network System Administration*, Wiley.
5. Salah Aiidarons & Thomas Plevayk, 1998, *Telecommunications Network Technologies and Implementations*, Eastern Economy Edition IEEE press, New Delhi.
6. Stephen Morris, 2003, *Network Management, MIBs and MPLS - Principles, Design and Implementation*, Pearson Education.

CN1240 PATTERN RECOGNITION AND MACHINE LEARNING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To study the fundamentals of pattern classifier.
- To know about various clustering concepts.
- To originate the various structural pattern recognition and feature extraction.
- To understand the basic of concept learning and decision trees
- To explore recent advances in pattern recognition.

UNIT I PATTERN CLASSIFIER 9

Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions –Minimum distance pattern classifier.

UNIT II CLUSTERING 9

Clustering for unsupervised learning and classification -Clustering concept – C-means algorithm –Hierarchical clustering procedures -Graph theoretic approach to pattern clustering -Validity of clusters.

UNIT III FEATURE EXTRACTION & STRUCTURAL PATTERN RECOGNITION 9

KL Transforms – Feature selection through functional approximation – Binary selection -Elements of formal grammars - Syntactic description - Stochastic grammars – Structural representation.

UNIT IV INTRODUCTION, CONCEPT LEARNING AND DECISION TREES 9

Learning Problems – Designing Learning systems, Perspectives and Issues – Concept Learning – Version Spaces and Candidate Elimination Algorithm – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search

UNIT V RECENT ADVANCES **9**

Neural network structures for pattern recognition -Neural network based pattern associators –Unsupervised learning in neural pattern recognition -Self organizing networks -Fuzzy logic -Fuzzy pattern classifiers -Pattern classification using Genetic Algorithms.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Classify the data based on pattern recognition.

CO2: Make use of Clustering algorithms for unsupervised learning.

CO3: Utilize the given data set to extract and select features for Pattern recognition.

CO4: Apply the basic concepts of decision tree and concept learning for different algorithms.

CO5: Develop Neural Networks and Fuzzy Logic in pattern recognition.

REFERENCES:

1. Duda R.O., & Hart.P.E., 1973, *Pattern Classification and Scene Analysis*, Wiley, New York.
2. Morton Nadier & Eric Smith P, 1993, *Pattern Recognition Engineering*, John Wiley & Sons, New York.
3. NarasimhaMurty M & Susheela Devi V, 2011, *Pattern Recognition – An Algorithmic Approach*, Springer, Universities Press.
4. Robert J.Schalkoff, 2007, *Pattern Recognition: Statistical, Structural and Neural Approaches*, John Wiley &Sons Inc., New York.
5. Tom M. Mitchell, 2013, *Machine Learning*, (INDIAN EDITION), McGraw-Hill Education.
6. Tou & Gonzalez, 1974, *Pattern Recognition Principles*, Wesley Publication Company, London.

CN1241 **RADAR SIGNAL PROCESSING** L T P C

3 0 0 3

OBJECTIVES:

- To understand the basic concepts of Radar systems and Signal models.
- To illustrate the concepts of Sampling and Quantization of pulsed radar signals.
- To provide in-depth knowledge in Radar waveforms and Doppler processing.

UNIT I INTRODUCTION TO RADAR SYSTEMS **9**

Basic radar function, elements of pulsed radar, review of signal processing concepts and operations, A preview of basic radar signal processing, radar system components, advanced radar signal processing

UNIT II SIGNAL MODELS **9**

Components of a radar signal, amplitude models, types of clutters, noise model and signal-to noise ratio, jamming, frequency models: the doppler shift, spatial models, spectral model

UNIT III SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS **9**

Domains and criteria for sampling radar signals, Sampling in the fast time dimension, Sampling in slow time: selecting the pulse repetition interval, sampling the doppler spectrum, Sampling in the spatial and angle dimension, Quantization, I/Q Imbalance and Digital I/Q.

UNIT IV RADAR WAVEFORMS **9**

Introduction, The waveform matched filter, Matched filtering of moving targets, The ambiguity function, The pulse burst waveform, frequency-modulated pulse compression waveforms, Range side lobe control for FM waveforms, the stepped frequency waveform, Phase-modulated pulse compression waveforms, COSTAS Frequency codes.

UNIT V DOPPLER PROCESSING **9**

Alternate forms of the Doppler spectrum, Moving target indication (MTI), Pulse Doppler processing, dwell-to-dwell stagger, Pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, MTI for moving platforms: adaptive displaced phase center antenna processing

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Explain the principles of elements and functions involved in radar signal processing

CO2: Explains the various signal models

CO3: Describe different types of radar waveforms

CO4: Discuss the radar waveforms

CO5: Discuss on Doppler processing and its issues

REFERENCES:

1. Francois Le Chevalier, *Principles of Radar and Sonar Signal Processing*, Artech House
2. Fred E. Nathanson, *Radar Design Principles-Signal Processing and the Environment*, PHI
3. Mark A. Richards, 2005, *Fundamentals of Radar Signal Processing*, McGraw-Hill, New York.

4. Michael O Kolawole, 2010, *Radar systems, Peak Detection and Tracking*, Elsevier.
5. Peyton Z. Peebles, 2009, *Radar Principles*, Wiley India.
6. Skolnik, *Introduction to Radar Systems*, 3rd Edition, McGraw Hill.

CN1242 SPEECH PROCESSING AND SYNTHESIS L T P C

3 0 0 3

OBJECTIVES:

- To introduce speech production and related parameters of speech.
- To illustrate the concepts of speech signal representations and coding.
- To understand different speech modeling procedures such Markov and their implementation issues.
- To gain knowledge about text analysis and speech synthesis.

UNIT I FUNDAMENTALS OF SPEECH PROCESSING 9

Introduction , Spoken Language Structure –Phonetics and Phonology – Syllables and Words -Syntax and Semantics – Probability, Statistics and Information Theory – Probability Theory –Estimation Theory – Significance Testing – Information Theory.

UNIT II SPEECH SIGNAL REPRESENTATIONS AND CODING 9

Overview of Digital Signal Processing – Speech Signal Representations – Short time Fourier Analysis Acoustic Model of Speech Production – Linear Predictive Coding – Cepstral Processing – Formant Frequencies – The Role of Pitch – Speech Coding – LPC Coder, CELP, Vocoders

UNIT III SPEECH RECOGNITION 9

Hidden Markov Models – Definition – Continuous and Discontinuous HMMs – Practical Issues – Limitations. Acoustic Modeling – Variability in the Speech Signal – Extracting Features – Phonetic Modeling – Adaptive Techniques – Confidence Measures – Other Techniques.

UNIT IV TEXT ANALYSIS 9

Lexicon – Document Structure Detection – Text Normalization – Linguistic Analysis – Homograph Disambiguation – Morphological Analysis – Letter-to-sound Conversion – Prosody – Generation schematic – Speaking Style – Symbolic Prosody – Duration Assignment – Pitch Generation

UNIT V SPEECH SYNTHESIS 9

Attributes – Formant Speech Synthesis – Concatenative Speech Synthesis – Prosodic Modification of Speech – Source-filter Models for Prosody Modification – Evaluation of TTS Systems.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Model speech production system and describe the fundamentals of speech.

CO2: Extract and compare different speech parameters.

CO3: Choose an appropriate statistical speech model for a given application.

CO4: Design a speech recognition system.

CO5: Use different text analysis and speech synthesis techniques.

