NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution – Affiliated to Anna University Chennai)

K.R.NAGAR, KOVILPATTI – 628 503

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REGULATIONS - 2015

DEPARTMENT OF

ELECTRONICS AND COMMUNICATION ENGINEERING

CURRICULUM AND SYLLABI OF

M.E. – COMMUNICATION SYSTEMS

SEMESTER I

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	SFC	15CM11C	Applied Mathematics for Communication Engineers	3	2	0	4	B
2.	PCC	15CM12C	Advanced Digital Signal Processing*	3	0	0	3	B
3	PCC	15CM13C	Advanced Radiation Systems	3	0	0	3	B
4.	PCC	15CM14C	Optical Communication Networks	3	0	0	3	B
5.	PCC	15CM15C	Mobile Communication Systems and Standards	3	0	0	3	B
6.	PCC	15CM16C	Cryptography and Network Security	3	0	0	3	B
PRACTICAL COURSES								
7.	PCC	15CM17C	Communication System Laboratory – I	0	0	4	2	
			Total	**18**	**2**	**4**	**21**	

SEMESTER II

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	PCC	15CM21C	Wireless MIMO Communication	3	0	0	3	B
2.	PCC	15CM22C	High Speed Communication Networks	3	2	0	4	B
3	PCC	15CM23C	Microwave Integrated Circuits	3	0	0	3	B
4.	PCC	15CM24C	RF System Design	3	0	0	3	B
5.	PEC		Elective – I	3	0	0	3	B
PRACTICAL COURSES								
6.	PCC	15CM25C	Communication System Laboratory – II	0	0	4	**2**	
7.	PCC	15CM26C	Research Paper and Patent Review - Seminar	0	0	4	2	
			Total	**15**	**2**	**8**	**20**	

SFC – Specific Foundation Course, PCC – Programme Core Course, PEC – Programme Elective Course, OEC – Open Elective Course
* Common to CS, HVE and C&I; ¥ Common to CS and CN; @ Common to CS and CSE; # Common to CS and C&I

SEMESTER III

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	PEC		Elective -II	3	0	0	3	
2.	PEC		Elective –III	3	0	0	3	
3.	PEC		Elective –IV	3	0	0	3	
4.	OEC		Elective - V	3	0	0	3	
PRACTICAL COURSES								
5.	PCC	15CM31C	Project Work Phase-I	0	0	12	6	
			Total	**12**	**0**	**12**	**18**	

SEMESTER IV

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
PRACTICAL COURSES								
1.	PCC	15CM41C	Project Work Phase-II	0	0	24	12	
			TOTAL	**0**	**0**	**24**	**12**	

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE – 71

SFC – Specific Foundation Course, PCC – Programme Core Course, PEC – Programme Elective Course, OEC – Open Elective Course
* Common to CS, HVE and C&I; ¥ Common to CS and CN; @ Common to CS and CSE; # Common to CS and C&I

PROGRAMME ELECTIVE COURSES

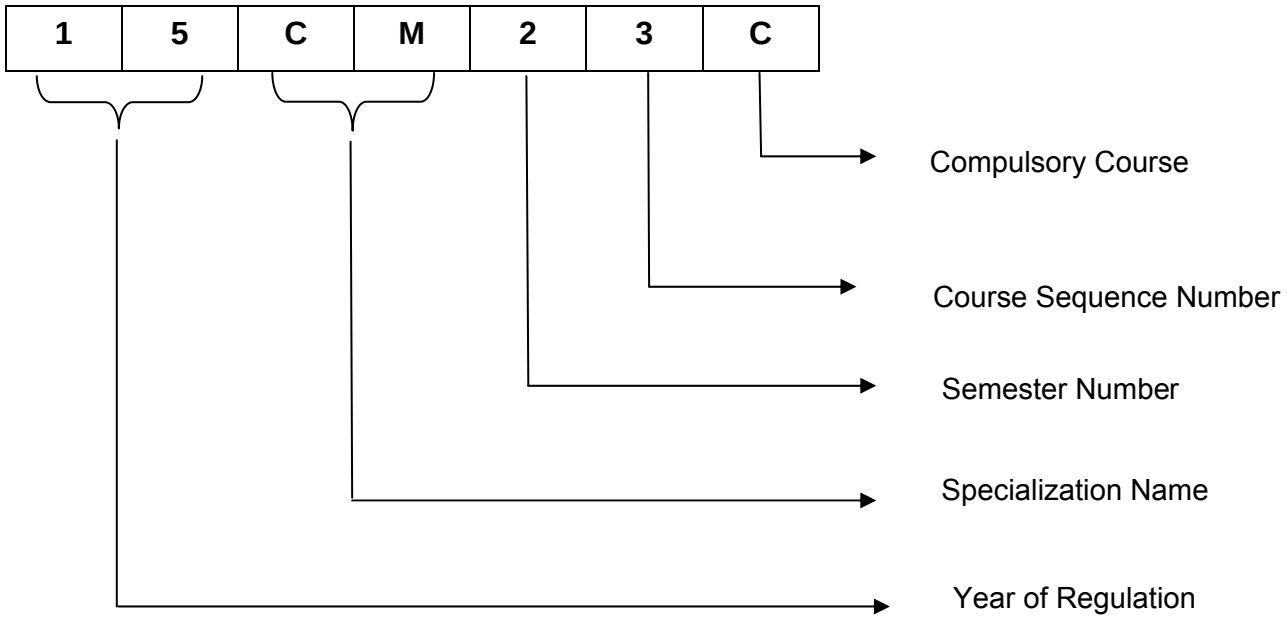
S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
1.	PEC	15CM01E	Data Hiding and Ethical Hacking	3	0	0	3	B
2.	PEC	15CM02E	VLSI Signal Processing	3	0	0	3	B
3.	PEC	15CM03E	Advanced Digital Image Processing	3	0	0	3	B
4.	PEC	15CM04E	Multimedia Compression Techniques¥	3	0	0	3	B
5.	PEC	15CM05E	Sparse Theory and Application	3	0	0	3	B
6.	PEC	15CM06E	Video Surveillance Systems	3	0	0	3	B
7.	PEC	15CM07E	Cognitive Radio Techniques	3	0	0	3	B
8.	PEC	15CM08E	Multi User Detection	3	0	0	3	B
9.	PEC	15CM09E	Non Linear Fiber Optics	3	0	0	3	B
10.	PEC	15CM10E	Optical Network and Photonic Switching	3	0	0	3	B
11.	PEC	15CM11E	Wireless Sensor Networks#	3	0	0	3	B
12.	PEC	15CM12E	Multicasting Techniques in MANET	3	0	0	3	B
13.	PEC	15CM13E	FPGA Based Communication System Design	3	0	0	3	B
14.	PEC	15CM14E	Speech Processing	3	0	0	3	B
15.	PEC	15CM15E	Pattern Recognition Techniques and Applications	3	0	0	3	B
16.	PEC	15CM16E	LTE for Mobile Broadband	3	0	0	3	B
17.	PEC	15CM17E	Micro Electro Mechanical Systems	3	0	0	3	B
18.	PEC	15CM18E	Multimedia Communication Security	3	0	0	3	B
19.	PEC	15CM19E	Adaptive Signal Processing ¥	3	0	0	3	B
20.	PEC	15CM20E	Medical Image Processing@	3	0	0	3	B
21.	PEC	15CM21E	Wavelet and Multiresolution Processing@	3	0	0	3	B
22.	PEC	15CM22E	Mobile Adhoc Networks	3	0	0	3	B
23.	PEC	15CM23E	Design and Deployment of Wireless Sensor Network	3	0	0	3	B
24.	PEC	15CM24E	Vehicular Adhoc Networks	3	0	0	3	B
25.	OEC		Courses offered by other PG programmes					

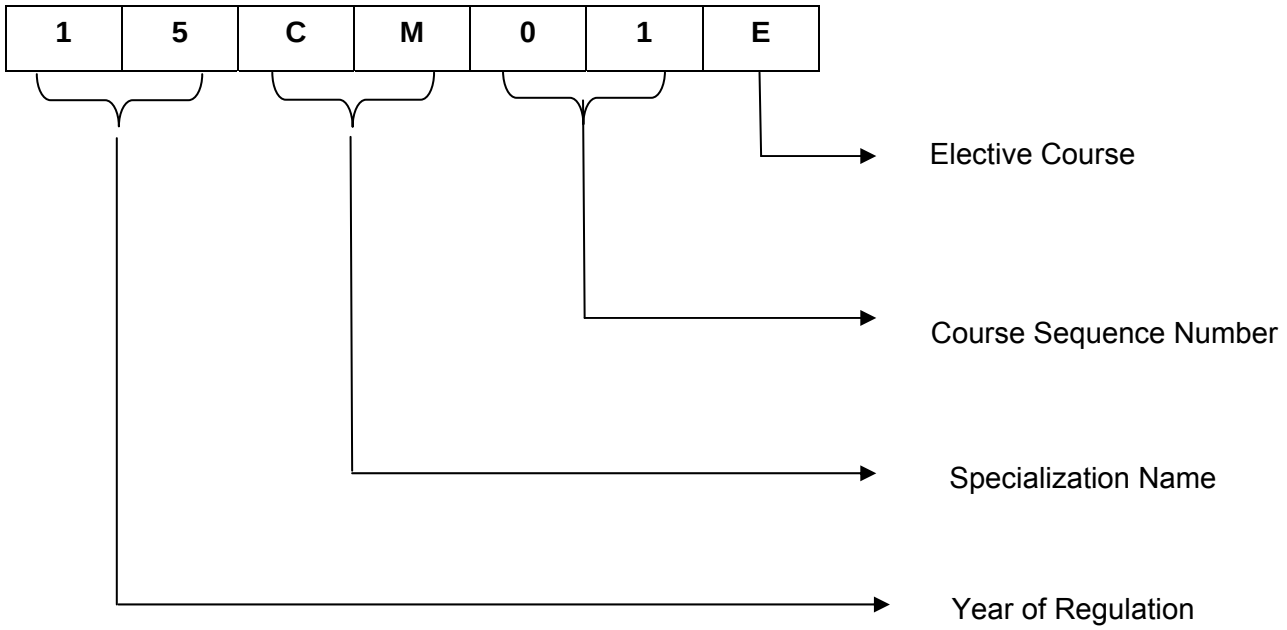
SFC – Specific Foundation Course, PCC – Programme Core Course, PEC – Programme Elective Course, OEC – Open Elective Course
* Common to CS, HVE and C&I; ¥ Common to CS and CN; @ Common to CS and CSE; # Common to CS and C&I