REFERENCES:

1. Ben Gold & Nelson Morgan, 2006*, Speech and Audio Signal Processing, Processing and Perception of Speech and Music*, India Edition, Wiley.
2. Claudio Becchetti & LucioPrina Ricotti, 1999, *Speech Recognition*, John Wiley and Sons.
3. Daniel Jurafsky & James H Martin, 2002, *Speech and Language Processing – An Introduction to Natural Language Processing*, *Computational Linguistics, and Speech Recognition*, Pearson Education.
4. Frederick Jelinek, 1997, *Statistical Methods of Speech Recognition*, MIT Press.
5. Lawrence Rabiner & Biing-Hwang Juang, 2003, *Fundamentals of Speech Recognition*, Pearson Education.
6. Steven W. Smith, 1997, *The Scientist and Engineers Guide to Digital Signal Processing*, California Technical Publishing.
7. Thomas F Quatieri, 2004, *Discrete-Time Speech Signal Processing – Principles and Practice*, Pearson Education.

Professional Elective - IV (Semester - III)

CN1331	BROADBAND ACCESS TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To give fundamental concepts related to broadband access technologies.
- To understand the current and emerging wired and wireless access technologies.
- To acquire knowledge about cable modems and fiber access technologies.
- To have an exposure to different systems standards for next generation broadband access networks.

UNIT I REVIEW OF ACCESS TECHNOLOGIES 9

Phone-Line modem, cable-access, ISDN, Emerging Broad band Technologies, Cable DSL, Fiber and Wireless, Standards for access network.

UNIT II DIGITAL SUBSCRIBER LINES 9

Asymmetric Digital subscriber lines (ADSL) – Rate Adaptive subscriber line (RADSL)- ISDN Digital subscriber line (IDSL) - High bit rate DSL (HDSL)-Single line DSL (SDSL) - very high bit rate DSL (VDSL) - Standards for XDSL & Comparison.

UNIT III CABLE MODEM 9

Cable Modem, DOCSIS – Physical Cabling, Dual Modem Operation, Hub Restriction, Upstream Operation – Downstream operation – Access control – framing Security sub layer – Data link layer – LLC & Higher layers – ATM centric VS IP – centric cable modem.

UNIT IV FIBER ACCESS TECHNOLOGIES 9

Optical Fiber in access networks, Architecture and Technologies- Hybrid fiber – Coax (HFC) system, Switched Digital Video (SDV) – Passive optical networks (PON) – FTTX (FTTH, FTTB, FTTC, FTT cab) comparison, Broadband PON , Gigabit-Capable PON.

UNIT V BROADBAND WIRELESS 9

Fixed Wireless, Direct Broadcast Satellite (DBS), Multi channel multi point distribution services (MMDS), Local multi point distribution services (LMDS), and Wideband integrated Digital Interactive Services (WIDIS), Mobile Wireless 3G – IMT 2000, Introduction to LTE-A.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Explain the fundamental concepts of broadband access technologies.
CO2: Compare various standards of Digital Subscriber lines.
CO3: Illustrate the layers of Cable Modem.
CO4: Describe the different types of optical fiber access technologies.
CO5: Explain the enhancement of existing wireless technologies.

REFERENCES:

1. Dennis J. Rauschmayer, 1998, *ADSL/VDSL Principles: A Practical and Precise Study of Asymmetric Digital Subscriber Lines and Very High Speed Digital Subscriber Lines*, Macmillan Technology Series.
2. Gilbert Held, 2000, *Next Generation Modems: A Professional Guide to DSL and Cable Modems*, John Wiley & Sons.
3. Leonid G. Kazovsky, Ning Cheng, Wei-Tao Shaw, David Gutierrez & Shing-Wa Wong, 2011, *Broadband Optical Access Networks*, John Wiley and Sons, New Jersey.
4. Martin P.Clarke, 2000, *Wireless Access Network: Fixed Wireless Access and WLL Network Design and Operation*, John Wiley & Sons.
5. Niel Ransom & Albert A. Azzam, 1999, *Broadband Access Technologies: ADSL, VDSL Cable Modem, Fiber and LMDS*, McGraw Hill.
6. Sassan Ahmadi, 2014, *LTE-Advanced – A practical systems approach to understanding the 3GPP LTE Releases 10 and 11 radio access technologies*, Elsevier.
7. Walter J Woralski, 2001, *ADSL and DSL Technologies*, Second Edition, McGraw Hill Computer Communication Series.
8. William Webb, 2000, *Introduction to Wireless Local Loop Broadband and Narrow Band System*, Second Edition, Mobile Communication Series, Artech House Publishers.

CN1332	**DSP PROCESSOR ARCHITECTURE AND PROGRAMMING**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide in-depth knowledge on Digital Signal Processor basics
- To acquire knowledge on Third generation DSP Architecture and programming skills
- To give knowledge on Advanced DSP architectures and some applications

UNIT I FUNDAMENTALS OF PROGRAMMABLE DSPs **9**

Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.

UNIT II TMS320C5X PROCESSOR **9**

Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

UNIT III TMS320C6X PROCESSOR **9**

Architecture of the C6x Processor - Instruction Set - DSP Development System: Introduction – DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals.

UNIT IV ADSP PROCESSORS **9**

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors - Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.

UNIT V ADVANCED PROCESSORS **9**

Architecture of TMS320C54X: Pipe line operation, Code Composer studio – Architecture of TMS320C6X - Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Explain the fundamentals of programmable Digital Signal Processors.

CO2: Make use of the architecture, addressing modes and instruction sets of TMS320C5X DSP processor to program for processing real time signals.

CO3: Utilize the architecture, addressing modes and instruction sets of TMS320C6X DSP processor to program for processing real time signals in Code Composer Studio.

CO4: Make use of the addressing modes and instruction sets of ADSP-21XX and ADSP-210XX series of DSP processors to program for Filter design and FFT calculation.

CO5: Compare the various features of Advanced DSP architectures.

REFERENCES:

1. Avtar Singh & Srinivasan.S, 2012, *Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx*, Cengage Learning India Private Limited, Delhi.

2. Venkataramani.B and Bhaskar.M, 2003, *Digital Signal Processors – Architecture, Programming and Applications*, Tata McGraw Hill Publishing Company Limited, New Delhi.
3. Rulph Chassaing, 2005, *Digital Signal Processing and Applications with the C6713 and C6416,* Dsk, A John Wiley & Sons, Inc., Publication.
4. User guides Texas Instrumentation, Analog Devices, Motorola.

CN1333 NETWORK PROCESSORS L T P C

3 0 0 3

OBJECTIVES:

- To learn network processors
- To study commercial network processors
- To understand network processor architecture

UNIT I INTRODUCTION 9

Traditional protocol processing Systems – Network processing Hardware – Basic Packet Processing Algorithms and data Structures - Packet processing functions – Protocol Software – Hardware Architectures for Protocol processing – Classification and Forwarding – Switching Fabrics.

UNIT II NETWORK PROCESSOR TECHNOLOGY 9

Network Processors: Motivation and purpose - Complexity of Network Processor Design – Network Processor Architectures architectural variety, architectural characteristics Peripheral Chips supporting Network Processors: Storage processors, Classification Processors, Search Engines, Switch Fabrics, Traffic Managers.

UNIT III COMMERCIAL NETWORK PROCESSORS 9

Multi-Chip Pipeline, Augmented RISC processor, Embedded Processor plus Coprocessors, Pipelilne of Flomogeneous processors. Configurable Instruction set processors – Pipeline of Electrogeneous processors – Extensive and Diverse processors – Flexible RISC plus Coprocessors – Scalability issues – Design Tradeoffs and consequences.

UNIT IV NETWORK PROCESSOR: ARCHITECTURE AND PROGRAMMING 9

Embedded EISC processor - Packet Processor Hardware – Memory interfaces – System and Control Interface Components – Bus Interface. Programming Software Development Kit-IXP Instruction set – register formats – Micro Engine Programming – Intra thread and Inter-thread communication– thread synchronization – developing sample applications – control plane – ARM programming.