⊕

Question pattern	1 mark	2 marks	4 marks	10 marks	12 marks	16 marks	20 marks	Total
A	-	-	-	-	--	-	1 Qn Compulsory & 4 Qns (either or type)	100
B	-	10	-	-	--	1 Qn Compulsory & 4 Qns (either or type)	--	100
C	10	-	10 out of 12	1 Qn Compulsory & 4 Qns (either or type)	--	--	--	100
D	10	10	5 out of 6	1 Qn Compulsory & 4 Qns (either or type)	--	--	--	100
E	-	10	5 out of 6	-	1 Qn Compulsory & 4 Qns (either or type)	--	--	100

FORMAT FOR COURSE CODE





15CM11C	APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS	L	T	P	C
		3	2	0	4

COURSE OUTCOMES

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

CO 1: Explain the concepts and properties of Bessel's functions and Fourier-Bessel expansion.(K2)
CO 2: Enrich the knowledge about matrix Theory. (K2)
CO 3: Acquire the knowledge of moment generating functions and distributions. (K1)
CO 4: Explain the concepts of two dimensional random variables. (K2)
CO 5: Discuss the various queuing models. (K1)

UNIT I SPECIAL FUNCTIONS 15

Bessel's equation – Bessel function – Recurrence relations - Generating function and orthogonal property for Bessel functions of first kind – Fourier-Bessel expansion.

UNIT II ADVANCED MATRIX THEORY 15

Eigen-values using QR transformations - Generalized eigen vectors - Canonical forms - Singular value decomposition and applications - Pseudo inverse - Least square approximations.

UNIT III ONE DIMENSIONAL RANDOM VARIABLES 15

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Uniform, Exponential, Gamma and Normal distributions**.**

UNIT IV TWO DIMENSIONAL RANDOM VARIABLES 15

Joint distributions – Marginal and Conditional distributions – Correlation and Regression, Regression Curve for means.

UNIT V QUEUEING MODELS 15

Poisson Process – Markovian queues – Single and Multi-server Models – Little's formula - Steady State analysis – Self Service queue.

L:45 T:30 TOTAL: 75 PERIODS

REFERENCES

1. Taha, H.A., "Operations Research, An introduction", 7th Edition, Pearson Education Editions, Asia, New Delhi, 2002.
2. Bronson.R, "Matrix operation, Schaum's outline series", Mc Graw Hill, New York, 1989.
3. Grewal B.S, "Higher Engineering Mathematics", 37th Edition, Khanna Publishers, 2003.
4. Ramana B.V, Higher Engineering Mathematics –Tata McGraw Hill, 2007.
5. Donald Gross and Carl M. Harris, "Fundamentals of Queuing theory", 2nd Edition, John Wiley and Sons, New York, 1985.

15CM12C	ADVANCED DIGITAL SIGNAL PROCESSING (Common to CS, HVE and C&I)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO 1: Discuss the essentials for the postgraduate level research in the area of statistical signal processing. (K1-K2)

CO 2: Model random signals and determine its solution. (K1-K3)

CO 3: Estimate the coefficient for perfect reproduction filter for both the stationary and non-stationary signals. (K1- K3)

CO 4: Design FIR and IIR adaptive filters using adaptive algorithms. (K1- K4)

CO 5: Estimate the power spectrum for discrete random signals using classical and non-classical methods. (K1- K3)

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9

Random Processes - Ensemble Averages, Gaussian processes, Stationary processes, Auto covariance and Autocorrelation matrices, Bias and Estimation, Parseval's theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes, Special types of Random Processes - ARMA, AR, MA.

UNIT II SIGNAL MODELING 9

Least Squares method, Pade approximations, Prony's method – Pole zero modeling, All pole modeling, Linear prediction, Forward and Backward prediction, Finite data records, stochastic models, Solution of Prony's normal equations – Levinson Durbin recursion.

UNIT III WIENER FILTERING 9

FIR Wiener filter – Filtering, Linear prediction, Noise cancellation, Lattice representation, Causal and Non-causal IIR Wiener filters, Weiner Deconvolution, Discrete Kalman filter.

UNIT IV ADAPTIVE FILTERS 9

FIR adaptive filters, Steepest Descent Adaptive Filter, LMS algorithm, Normalized LMS algorithm, Noise cancellation, Channel equalization, Adaptive Recursive filters, Recursive Least squares algorithm.