UNIT V IOS TECHNOLOGIES **9**

CISCO COS – Connectilvity and scalability – high availability – IP routing – IP services – IPV6 –Mobile IP – MPLS – IP Multicast 0 Manageability – QoS – Security – Switching – Layer VPN2.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Illustrate the concept of network processing & hardware.
CO2: Summarize the various Network Processor Technologies.
CO3: Explain the various commercial Network Processors.
CO4: Outline the usage of Network Processor Architecture & programming.
CO5: Illustrate the various IOS Technologies

REFERENCES:

1. Douglas E.Comer, 2003, *Networks Systems Design using Network Processors*, Prentice Hall JaN.
2. Erik, J.Johnson & Aaron R.Kunze, *IXP2400/2806 Programming: The Microengine Coding Grade*, Intel Press.
3. Hill Carlson, *Intel Internet Exchange Architecture & Applications a Practical Guide to Intel's network Processors*, Intel press. www.cisco.com.
4. Panas C. Lekkas, 2003, *Network Processors: Architectures, Protocols and Paradigms Telecom Engineering*, McGraw Hill.
5. Patrick Crowley, M aEranklin, H. Hadminglu & PZ Onfryk, 2002, *Network Processor Design, Issues and Practices Vol-1*, Morgan Kaufman.
6. Patrick Crowley, M a Frankliln & H. Hadimioglyum PZ Onufryk, 2003, *Network Processor Design, Issues and Prentices vol.II*, Morgan Kaufman.
7. Ran Giladi, 2008, *Network Processors: Architecture, Programming, and Implementation*, Morgan Kauffmann.

CN1334 **SOFTWARE DEFINED RADIO** L T P C

3 0 0 3

OBJECTIVES:

- To understand radio frequency implementation of Software Defined Radio.
- To learn multi rate signal processing and digital generation of signals.

UNIT I INTRODUCTION & CASE STUDIES **9**

Introduction to software Radio concepts: Need for software Radios, Definition of software Radio, Characteristics and Benefits. Design Principles. Case studies: SPEAK easy, JTRS, SDR-3000.

UNIT II RADIO FREQUENCY IMPLEMENTATION 9

The purpose of the RF Front End, Dynamic Range, RF receivers front end Topologies, Importance of the components to Overall performance, Transmitter Architecture, Noise and Distortion in the RF Chain, ADC and DAC Distortion, Flexible RF systems using MEMS.

UNIT III MULTIRATE SIGNAL PROCESSING & DIGITAL GENERATION OF SIGNALS 9

Sample rate conversion principles. Digital filter Banks. Timing recovery in Digital Receivers using Multi rate Digital filters. Approaches to Direct Digital Synthesis. Analysis of spurious signal Band pass signal generation, Generation of Random sequences.

UNIT IV DATA CONVERTERS AND SMART ANTENNAS 9

Parameters of Ideal and practical Data Converters, Techniques to Improve Data Converter performance, Common ADC and DAC Architectures. Smart Antennas-Hardware implementation of Smart Antennas.

UNIT V DIGITAL HARDWARE AND SOFTWARE CHOICES 9

DSP Processors, FPGA, ASIC s. Trade offs, Object oriented programming, Object Brokers, GNU Radio-USRP.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Outline the design principles of Software Defined Radio (SDR) using the characteristics and benefits of Software Defined Radio.

CO2: Explain the various modules in the radio frequency implementation of Software Defined Radio.

CO3: Discuss the concepts of multirate signal processing in the implementation of Software Defined Radio using the digitally generated signals.

CO4: Describe the parameters and techniques of data converters and smart antenna used in the Software Defined Radio.

CO5: Compare the various digital hardware and software choices for the implementation of Software Defined Radio.

REFERENC ES:

1. Jeffrey H.Reed, 2002, *Software Radio: A Modern Approach to Radio Engineering*, Prentice Hall.
2. Joseph Mitola, 2000, *Software Radio Architecture: Object oriented Approaches to Wireless System Engineering*, I Edition 2000, ISBN: 0471384925, Wiley-Inter Science.

3. Radio, G. N. U, 2007, *The gnu software radio,* available from world wide web: https://gnuradio. org.
4. S.Shanmugavel, M.A.Bhagyaveni & R.Kalidoss, 2017, *Cognitive Radio-An Enabler for Internet of things*, River Publishers.

CN1335 SPACE TIME WIRELESS COMMUNICATION L T P C

3 0 0 3

OBJECTIVES:

- To acquire the knowledge on various modulation and coding schemes for space-time wireless communications.
- To understand transmission and decoding techniques associated with wireless communications.
- To understand multiple-antenna systems such as multiple-input multiple-output (MIMO) and space-time codes.

UNIT I MULTIPLE ANTENNA PROPAGATION AND ST CHANNEL CHARACTERIZATION 9

Wireless channel, Scattering model in macrocells, Channel as a ST random field, Scattering functions, Polarization and field diverse channels, Antenna array topology, Degenerate channels, reciprocity and its implications, Channel definitions, Physical scattering model, Extended channel models, Channel measurements, sampled signal model, ST multiuser and ST interference channels, ST channel estimation.

UNIT II CAPACITY OF MULTIPLE ANTENNA CHANNELS 9

Capacity of frequency flat deterministic MIMO channel: Channel unknown to the transmitter, Channel known to the transmitter, capacity of random MIMO channels, Influence of ricean fading, fading correlation, XPD and degeneracy on MIMO capacity, Capacity of frequency selective MIMO channels.

UNIT III SPATIAL DIVERSITY 8

Diversity gain, Diversity order and channel variability, Diversity performance in extended channels, Combined space and path diversity, Indirect transmit diversity, Diversity of a space-time- frequency selective fading channel.

UNIT IV MULTIPLE ANTENNA CODING AND RECEIVERS 10

Coding and interleaving architecture, ST coding for frequency flat channels, ST coding for frequency selective channels, Iterative MIMO receivers, Exploiting channel knowledge at the transmitter: linear pre-filtering, optimal pre-filtering for maximum rate, optimal pre-filtering for error rate minimization, selection at the transmitter, Exploiting imperfect channel knowledge

UNIT V ST OFDM, SPREADSPECTRUM AND MIMO MULTIUSER DETECTION 9

SISO-OFDM modulation, MIMO-OFDM modulation, Signaling and receivers for MIMOOFDM,SISO-SS modulation, MIMO-SS modulation, Signaling and receivers for MIMO- SS. MIMO MAC, MIMO-BC, Outage performance for MIMO-MU, MIMO-MU with OFDM, CDMA and multiple antennas.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Describe the Space Time MIMO concepts of propagation and channel characterization.

CO2: Discuss the Calculation of capacity of MIMO systems

CO3: Explain the receiver and transmitter diversity techniques

CO4: Explain the space time coding and optimal pre-filter design in the absence of CSIT and presence of CSIT

CO5: Illustrate the OFDM, spread spectrum and MIMO multiuser detection techniques.

REFERENCES:

1. Paulraj.A, Rohit Nabar & Dhananjay Gore, 2003, *Introduction to Space Time Wireless Communication Systems*, Cambridge University Press.
2. Andre Viterbi, 1995 *Principles of Spread Spectrum Techniques*, Addison Wesley
3. Jafarkhani, Hamid, 2005, *Space-time coding: theory and practice*, Cambridge university press.
4. Sergio Verdu, 1998, *Multi User Detection*, Cambridge University Press.

CN1336 **WAVELET TRANSFORMS AND ITS APPLICATIONS**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce the fundamentals concepts of wavelet transforms
- To study wavelet functions and its properties
- To study system design using Wavelets
- To learn the different wavelet families
- To build various applications using wavelet transform

UNIT I INTRODUCTION TOWAVELETS 9

Introduction to Multirate signal processing- Decimation and Interpolation, Quadrature Mirror Filters, Subband coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous Wavelet transform, Time frequency representation, Wavelet System and its characteristics, Orthogonal and Orthonormal functions and function space

UNIT II MULTIRESOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM 9

Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banks-Analysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured filter bank,Multichannel filter bank, Undecimated wavelet transform

UNIT III WAVELETSYSTEMDESIGN 9

Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets.