UNIT V SPECTRAL ESTIMATION 9

Nonparametric methods - Periodogram, Modified periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric methods - ARMA, AR and MA model based spectral estimation

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 1st Edition, 2008.
2. John G. Proakis and Dimitris K Manolakis, "Digital Signal Processing", Pearson Education, 4th Edition, 2009.
3. Alan V. Oppenheim and Ronald W. Schafer, "Discrete-Time Signal Processing", 3rd Edition, Prentice Hall, 2009.
4. Emmanuel C. Ifeachor and Barrie W. Jervis, "Digital signal processing: A practical approach", 2nd Edition, Prentice Hall, 2002.

15CM13C ADVANCED RADIATION SYSTEMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Determine the fundamental parameters for antenna design and derive the radiated fields using radiation integral. (K1-K3)

CO 2: Design wire antennas and loop antennas.(K1-K4)

CO 3: Analyze and synthesis of array antennas and explore the concepts of aperture antennas. (K1-K3)

CO 4: Develop microstrip and smart antennas.(K1-K5)

CO 5: Measure the antenna parameters. (K1-K4)

UNIT I ANTENNA FUNDAMENTALS 9

Types of Antennas, Radiation Mechanism, Fundamental Parameters of Antennas, Radiation Integrals, Vector Potential and Radiated Fields for Electric and Magnetic Current Sources, Solution of Vector Potential Wave Equation, Far-Field Radiation, Duality, Reciprocity and Reaction Theorems.

UNIT II WIRE AND LOOP ANTENNAS 9

WIRE ANTENNAS: Infinitesimal dipole, Finite length dipole, half-wavelength dipole, Image Theory, Vertical and Horizontal electrical dipoles. **LOOP ANTENNAS:** small circular loop, polygonal loop antennas, ferrite loop, Wire and loop antennas for Mobile communication.

UNIT III ARRAY AND APPERTURE ANTENNAS 9

ARRAY ANTENNAS: Two-element array, N-element linear array: uniform amplitude and spacing, directivity, Antenna Synthesis using Schelkunoff polynomial method and Fourier transform method. **APERTURE ANTENNAS:** Field equivalence principle, radiation equations, Rectangular apertures, Circular apertures, Babinet's principle, Slot Antenna, E-plane and H-plane sectoral Horn Antennas.

UNIT IV MICROSTRIP AND SMART ANTENNAS 9

MICROSTRIP ANTENNAS: Basic Characteristics, Feeding Methods, Rectangular Patch, Circular Patch, Quality Factor, Bandwidth, and Efficiency. **SMART ANTENNAS:** Analogy, cellular radio systems evolution, Signal propagation.

UNIT V ANTENNA MEASUREMENTS 9

Antenna Ranges, Radiation Patterns, Gain Measurements, Directivity Measurements, Radiation Efficiency, Impedance Measurements, Current Measurements, Polarization Measurements, Scale Model Measurements

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Constantine A. Balanis, "Antenna Theory: Analysis and Design", 3rd Edition, Wiley-Inter science, 2005.
2. Krauss.J.D, "Antennas", 2nd Edition, McGraw Hill, 2001.
3. Robert S. Elliott, "Antenna Theory and Design", John Wiley & Sons, 2007.
4. W.L. Stutzman and G.A.Thiele, "Antenna Theory and Design", 2nd Edition, John Wiley & Sons Inc., 1998.

15CM14C OPTICAL COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, students will be able to:

CO 1: Describe the optical networks components for optical network Communication (K1-K2)

CO 2: Analyze various Network architecture and topologies for optical networks. (K4)

CO 3: Evaluate the issues in the network design and operation for wavelength routing in optical networks. (K1-K5)

UNIT I OPTICAL SYSTEM COMPONENTS 9

Light propagation in optical fibers, Loss & bandwidth, System limitations, Non-Linear effects, Solitons, Optical Network Components, Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters.

UNIT II OPTICAL NETWORK ARCHITECTURES 9

Introduction to Optical Networks; SONET / SDH, Metropolitan Area Networks, Layered Architecture ; Broadcast and Select Networks , Topologies for Broadcast Networks, Media-Access Control Protocols, Test beds for Broadcast & Select WDM.

UNIT III WAVELENGTH ROUTING NETWORKS 9

The optical layer, Node Designs, Optical layer cost tradeoff, Routing and wavelength assignment, Virtual topology design, Wavelength Routing Test beds, Architectural variations.

UNIT IV PACKET SWITCHING AND ACCESS NETWORKS 9

Photonic Packet Switching, OTDM, Multiplexing and Demultiplexing, Synchronization, Broadcast OTDM networks, Switch-based networks; Access Networks, Network Architecture overview, Future Access Networks, Optical Access Network Architectures; and OTDM networks.