UNIT IV WAVELET FAMILIES 9

Continuous Wavelets- Properties of Mexican hat wavelet, Morlet, Gaussian and Meyer wavelets. Orthogonal wavelets- Properties of Haar wavelets, Daubechies wavelets, Symlets, Coiflets and Discrete Meyer wavelets. Properties of Biorthogonal wavelets, Applications of wavelet families.

UNIT V WAVELETAPPLICATIONS 9

Denoising of Signals and Images, Image enhancement, Edge detection, Image Fusion, Image compression, Wavelet based feature extraction, Analysis of phonocardiogram signals, Analysis of EEG signals, Speech enhancement for hearing aids

Total Periods: 45

OUTCOMES:

Upon Successful Completion of this course, the students will be able to

CO1: Study the basic concepts of wavelet transforms

CO2: Elucidate the properties of wavelet functions

CO3: Explain the system design using wavelets

CO4: Study different wavelet families

CO5: Build various applications using wavelet transforms

REFERENCES:

1. Sidney Burrus.C, Ramesh Gopinath & Haito Guo, 1998, *Introduction to wavelets and wavelet transform* Prentice Hall.
2. Strang.G & Nguyen.T, *Wavelet and filter banks*, Wesley and Cambridge Press.
3. MetinAkay, 1997, *Time frequency and wavelets in biomedical signal processing*, Wiley-IEEE Press.
4. Vetterli.M & Kovacevic.J, 1995, *Wavelets and sub band coding*, Prentice Hall.
5. Vaidyanathan. P.P, 1993, *Multi rate systems and filter banks*, Prentice Hall.
6. Raguveer M Rao & Ajith S. Bopardikar, 1998, *Wavelet transforms – Introduction to theory and applications* Addison Wesley.
7. Mallet.S, 1998, *A Wavelet tour of signal processing*, Academic Press.

Professional Elective - V (Semester - III)

CN1337 **GAME THEORY FOR WIRELESS COMMUNICATION AND NETWORKING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To give an overview of a broad range of models that is studied in game theory.
- To understand classification of games.
- To understand a range of mathematical models of Conflict and cooperation between two or more agents.
- To discuss the main concepts in the game theory and to explain the classes of games.
- To discuss the application of game theory in wireless communication and networking.

UNIT I INTRODUCTION **9**

Introduction to theory of games- conflict, strategy, utility theory, games in extensive and normal forms, Examples: prisoners dilemma, battle of sexes.

UNIT II CLASSIFICATION OF GAMES **9**

NON CO-OPERATIVE GAMES: Basics of Non-Cooperative games, Non-Cooperative games in strategic form – Matrix games, Nash Equilibrium, Mixed Strategies. Dynamic Non-Cooperative games – Non-Cooperative game in extensive form, repeated games, and stochastic games. COOPERATIVE GAMES : Basics of Cooperative games, bargaining theory – Introduction, Nash bargaining solution, Coalition game theory – shapley value, Dynamic Coalition formation algorithms, Hedonic coalition

UNIT III BAYESIAN GAMES **9**

Overview of Bayesian Games, Bayesian Games in extensive form, Cournot duopoly model with incomplete information, Super-Modular games, Learning in games: Fictitious play, and Regret minimization, Vickrey-Clarke-Groves Auction, Optimal Auction

UNIT IV APPLICATIONS TO NETWORKING - I **9**

Cellular & Broadband wireless access networks – Routing & Resource allocation, Power allocation, Network selection in Multi-technology, WLAN – MAC Protocol design, Random Access Control, Rate Selection for VOIP services, throughput efficiency, competition and implication on network performance

UNIT V APPLICATIONS TO NETWORKING - II **9**

Game theoretic solutions for cooperation in ad hoc networks. Game theory for co-operative node selection for Cognitive network, Game theory for cooperative sensing in CR network, Game theory for optimal power allocation for co-operative CR networks.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1 : Interpret the theory of games and the different forms of games

CO2: Summarize the types of non co-operative and co-operative games

CO3: Infer about the different forms & learning the parameters of Bayesian games.

CO4: Outline the routing, resource allocation & random access of cellular and broadband wireless access networks.

CO5: Relate the game theory principle with the node selection, sensing & Optimal power allocation for Cognitive Radio networks.

REFERENCES:

1. Allan MacKenzie & Luiz DaSilva, 2006, *Game Theory for Wireless Engineers, Synthesis Lectures on Communication*, Morgan and Claypool Publishers.
2. Drew Fudenberg & Jean Tirole, 1991, *Game Theory*, MIT Press.
3. Hao, Xiaolei, 2012, *Hedonic coalition formation game for cooperative spectrum sensing and channel access in cognitive radio networks,* IEEE Transactions on Wireless Communications.
4. Khayatian, Hasan, Reza Saadat & Jamshid Abouei, 2013, *Coalition-based approaches for joint power control and relay selection in cooperative networks,* IEEE Transactions on Vehicular Technology 62.2 (2013): 835-842.
5. Martin J. Osborne, 2006, *An Introduction to Game Theory*, Oxford Press.
6. Prajit K.Dutta, 1999, *Strategies and Games: Theory and Practice*, MIT Press.
7. Vijay Krishna, 2010, *Auction Theory*, Academic Press.
8. Zhu Han, Dusit Niyato, Walid Saad, Tamer Basar & Are Hjorungnes, 2012, *Game Theory in Wireless and Communication Networks: Theory, Models, and Applications*, First Edition, University Press Cambridge.

CN1338 MULTIMEDIA COMPRESSION TECHNIQUES L T P C

3 0 0 3

OBJECTIVES:

- To understand the basic ideas of compression algorithms related to multimedia components – Text, speech, audio, image and Video.
- To understand the principles and standards and their applications with an emphasis on underlying technologies, algorithms, and performance.
- To appreciate the use of compression in multimedia processing applications
- To understand and implement compression standards in detail

UNIT I FUNDAMENTALS OF COMPRESSION 9

Introduction To multimedia – Graphics, Image and Video representations – Fundamental concepts of video, digital audio – Storage requirements of multimedia applications – Need for compression – Taxonomy of compression Algorithms - Elements of Information Theory – Error Free Compression – Lossy Compression.

UNIT II TEXT COMPRESSION 9

Huffman coding – Adaptive Huffman coding – Arithmetic coding – Shannon-Fano coding – Dictionary techniques – LZW family algorithms.

UNIT III IMAGE COMPRESSION 9

Image Compression: Fundamentals –– Compression Standards – JPEG Standard – Sub-band coding – Wavelet Based compression – Implementation using Filters – EZW, SPIHT coders – JPEG 2000 standards – JBIG and JBIG2 standards.

UNIT IV AUDIO COMPRESSION 9

Audio compression Techniques – law, A-Law companding – Frequency domain and filtering – Basic sub-band coding – Application to speech coding – G.722 – MPEG audio – progressive encoding – Silence compression, Speech compression – Formant and CELP vocoders.

UNIT V VIDEO COMPRESSION 9

Video compression techniques and Standards – MPEG video coding: MPEG-1 and MPEG-2 video coding: MPEG-3 and MPEG-4 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – DVI real time compression – Current Trends in Compression standards.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Explain the various compression algorithm techniques with MATLAB for multimedia.

CO2: Solve encoding/decoding process of text using various compression techniques.

CO3: Discuss the various image compression techniques.

CO4: Discuss the various audio compression techniques with mini project**.**

CO5: Discuss the various video compression techniques with mini project**.**

REFERENCES:

1. David Solomon, 2006, *Data Compression – The Complete Reference*, Fourth Edition, Springer Verlog, New York.
2. Darrel Hankerson, Greg A Harris & Peter D Johnson, 2003, *Introduction to Information Theory and Data Compression*, Second Edition, Chapman and Hall, CRC press.
3. Khalid Sayood, 2010, *Introduction to Data Compression*, Third Edition, Morgan Kauffman Harcourt, India.
4. Mark S. Drew & Ze-Nian Li, 2009,*Fundamentals of Multimedia*, PHI.
5. Peter Symes, 2004, *Digital Video Compression*, McGraw Hill Pub.
6. Yun Q.Shi & Huifang Sun, 2003, *Image and Video Compression for Multimedia Engineering, Algorithms and Fundamentals*, CRC Press.

CN1339	**NETWORK ROUTING ALGORITHM**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To expose the students to the layered architecture for communication networks and the specific functionality of the network layer.
- To enable the student to understand the basic principles of routing and the manner this is implemented in conventional networks and the evolving routing algorithms based on internetworking requirements, optical backbone and the wireless access part of the network
- To enable the student to understand the different routing algorithms existing and their performance characteristics.

UNIT I INTRODUCTION **7**

ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Routing in telephone networks, Dynamic Non hierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing, Link state routing, Hierarchical routing.

UNIT II INTERNET ROUTING **10**

Interior protocol : Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Bellman Ford Distance Vector Routing. Exterior Routing Protocols: Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). Multicast Routing: Pros and cons of Multicast and Multiple Unicast Routing, Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), MBONE, Core Based Tree Routing.

UNIT III ROUTING IN OPTICAL WDM NETWORKS **10**

Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength ReroutingBenefits and Issues, Lightpath Migration, Rerouting Schemes, Algorithms- AG, MWPG.

UNIT IV MOBILE - IP NETWORKS **9**

Macro-mobility Protocols, Micro-mobility protocol: Tunnel based : Hierarchical Mobile IP, Intra domain Mobility Management, Routing based: Cellular IP, Handoff Wireless Access Internet Infrastructure (HAWAII).

UNIT V MOBILE AD –HOC NETWORKS **9**

Internet-based mobile ad-hoc networking communication strategies, Routing algorithms – Proactive routing: destination sequenced Distance Vector Routing (DSDV), Reactive routing:Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV), Hybrid Routing: Zone Based Routing (ZRP).

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Illustrate the concept of network layer.

CO2: Make use of Internet routing Protocols.

CO3: Explain the Routing In Optical WDM Networks.

CO4: Outline the Mobile-IP Networking Concepts for various applications.

CO5: Illustrate the concept of Mobile Adhoc Networks.

REFERENCES:

1. Campbell.A.T, Feb 2002, *Comparison of IP Micromobility Protocols*, IEEE Wireless Communications, pp 72-82.
2. Perkins.C.E, 2001, *Ad Hoc Networking*, Addison Wesley.

3. Siva Rama Murthy.C & Mohan Gurusamy, 2002, *WDM Optical Networks – Concepts, Design and Algorithms*, Prentice Hall of India Pvt. Ltd, New Delhi.
4. Ian F. Akyildiz, Jiang Xie & Shantidev Mohanty, Aug.2004, *A Survey of mobility Management in Next generation All IP- Based Wireless Systems*, IEEE Wireless Communications, pp 16-27.
5. Steen Strub.M, 1995, *Routing in Communication network*, Prentice Hall International, Newyork.
6. Keshav.S, 1999, *An engineering approach to computer networking*, Addison Wesley.
7. William Stallings, 1995, *High speed Networks TCP/IP and ATM Design Principles*, Prentice Hall, New York.
8. William Stallings, 2002, *High speed networks and Internets Performance and Quality of Service*, II Edition, Pearson Education Asia. Reprint India.

CN1340 **OPTICAL NETWORKS** L T P C

3 0 0 3

OBJECTIVES:

- To understand the optical system components like optical amplifiers, wavelength converters.
- To understand the up-to-date survey of development in optical network architectures.
- To understand the packet switching.
- To understand the network design perspectives.
- To understand the different optical network management techniques and functions

UNIT I INTRODUCTION TO OPTICAL NETWORKS **9**

Telecommunications Networks Architecture, Services, circuit switching and packet switching, Optical Networks: Multiplexing Techniques, Second generation Optical Networks, Optical Packet Switching, Transmission Basics: Wavelength, frequencies, and channel spacing, Wavelength standards, Optical power and loss, Network Evolution, Nonlinear Effects: Self-phase Modulation, Cross-phase Modulation, Four Wave mixing, Solitons. Components: Couplers, Isolators and Circulators, Multiplexers and Filters, Optical Amplifiers, Transmitters, Detectors, Switches, Wavelength Converters.

UNIT II TRANSMISSION SYSTEM ENGINEERING 9

System Model, Power Penalty, Transmitter, Receiver, Optical Amplifiers, Crosstalk, Dispersion, Wavelength Stabilization, Overall Design Considerations. Optical Internets: Migration to IP optical networking, IP and Optical backbone, IP Routing table, MPLS and optical cross connect table, Protocol stack Alternatives, Internetworking SS7 and Legacy Transport, Internet transport network protocol stack.

UNIT III SONET, SDH AND OPTICAL TRANSPORT NETWORKS (OTNS) 9

SONET and SDH: SONET multiplexing hierarchy, Frame structure, Functional Component, problem detection, concatenation. Architecture of Optical Transport Networks (OTNs): Digital wrapper, in-band and out-ofband control signalling, Importance of Multiplexing and multiplexing hierarchies, SONET multiplexing hierarchies, SDH multiplexing hierarchies, New Optical Transport, OTN layered Model, Generic Framing Procedure (GFP) **.**

UNIT IV WDM, NETWORK TOPOLOGIES, MPLS AND OPTICAL NETWORKS 9

WDM: WDM operation, Dense Wavelength Division Multiplexing (DWDM), Erbium-doped Fiber (EDF), WDM amplifiers, Add-Drop Multiplexers, Wavelength Continuity Property, Higher dispersion for DWDM, Tunable DWDM Lasers.

UNIT V NETWORK TOPOLOGIES AND PROTECTION SCHEMES 9

Robust networks, Line and path protection switching, Types of topology, Point to point topology, bi-directional line-switched ring (BLSR), meshed topology, Passive optical networks, Metro optical networks 28 MPLS and Optical Networks: IS label switching, Forwarding equivalence class (FEC), Types of MPLS nodes, Label distribution and binding, label swapping and traffic forwarding, MPLS support of Virtual Private Networks (VPN), MPLS traffic engineering, Multi protocol Lambda switching (MPIS).

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Explain the circuit switching, packet switching and optical networks.

CO2: Design the optical amplifiers and optical internets.

CO3: Describe the SONET, SDH and Optical Transport Networks.

CO4: Design the WDM and DWDM in fiber optic system.

CO5: Explain the concept of various types of network topologies and its nodes.

REFERENCES:

1. Rajiv Ramaswami & Kumar Sivarajan, *Optical Networks Practical Perspective*, 3rd Edition, Morgan - Kaufmann Publishers.
2. Uyless Black, *Optical Networks, Third Generation Transport Systems*, Pearson.

CN1341 ULTRA WIDEBAND COMMUNICATION L T P C

3 0 0 3

OBJECTIVES:

- To give fundamental concepts related to Ultra wide band
- To understand the channel model and signal processing for UWB.
- To acquire knowledge about UWB antennas and regulations.

UNIT I INTRODUCTION TO UWB 9

History, Definition, FCC Mask, UWB features, UWB Interference: IEEE 802.11.a Interference, Signal to Interference ratio calculation, Interference with other wireless services.

UNIT II UWB TECHNOLOGIES AND CHANNEL MODELS 9

Impulse Radio, Pulsed Multiband, Multiband OFDM, features: Complexity, Power Consumption, Security and achievable data rate. MIMO Multiband OFDM, Differential multiband OFDM, Performance characterization, Ultra Wide Band Wireless Channels Channel model: Impulse Response Modeling of UWB Wireless Channels, IEEE UWB channel model, Path loss, Delay profiles, Time and frequency modeling.