UNIT V NETWORK DESIGN AND MANAGEMENT 9

Transmission System Engineering, System model, Power penalty, transmitter, receiver, Optical amplifiers, crosstalk, dispersion, Wavelength stabilization, Overall design considerations, Control and Management, Network management functions, Configuration management, Performance management, Fault management, Optical safety, Service interface.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. John M. Senior, “Optical Fiber Communications: Principles and Practice”, Prentice Hall, 3rd Edition, 2008
2. Rajiv Ramaswami, Kumar Sivarajan and Galen Sasaki “Optical Networks: A Practical Perspective”, Morgan Kaufmann, 3rd Edition, 2009.
3. William Shieh and Ivan Djordjevic, “OFDM for Optical Communications”, Academic Press, 2009.
4. Gerd Keiser, “Optical Fiber Communications”, McGraw Hill, 4th Edition, 2010
5. Leonid G. Kazovsky, Ning Cheng, Wei-Tao Shaw and David Gutierrez, “Broadband Optical Access Networks” , Wiley Interscience, 2011
6. C. Siva Ram Moorthy and Mohan Gurusamy, “WDM Optical Networks: Concept, Design and Algorithms”, Prentice Hall of India, 1st Edition, 2002.

15CM15C MOBILE COMMUNICATION SYSTEMS AND STANDARDS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, students will be able to:

CO 1: Discuss the basic fundamental concept of mobile and wireless Communication. (K1-K2)

CO 2: Explain the different standards evolved in mobile communication. (K1–K2)

CO 3: Analyze the radio channels. (K1-K4)

CO 4: Describe the communication technologies and networks adapted. (K1–K2)

UNIT I CELLULAR CONCEPT **9**

Cellular concept – Frequency reuse –Handoff strategies – Interference and System capacity – Trunking and Grade of service – Improving capacity in cellular systems - Channel Assignment strategies.

UNIT II WIRELESS FADING CHANNEL **9**

Small-scale multipath propagation – Impulse response of a multipath channel – Parameters of mobile multipath channel – Types of small-scale fading – Rayleigh and Rician distributions – Statistical models for multipath fading channels.

UNIT III GSM, GPRS STANDARDS **9**

GSM services and features – GSM system architecture – GSM radio subsystem – Frame structure for GSM – Signal processing in GSM – GPRS network architecture – GPRS services and features.

UNIT IV 3G EVOLUTION **9**

Migration path to UMTS, UMTS Basics, Air Interface, 3GPP Network Architecture, UTRAN Architecture – Establishment of UMTS speech call – HSDPA– HSUPA – Mobile IP and Wireless Application Protocol.

UNIT V 4G STANDARDS AND EVOLUTION **9**

Multiple access techniques – OFDMA/MIMO/SC-FDMA, OFDM/MIMO – Wireless networking – Design issues in personal wireless systems – Cordless systems and Wireless Local Loop (WLL).

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Rappaport, T.S., “Wireless Communications, Principles and Practice”, 2nd Edition, Prentice Hall, NJ, 2002.
2. William Stallings, “Wireless Communications and Networks”, 2nd Edition, Pearson Education, 2005.
3. Clint Smith. P.E., and Daniel Collins, “3G Wireless Networks”, 2nd Edition, Tata McGraw Hill, 2007.
4. Kaveth Pahlavan, K.Prashanth Krishnamoorthy, "Principles of Wireless networks", Prentice Hall of India, 2006.
5. Vijay. K. Garg, “Wireless Communication and Networking”, Morgan Kaufmann Publishers, http://books.elsevier.com/9780123735805, 2007.

15CM16C CRYPTOGRAPHY AND NETWORK SECURITY

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Describe the need for security and the various security techniques. (K1-K2)
CO 2: Explain the various symmetric and asymmetric key algorithms. (K1-K2)
CO 3: Apply suitable authentication functions to ensure authentication. (K1- K3)
CO 4: Provide solutions for security at the system level. (K1- K5)
CO 5: Elaborate security protocols for Adhoc wireless network. (K1-K2)

UNIT I INTRODUCTION ON SECURITY 9

Security Goals – Types of Attacks: Passive attack – active attack – attacks on confidentiality –Integrity and availability – Security services and mechanisms – Cryptography Techniques – Substitutional and Transposition Ciphers- Steganography.

UNIT II SYMMETRIC AND ASYMMETRIC KEY ALGORITHMS 9

Stream and Block Ciphers – Data Encryption Standards (DES) – Advanced Encryption Standard (AES) – Block Cipher modes of operation- RC4 – principle of asymmetric key algorithms – RSA Cryptosystem – Diffie Hellmen Key Exchanging algorithm.

UNIT III INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT 9

Message Integrity – Hash functions – SHA-1 – Digital signatures – Digital signature standards Authentication – Message Authentication Code - Kerberos – Entity Authentication – Biometrics – Key management Techniques.

UNIT IV NETWORK SECURITY 9

Introduction on Firewalls – Types of Firewalls – Firewall Configuration and Limitation of Firewall –IP Security Overview – IP security Architecture – Authentication Header – Encapsulating Security Payload – security associations – ISAKMP Key Management.