UNIT III UWB SIGNAL PROCESSING 9

Data Modulation schemes, UWB Multiple Access Modulation, BER, Rake Receiver, Transmit- Reference (T-R) Technique, UWB Range- Data Rate Performance, UWB Channel Capacity, UWB Wireless Locationing: Position Locationing Methods, Time of Arrival Estimation, NLOS Location Error, Locationing with OFDM.

UNIT IV UWB ANTENNAS 9

Antenna Requirements, Radiation Mechanism of the UWB Antennas, Types of Broad band antennas, Parameters, Analysis of UWB Antennas, Link Budget for UWB System. Design examples of broad band UWB antennas.

UNIT V UWB APPLICATIONS AND REGULATIONS 9

Wireless Ad hoc Networking, UWB Wireless Sensor, RFID, Consumer Electronics and Personal, Asset Location, Medical applications, UWB Regulation and standards in various countries , UWB Regulation in ITU, IEEE Standardization

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1 : Understand the concepts of UWB Communications

CO2 : Explain the UWB signal processing technologies and Channel models

CO3 : Describe the Performance of UWB channels

CO4 : Explain the UWB antenna for various applications

CO5 : Discuss the various UWB Applications

REFERENCES:

1. Homayoun Nikookar & Ramjee Prasad, 2010, *Introduction to Ultra Wideband for Wireless Communications,* 1st Edition, Springer Science & Business Media B.V.
2. Thomas Kaiser & Feng Zheng, 2010, *Ultra Wideband Systems with MIMO*, 1st Edition, John Wiley & Sons Ltd, New York.
3. Pam Siriwong Pairat.W & Ray Liu.K. J, 2008, *Ultra-Wideband Communications Systems: Multiband OFDM approach*, John Wiley and IEEE press, New York.

CN1342	WIRELESS ADHOC AND SENSOR NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of Ad-hoc & Sensor Networks.
- To learn various fundamental and emerging protocols of all layers.
- To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.
- To understand the nature and applications of Ad-hoc and sensor networks.
- To understand various security practices and protocols of Ad-hoc and Sensor Networks

UNIT I MAC & TCP IN AD HOC NETWORKS 9

Fundamentals of WLANs – IEEE 802.11 Architecture - Self configuration and Auto configuration-Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – Contention Based Protocols - TCP over Ad-Hoc networks-TCP protocol overview - TCP and MANETs – Solutions for TCP over Ad-Hoc Networks.

UNIT II ROUTING IN AD HOC NETWORKS 9

Routing in Ad-Hoc Networks- Introduction-Topology based versus Position based Approaches-Proactive, Reactive, Hybrid Routing Approach-Principles and issues – Location services - DREAM – Quorums based location service – Grid – Forwarding strategies – Greedy packet forwarding – Restricted directional flooding- Hierarchical Routing- Issues and Challenges in providing QoS.

UNIT III MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS 9

Introduction – Architecture - Single node architecture – Sensor network design considerations – Energy Efficient Design principles for WSNs – Protocols for WSN – Physical Layer : Transceiver Design considerations – MAC Layer Protocols – IEEE 802.15.4 Zigbee – Link Layer and Error Control issues - Routing Protocols – Mobile Nodes and Mobile Robots - Data Centric & Contention Based Networking – Transport Protocols & QOS – Congestion Control issues – Application Layer support.

UNIT IV SENSOR MANAGEMENT 9

Sensor Management - Topology Control Protocols and Sensing Mode Selection Protocols - Time synchronization - Localization and positioning – Operating systems and Sensor Network programming – Sensor Network Simulators.

UNIT V SECURITY IN AD HOC AND SENSOR NETWORKS 9

Security in Ad-Hoc and Sensor networks – Key Distribution and Management – Software based Anti-tamper techniques – water marking techniques – Defense against routing attacks - Secure Adhoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Infer about the network architectures, Issues & design challenges and MAC & TCP protocols of adhoc networks.

CO2: Demonstrate the types of routing protocols and their challenges & issues in adhoc networks.

CO3: Interpret the MAC and routing protocols for wireless sensor networks with respect to some protocol design issues.

CO4: Summarize the protocols, time synchronization, localization & position in sensor management.

CO5: Outline the different attacks and secure routing for sensor networks.

REFERENCES:

1. Adrian Perrig &Tygar. J. D, 2006, *Secure Broadcast Communication: In Wired and Wireless Networks*, Springer.
2. Carlos De Morais Cordeiro & Dharma Prakash Agrawal, 2011, *Ad Hoc and Sensor Networks: Theory and Applications*, Second Edition, World Scientific Publishing.
3. Siva Ram Murthy.C & Manoj.B.S, 2004, *Ad Hoc Wireless Networks – Architectures and Protocols*, Pearson Education.
4. Toh.C.K, 2002, *Ad Hoc Mobile Wireless Networks*, Pearson Education.

5. ErdalÇayırcı &Chunming Rong, 2009, *Security in Wireless Ad Hoc and Sensor Networks*, John Wiley and Sons.
6. Holger Karl & Andreas willig, 2005, *Protocols and Architectures for Wireless Sensor Networks*, John Wiley & Sons.
7. Subir Kumar Sarkar, Basavaraju. T.G & Puttamadappa.C, 2008, *Ad Hoc Mobile Wireless Networks*, Auerbach Publications.
8. Waltenegus Dargie & Christian Poellabauer, 2010, *Fundamentals of Wireless Sensor Networks Theory and Practice*, John Wiley and Sons.

Open Electives

OCN151	BIOSENSORS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the students to different types of electrodes used in bio potential recording and to expose the students to perceive the need for bio amplifiers and their characteristics needed to be design for various bandwidth and frequency response.
- To facilitate the students in recognizing electrode configuration and issues related with the electrode relative motions.
- To review the cardiac, respiratory and muscular physiological systems. Study the designs of several instruments used to acquire signals from living systems.
- To proclaim the conception in detection of chemical and biomolecules. The students also understand the theory behind the sound and tissue interaction, and able to apply in therapeutic application.

UNIT I BIO POTENTIAL ELECTRODES & BIO AMPLIFIERS 9

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, impedance, polarization effects of electrode – nonpolarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes. Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference.

UNIT II PHYSICAL SENSORS IN BIOMEDICINE 9

Temperature measurement: core temperature,-surface temperature- invasive. Blood flow measurement: skin blood- hot film anemometer- Doppler sonography-electromagnetic sensor - blood pressure measurement: noninvasive-hemodynamic invasive. Spirometry- sensors for pressure pulses and movement-ocular pressure sensor- acoustic sensors in hearing aid, in blood flow measurement, sensors for bio-magnetism, tactile sensors for artificial limbs, sensors in ophthalmoscopy, artificial retina.

UNIT III SENSORS FOR CHEMICAL QUANTITIES IN BIOMEDICINE & DETECTORS IN RADIOLOGY 9

Blood gas and pH sensor, electrochemical sensor, transcutaneous, optical fiber sensor, mass spectrometer, optical oximetry, pulseoximetry, earoximetry.X ray imaging with sensors, detectors in nuclear radiology, magnetic field sensors for imaging, magnetic resonance imaging.

UNIT IV SOUND IN MEDICINE & EEG, EMG & ECG 9

Interaction of Ultrasound with matter; Cavitations, Reflection, Transmission-Scanning systems – Artefacts- Ultrasound- Doppler-Double Doppler shift-Clinical Applications.Bio signal characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. EEG-procedure, signal artefacts, signal analysis, evoked potential, EMG- procedure and signal analysis, Nerve conduction study.

UNIT V BIO SENSORS 9

Principles- DNA based biosensors – Protein based biosensors – materials for biosensor applications fabrication of biosensors—future potential.

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Explain the need for reusable electrodes and the method of implementation.

CO2: Interpret the electrode placements for various bio potential recording as per the voltage range.