UNIT V SECURITY PROTOCOLS FOR ADHOC WIRELESS NETWORK 9

Security in Adhoc wireless networks – Requirements – Issues and Challenges – Attacks in various layers – Key Management. Secure Routing Protocols – Requirements – Authenticated Routing for Adhoc Networks - Security Aware AODV Protocol.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Behrouz A. Fourouzan, “Cryptography and Network security”, 2nd Edition, Tata McGraw Hill, 2008.
2. William Stallings, “Cryptography and Network Security”, 3rd Edition, Pearson Education, 2003.
3. C.Siva Ram Murthy, B.S.Manoj, “Adhoc Wireless Networks: Architectures and Protocols”, Prentice Hall, 2004.
4. Mark D. Ciampa, “Security+ Guide to Network Security Fundamentals”, 3rd Edition, Cengage Learning, 2009.
5. Stuart McClure, Joel Scambray and George Kurtz, “Hacking Exposed: Network Security Secrets and Solutions”, 6th Edition, McGraw Hill Publications, 2009.
6. Fahim Hussain Yusuf Bhaiji, “Network Security Technologies and Solutions (CCIE Professional Development Series)”, 1st Edition, Cisco Press, 2008.

15CM17C	COMMUNICATION SYSTEM LABORATORY – I	L	T	P	C
		0	0	4	2

COURSE OUTCOMES

Upon completion of this course, students will be able to:

CO 1: Utilize advanced software tools for digital signal processing applications.(K1 -K3)
CO 2: Design transform based compression algorithms. (K1-K4)
CO 3: Design error detection and error correction codes. (K1-K4)
CO 4: Determine the fundamental parameters of antennas. (K1- K3)
CO 5: Evaluate the performance of an optical communication link. (K1-K4)
CO 6: Evaluate the performance of digital modulation schemes. (K1-K4)

LIST OF EXPERIMENTS

1. Power spectrum estimation using MATLAB
2. Channel equalizer design with least mean square algorithm and recursive least square algorithm using MATLAB
3. DCT and DWT based compression techniques using MATLAB & LABVIEW
4. Object tracking with Kalman filter using MATLAB
5. Design of Adaptive filters using MATLAB and LABVIEW
6. Performance Evaluation of digital modulation schemes using MATLAB and LABVIEW
7. Implementation of error detection and error correcting codes.
8. Performance evaluation of Digital Data Transmission through Fiber Optic Link
9. Radiation Pattern measurement for wire, aperture and array antennas.
10. Simulation of Microstrip Antennas.

P:60 TOTAL: 60PERIODS

15CM21C WIRELESS MIMO COMMUNICATION

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Describe the mathematical model of SISO wireless channel. (K1-K2)
CO 2: Calculate the capacity of wireless channel. (K1-K3)
CO 3: Illustrate the V-BLAST and D-BLAST multiplexing architectures. (K1-K3)
CO 4: Describe the mathematical model of MIMO wireless channel. (K1-K2)
CO 5: Design a system in multiuser environment. (K1-K6)

UNIT I THE WIRELESS CHANNEL AND CAPACITY OF WIRELESS CHANNELS **9**

Overview of wireless systems, Physical modeling for wireless channels, Time and Frequency coherence, Statistical channel models, AWGN channel capacity, Capacity of fading channels: Capacity of Flat Fading Channel, Channel Distribution Information known, Channel Side Information at Receiver, Channel Side Information at Transmitter and Receiver, Capacity of Frequency Selective Fading channels.

UNIT II SPATIAL MULTIPLEXING AND CHANNEL MODELING **9**

Multiplexing capability of deterministic MIMO channels : Capacity via singular value decomposition, Physical modeling of MIMO channels: Line-of-sight SIMO channel, Line-of-sight MISO channel, Modeling of MIMO fading channels: MIMO multipath channel, Angular domain representation of signals, Angular domain representation of MIMO channels, Statistical modeling in the angular domain, Degrees of freedom and diversity, Dependency on antenna spacing, Independent identically distributed(I.I.D) Rayleigh fading model.

UNIT III CAPACITY AND MULTIPLEXING ARCHITECTURES **9**

The V-BLAST architecture, Fast fading MIMO channel: Capacity with CSI at receiver, Performance gains, Full CSI, Receiver architectures: Linear decorrelator, Successive cancellation, Linear MMSE receiver, slow fading MIMO channel, D-BLAST architecture.

UNIT IV DIVERSITY–MULTIPLEXING TRADEOFF **9**

Diversity–multiplexing tradeoff: Formulation, Scalar Rayleigh channel, Parallel Rayleigh channel, MISO Rayleigh channel, 2×2 MIMO Rayleigh channel, MIMO Independent identically distributed Rayleigh channel.

UNIT V MIMO MULTIUSER COMMUNICATION **9**

Uplink with multiple receive antennas, MIMO uplink, Downlink with multiple transmit antennas, MIMO downlink, Multiple antennas in cellular networks: a system view.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. David Tse and Pramod Viswanath, “Fundamentals of Wireless Communication”, 1st Edition, Cambridge University Press, 2005.
2. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press, 2005.
3. A.B. Gershman and N.D. Sidiropoulus, “Space-time processing for MIMO communications”, Wiley, Hoboken, NJ, USA, 2005.
4. H. Jafarkhani, “Space-time coding: Theory & Practice”, Cambridge University Press, 2005.