CO3: Outline the design principles of bio-amplifiers and drawback related with noises.

CO4: Explain different types of physiological parameter measurement using appropriate sensors.

CO5: Apply site specific chemical sensors design and imaging techniques for typical

Issues

REFERENCES:

1. Webster.J.G, 2015, *Medical Instrumentation; Application and Design*, 4th Edition, John Wiley & Sons, Inc., New York.
2. Biosensors: an introduction / Brian R. Eggins. Eggins, Brian R.; R857.B54 E35 1996.
3. Khandpur.R.S, 2014, *Handbook of Biomedical Instrumentation*, 3rd edition, Tata McGraw Hill, New Delhi.
4. John Enderle & Joseph Bronzino, 2011, *Introduction to Biomedical Engineering,* 3rd Edition, Academic Press.
5. Myer Kutz, 2009, *Biomedical Engineering and Design Handbook, Volume 1: Volume I: Biomedical Engineering Fundamentals,* 2nd Edition, McGraw Hill Publisher, USA.
6. Bard.A.J & Faulkner.L.R., 2001, *Electrochemical Methods: Fundamentals and Applications*, 2nd Edition, Wiley.
7. Banica.F.G, 2012, Chemical Sensors and Biosensors: Fundamentals and Applications, Wiley.

OCN152 COMPUTER VISION AND APPLICATIONS L T P C

3 0 0 3

OBJECTIVES:

- To understand how computer treats vision as a process to understand human visual world.
- To understand feature detection techniques and grouping algorithms
- To deal with various segmentation algorithms such as thresholding, connected component, contour detection and motion segmentation
- To learn object recognition and applications such as face recognition, scene understanding, activity recognition and augmented reality.

UNIT I INTRODUCTION TO COMPUTER VISION, CAMERA MODELS AND PROJECTIVE GEOMETRY 9

Introduction to Computer Vision, Applications, Camera Model- Pinhole camera, Camera parameters, intrinsic and extrinsic parameters, Projective Geometry- Perspective Projection, Orthographic Projection, Affine Projection, camera parameters for perspective projection.

UNIT II FEATURE DETECTION, MATCHING AND ALIGNMENT 9

Interest point detection, corner detection, SIFT, Feature matching- RANSAC, matching strategy and error rates, 2D Feature based Alignment- Least squares method

UNIT III SEGMENTATION AND GROUPING 9

Segmentation-Thresholding and Connected component, algorithm, Contour Detection, Region Segmentation, Motion Segmentation- Grouping- K means, clustering, Graph cut

UNIT IV OBJECT RECOGNITION 9

Object detection, Object Modeling, Model-based Object Recognition, Scene and Object Recognition, Shape based Object Recognition.

UNIT V APPLICATIONS 9

Application: Photo Album- Face detection-Face Recognition using PCA, Human Gait Analysis- Surveillance Applications: Foreground –background separation- particle filters- tracking- Scene Understanding- Action Recognition- Application: In-Vehicle Vision System: Locating roadway- road markings-identifying road signs-locating pedestrians.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Understand how to relate world coordinates and image coordinates.

CO2: Apply various feature detection techniques and grouping algorithms and recover transformation parameters.

CO3: Develop various segmentation algorithms such as thresholding, connected component, contour detection and motion segmentation.

CO4: Explain object recognition based on shape and scene understanding.

CO5: Develop applications such as face recognition, scene understanding, activity recognition and augmented reality.

REFERENCES:

1. Szeliski.R, 2010, *Computer vision: algorithms and applications*, Springer Science &
   Business Media.
2. David A. Forsyth & Jean Ponce, 2003, *Computer Vision – A Modern Approach*, ISBN: 0130851981, Prentice Hall.
3. Richard Hartley & Andrew Zisserman, 2004, *Multiple View Geometry in Computer Vision*, Second Edition, Cambridge University Press.
4. Al Bovik, 2000, *Handbook of Image & Video Processing*, ISBN: 0121197905, Academic Press.
5. Chris Stauffer & Grimson.W.E.L, 1999, *Adaptive background mixture models for real- time tracking,* IEEE Computer Vision and Pattern Recognition, volume 2, pages, 2242–2252.

OCN153	**MACHINE LEARNING USING PYTHON**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concepts of Machine Learning using Python
- To apply machine learning algorithm for classification
- To explore the techniques of supervised and unsupervised learning methods
- To handle data preprocessing and model evaluation.

UNIT I INTRODUCTION **9**

Machine learning – Python stack for Data Science – Anaconda Platform – Introduction to Python – Libraries in Python – Dataframes with Python – Exploration of data using visualization - Probability Distributions and Hypothesis test- Linear regression – Building simple linear regression model – Non linear regression.

UNIT II TRAINING MACHINE LEARNING ALGORITHM FOR CLASSIFICATION 9

Artificial neurons – Implementing a perceptron learning algorithm in Python – Training a perceptron model on Iris dataset – Adaptive linear neurons and convergence of learning – Minimizing cost functions with gradient descent – Implementing an adaptive linear neuron in Python – Large scale machine learning and stochastic gradient descent- Case study: A first application classifying Iris species

UNIT III SUPERVISED AND UNSUPERVISED LEARNING 9

Classification and Regression – Over fitting and under fitting – Supervised Machine learning algorithms – Uncertainty estimates from classifier – Unsupervised learning and its types – Preprocessing and scaling – Dimensionality reduction, feature extraction and manifold learning – Clustering.

UNIT IV DATA PREPROCESSING AND FEATURE EXTRACTION 9

Dealing with missing data – Handling categorical data – Mapping ordinal features – Encoding class labels – Performing one hot encoding on nominal features- Partitioning a dataset in training and test sets – Bringing features onto the same scale – Selecting meaningful features – Sparse solutions with L1 regularization- Sequential feature selection algorithm - Assessing feature importance with Random forest

UNIT V MODEL EVALUATION AND IMPROVEMENT 9

Cross validation – Grid search – Evaluation Metrics and scoring – Parameter selection with preprocessing – Building pipelines – Pipelines in Grid search – Grid searching Preprocessing steps and Model parameter. Case study: Representing text data as a bag of words.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Understand the concepts of machine learning.
CO2: Apply the Predictive and Probabilistic modeling techniques.
CO3: Explore the supervised and unsupervised learning techniques.
CO4: Extract the feature and Optimize the features.
CO5: Build reinforcement learning models.

REFERENCES:

1. Andreas C.Muller & Sarah Guido, 2016, *Introduction to Machine Learning with Python*, First Edition, O'Reilly Media.
2. Sebastian Raschka & VahidMirjalili, 2017, *Python Machine Learning*, Second Edition, Packt copy write.
3. Dinesh Kumar.U, Pradhan & Manaranjan, 2019, *Machine Learning using Python*, Wiley India Pvt Ltd.

4. Kevin P. Murphy, 2012, *Machine Learning: A Probabilistic Perspective*, MIT Press.
5. ShaiShalev-Shwartz & Shai Ben-David, 2014, *Understanding Machine Learning: From Theoryto Algorithms*, Cambridge University Press.
6. Christopher M. Bishop, 2011, *Pattern Recognition and Machine Learning*, Springer.
7. Tom Mitchell, 2017, *Machine Learning*, McGraw-Hill.
8. https://www.coursera.org/learn/machine-learning
9. http://machinelearningmastery.com/best-machine-learning-resources-forgettingstarted/
10. https://www.udemy.com/machinelearning/

OCN154	MEDICAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To update the knowledge about the current state-of-the-art in medical imaging and medical image analysis
- To extract, model, and analyze information from medical data.
- To apply analyzed information for diagnosis, treatment and monitoring of diseases through computer science.

UNIT I INTRODUCTION **9**

Introduction to medical imaging technology, systems, and modalities. Brief history; importance; applications; trends; challenges. Medical Image Formation Principles: X-Ray physics; X-Ray generation, attenuation, scattering; Basic principles of CT; reconstruction methods; artifacts; CT hardware.