15CM22C HIGH SPEED COMMUNICATION NETWORKS

L	T	P	C
3	2	0	4

COURSE OUTCOMES

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

CO 1: Explain the state-of-the-art in network protocols and architectures. (K1-K2)
CO 2: Discuss the issues in providing Quality of Service to multimedia networking applications. (K1- K2)
CO 3: Describe the advanced network concepts for high performance communication networks. (K1- K3)
CO 4: Model the network of queues from the basics of queuing theory. (K1-K2)
CO 5: Explain the concepts of network security and management. (K1-K3)v

UNIT I INTRODUCTION **15**

Review of OSI, TCP/IP; Multiplexing, Modes of Communication, Switching, Routing. SONET –DWDM – DSL – ISDN – BISDN – ATM.

UNIT II MULTIMEDIA NETWORKING APPLICATIONS **15**

Streaming stored Audio and Video – Best effort service – Protocols for real time interactive applications – Providing Multiple Classes of Service – Providing Quality of Service Guarantees.

UNIT III ADVANCED NETWORKS CONCEPTS **15**

VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN, MPLS operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlay networks-P2P connections.

UNIT IV TRAFFIC MODELLING **15**

Little's theorem, Birth-and-Death Process – Queuing Disciplines – Markovian FIFO Queuing Systems – Non-Markovian and Self-Similar Models – Networks of Queues.

UNIT V NETWORK SECURITY AND MANAGEMENT **15**

Principles of cryptography – Message Integrity and End-Point Authentication – Securing Email – Securing TCP connections – Network Layer Security – Securing Wireless LANs Operational Security- Infrastructure for network management – The internet standard management framework – SMI,MIB, SNMP, Security and administration – ASN.1

L:45 T:30 TOTAL: 75 PERIODS

REFERENCES

1. J.F. Kurose & K.W. Ross, "Computer Networking - A top down approach featuring the internet", 6th Edition, Pearson education, 2012.
2. Nader F.Mir, "Computer and Communication Networks", 1st Edition, Prentice Hall, 2010.
3. Walrand. J. Varatya, "High performance communication network", 2nd Edition, Morgan Kaufmann, Harcourt Asia Pvt. Ltd., 2000.
4. Leom-Garcia, Widjaja, "Communication networks", 7th reprint, TMH, 2002.

15CM23C	MICROWAVE INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO 1: Describe the intricacies in the design of microwave circuits. (K1)

CO 2: Analyze the RF networks and from design a matching Networks and filters (K1-K4)

CO 3: Design Amplifier and Oscillator (K1- K3)

CO 4: Configure various Control circuits and Mixers. (K1- K3)

CO 5: Discuss about the state of art in MIC technology. (K1- K2)

UNIT I INTRODUCTION TO MICROWAVE CIRCUITS 9

Definitions – Frequency Bands – Lumped versus Distributed Circuits - Behavior of finite length transmission lines – General Characteristics of PC Boards – Transmission Lines on PC Boards – Passives made from Transmission Lines – Resonators - Combiners, Splitters and Couplers.

UNIT II MATCHING NETWORKS AND FILTER DESIGN 9

Circuit Representation of two port RF/Microwave Networks: Low Frequency Parameters, High Frequency Parameters, Transmission Matrix, ZY Smith Chart, Design of Matching Circuits using Lumped Elements, Matching Network Design using Distributed Elements, Filter design.

UNIT III AMPLIFIERS AND OSCILLATORS 9

Amplifiers: Stability considerations in active networks – Gain Consideration in Amplifiers – Noise Consideration in active networks – Broadband Amplifier design – Low Noise Amplifier Design, Oscillators: Oscillator versus Amplifier Design – Oscillation conditions – Design and stability considerations of Microwave Transistor Oscillators.

UNIT IV MIXERS AND CONTROL CIRCUITS 9

Mixer Types – Conversion Loss – SSB and DSB Mixers – Design of Mixers: Single Ended Mixers – Single Balanced Mixers - Sub Harmonic Diode Mixers ,Microwave Diodes , Phase Shifters – PIN Diode Attenuators.

UNIT V MICROWAVE IC DESIGN AND MEASUREMENT TECHNIQUES 9

Microwave Integrated Circuits – MIC Materials- Hybrid versus Monolithic MICs – Multichip Module Technology - Fabrication Techniques, Miniaturization techniques, Introduction to SOC, SOP, Test fixture measurements, probe station measurements, thermal and cryogenic measurements, experimental field probing techniques.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Thomas H.Lee, “Planar Microwave Engineering”, Cambridge University Press, 2004
2. Matthew M. Radmanesh, “Radio Frequency and Microwave Electronics”, Pearson Education, 2nd Edition 2002
3. Guillermo Gonzalez “Microwave Transistor Amplifiers – Analysis and Design”, 2nd Edition, Prentice Hall, New Jersy,2001
4. Ravender Goyal, “Monolithic MIC; Technology & Design”, Artech House, 1989
5. Gupta K.C. and Amarjit Singh, “Microwave Integrated Circuits”, John Wiley, New York, 1975.