UNIT II STORAGE AND PROCESSING **9**

Medical Image Storage, Archiving and Communication Systems, Formats Picture archiving and communication system (PACS); Formats: DICOM Radiology Information Systems (RIS) and Hospital Information Systems (HIS). Medical Image Processing, Enhancement, Filtering Basic image processing algorithms Thresholding; contrast enhancement; SNR characteristics; filtering; histogram modeling.

UNIT III VISUALIZATION **9**

Medical Image Visualization Fundamentals of visualization; surface and volume rendering/visualization; animation; interaction. Magnetic Resonance Imaging (MRI) Mathematics of MR; spin physics; NMR spectroscopy; imaging principles and hardware; image artifacts.

UNIT IV SEGMENTATION AND CLASSIFICATION **9**

Medical Image Segmentation - Histogram-based methods; Region growing and watersheds; Markov Random Field models; active contours; model-based segmentation. Multi-scale segmentation; semi-automated methods; clustering-based methods; classification-based methods; atlas-guided approaches; multi-model segmentation. Medical Image Registration Intensity-based methods; cost functions; optimization techniques.

UNIT V NUCLEAR IMAGING **9**

PET and SPECT Ultrasound Imaging methods; mathematical principles; resolution; noise effect; 3D imaging; positron emission tomography; single photon emission tomography; ultrasound imaging; applications. Medical Image Search and Retrieval Current technology in medical image search, content-based image retrieval, new trends: Ontologies. Applications. Other Applications of Medical Imaging Validation, Image Guided Surgery, Image Guided Therapy, Computer Aided Diagnosis/Diagnostic Support Systems.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: To describe the particular characteristics of imaging modalities.

CO2: To perform enhancing operations on the medical image using image enhancement techniques in spatial and frequency domain for enhancing the quality of image.

CO3: To classify fundamental methods for visualization of medical images.

CO4: To utilize various image segmentation and classification techniques for medical image analysis.

CO5: To apply the techniques of medical image analysis to develop Computer aided detection systems.

REFERENCES:

1. John L. Semmlow, 2008, *Biosignal and Medical Image Processing*, Second Edition, CRC Press.
2. Paul Suetens, 2009, *Fundamentals of Medical Imaging*, Second Edition, Cambridge University Press, Belgium.
3. J. Michael Fitzpatrick & Milan Sonka, 2009, *Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis*, SPIE Publications.
4. Kayvan Najarian & Robert Splinter, 2005, *Biomedical Signal and Image Processing*, Second Edition, CRC Press.
5. Geoff Dougherty, 2009, *Digital Image Processing for Medical Applications*, First Edition, Cambridge University Press.
6. Jerry L. Prince and Jonathan Links, 2005, *Medical Imaging Signals and Systems*, First Edition, Prentice Hall.

OCN155	BASICS OF MEMS AND NEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concepts of microelectromechanical devices.
- To know the fabrication process of Microsystems.
- To know the design concepts of micro sensors and micro actuators.
- To familiarize concepts of quantum mechanics and nano systems.

UNIT I OVERVIEW **9**

New trends in Engineering and Science: Micro and Nanoscale systems, Introduction to Design of MEMS and NEMS, MEMS and NEMS Applications, Devices and structures. Materials for MEMS: Silicon, silicon compounds, polymers, metals.

UNIT II MEMS FABRICATION TECHNOLOGIES **9**

Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect- Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials.

UNIT III MICRO SENSORS **9**

MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Microsensors.

UNIT IV MICRO ACTUATORS **9**

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps.

UNIT V NANOSYSTEMS AND QUANTUM MECHANICS **9**

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Summarize the concept of scaling, applications of MEMS and the materials used for MEMS.

CO2: Ilustrate different techniques involved in MEMS fabrication and Packaging

CO3: Apply the Concept of various sensor design and its engineering mechanisms

CO4: Understand the design concepts of micro actuators

CO5: Understand the concepts of Nano systems and quantum Mechanics

REFERENCES:

1. Chang Liu, 2006, *Foundations of MEMS*, Pearson Education India Limited.
2. Vijay K Varadhan & Vinoy.K.J, 2003, *RF MEMS and their Applications*, John Wiley & Sons.
3. Marc Madou, 1997, *Fundamentals of Microfabrication*, CRC Press.
4. Stephen.D.Senturia, 2001, Micro system Design, Kluwer Academic Publishers.
5. Sergey Edward Lyshevski, 2002, *MEMS and NEMS: Systems, Devices, and Structures,* CRC Press.
6. Tai Ran Hsu, 2002, *MEMS and Microsystems Design and Manufactur*e, Tata Mcraw Hill.

OCN156	**SOFT COMPUTING**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the key aspects of Soft computing and Neural networks.
- To know about the components and building block hypothesis of Genetic algorithm.
- To understand the features of neural network and its applications
- To gain insight onto Neuro Fuzzy modeling and control.
- To gain knowledge in machine learning through Support vector machines.

UNIT I INTRODUCTION TO SOFT COMPUTING **9**

Evolution of Computing - Soft Computing Constituents – From Conventional AI to Computational Intelligence - Machine Learning Basics.

UNIT II GENETIC ALGORITHMS **9**

Introduction, Building block hypothesis, working principle, Basic operators and Terminologies like individual, gene, encoding, fitness function and reproduction, Genetic modeling: Significance of Genetic operators, Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator, GA optimization problems, JSPP (Job Shop Scheduling Problem), TSP (Travelling Salesman Problem), Differences & similarities between GA & other traditional methods, Applications of GA.

UNIT III NEURAL NETWORKS **9**

Machine Learning using Neural Network, Adaptive Networks – Feed Forward Networks – Supervised Learning Neural Networks – Radial Basis Function Networks – Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance Architectures – Advances in Neural Networks.

UNIT IV FUZZY LOGIC **9**

Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions- Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making

UNIT V NEURO-FUZZY MODELING **9**

Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees – Data Clustering Algorithms – Rule base Structure Identification –Neuro-Fuzzy Control – Case Studies.

Total Periods: 45

OUTCOMES:

Upon successful completion of the course, the students will be able to

CO1: Understand machine learning through Neural networks.

CO2: Explain a Fuzzy expert system and solve optimization problems using Genetic Algorithm.

CO3: Use Machine Learning Algorithms for Neural Networks.

CO4: Describe Fuzzy Expert systems.

CO5: Discuss Neuro-Fuzzy modelling.

REFERENCES:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun & Eiji Mizutani, 2003, *Neuro-Fuzzy and Soft Computing*, Prentice-Hall of India.
2. Kwang H.Lee, 2005, *First course on Fuzzy Theory and Applications*, Springer–Verlag Berlin Heidelberg.
3. George J. Klir & Bo Yuan, 1995, *Fuzzy Sets And Fuzzy Logic-Theory And Applications*, Prentice Hall,.
4. James A. Freeman & David M. Skapura, 2003, *Neural Networks Algorithms, Applications, and Programming Techniques*, Pearson Education.
5. David E. Goldberg, 2007, *Genetic Algorithms In Search, Optimization And Machine Learning*, Addison Wesley.
6. Mitsuo Gen & Runwei Cheng, 2000, *Genetic Algorithms and Engineering Optimization*, Wiley Publishers.

7. Mitchell Melanie, 1998, *An Introduction To Genetic Algorithm*, Prentice Hall.
8. Sivanandam.S.N & Deepa.S.N, 2007, *Introduction To Genetic Algorithms*, Springer
9. Eiben & Smith, 2007, *Introduction To Evolutionary Computing*, Springer.
10. Sanchez.E, Shibata.T & Zadeh.L.A, 1997, *Genetic Algorithms And Fuzzy Logic Systems: Soft Computing Perspectives, Advances In Fuzzy Systems - Applications*