6. Hoffman R.K. “Handbook of Microwave Integrated Circuits”, Artech House, Boston, 1987.
7. Ulrich L. Rohde and David P.N., “RF / Microwave Circuit Design for Wireless Applications”, John Wiley, 2000.
8. C. Gentili, “Microwave Amplifiers and Oscillators”, North Oxford Academic, 1986.
9. Samuel. Y. Liao, “Microwave Circuit Analysis and Amplifier Design”, Prentice Hall. Inc., 1987.

15CM24C	RF SYSTEM DESIGN	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO 1: Apply the knowledge of basic RF Electronics for realizing any RF System. (K1-K2)

CO 2: Analyze the impedance matching networks and amplifiers. (K1 –K3)

CO 3: Design an RF power amplifier. (K1- K4)

CO 4: State PLL and Frequency synthesizer for different RF applications. (K1- K3)

CO 5: Design RF mixers and Oscillators. (K1- K4)

UNIT I CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES 9

CMOS: Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise. Transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise, Specification distribution over a communication link. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Receiver Architectures, Transmitter: Direct upconversion, two step up conversion.

UNIT II IMPEDANCE MATCHING AND AMPLIFIERS 9

S-parameters with Smith chart, Passive IC components, Impedance matching networks Amplifiers: Common Gate, Common Source Amplifiers, OC Time constants in bandwidth estimation and enhancement, High frequency amplifier design, Low Noise Amplifiers: Power match and Noise match, Single ended and Differential LNAs, Terminated with Resistors and Source Degeneration LNAs.

UNIT III RF POWER AMPLIFIERS AND FEEDBACK SYSTEMS 9

Feedback Systems: Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation Power Amplifiers: General model, Class D, E, F and S amplifiers, Linearization Techniques , Efficiency boosting techniques, ACPR metric, Design considerations.

UNIT IV PLL AND FREQUENCY SYNTHESIZERS 9

PLL: Linearized Model, Noise properties, Phase detectors, Loop filters and Charge Pumps Frequency Synthesizers: Integer-N frequency synthesizers, Direct Digital Frequency synthesizers.

UNIT V MIXERS AND OSCILLATORS 9

Mixer: characteristics, Non-linear based mixers: Quadratic mixers, Multiplier based mixers: Single balanced and double balanced mixers, subsampling mixers, Oscillators: Describing Functions, Colpitts oscillators, Resonators, Tuned Oscillators, Negative resistance oscillators, Phase noise.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Thomas.H.Lee, “The Design of CMOS Radio-Frequency Integrated Circuits”, 2nd Edition, Cambridge University Press, 2004.
2. Jaime Aguilera and Roc Berenguer, “Design and Test of Integrated Inductors for RF Applications”, Kluwer Academic Publishers, 2010.

3. Qizheng Gu, “RF System Design of Transceivers for Wireless Communications”, Springer, 2010.
4. Michael B. Steer, “Microwave and RF Design: A Systems Approach”, SciTech Publishing, 2009.
5. Samuel Y Liao, “Microwave Devices & Circuits”, Pearson Education, 3rd Edition, 2003.

15CM25C	COMMUNICATION SYSTEM LABORATORY – II	L	T	P	C
		0	0	4	2

COURSE OUTCOMES

Upon completion of this course, students will be able to:

CO 1: Design digital transceiver. (K1- K3)
CO 2: Design algorithms for network security and routing. (K1- K3)
CO 3: Design compression, segmentation and pattern classification algorithms. (K1- K3)
CO 4: Utilize GPS receiver for object tracking and navigation. (K1- K2)
CO 5: Determine fundamental parameters of transmission lines and microwave integrated circuits. (K1- K2)

LIST OF EXPERIMENTS

1. Implementation of wireless communication system using USRP
2. Implementation of Advanced Encryption Standard
3. Simulation of EZW-SPIHT Image coding algorithm using MATLAB
4. Real time implementation of tracking and navigation using GPS.
5. Simulation of transmission lines and microwave integrated circuits.
6. Simulation of image segmentation and pattern classification using MATLAB and LABVIEW.
7. Performance analysis of routing algorithm for wireless sensor network by NS-2.

P:60 TOTAL: 60 PERIODS

15CM26C	RESEARCH PAPER AND PATENT REVIEW - SEMINAR	L	T	P	C
		0	0	4	2

The student will make atleast two technical presentations on current topics related to the specialization. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of the semester covering the various aspects of his/her presentation.

P:60 TOTAL: 60 PERIODS

15CM01E DATA HIDING AND ETHICAL HACKING

L	T	P	C
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COURSE OUTCOMES

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

CO 1: Describe the purpose of Data hiding in various applications. (K1- K2)

CO 2: Identify security vulnerabilities and weaknesses in the target applications. (K1- K3)

CO 3: Analyze how security controls can be improved to prevent hackers gaining access to networked environments. (K1- K4)

CO 4: Implement the impact of hacking in real time machines. (K1- K4)

UNIT I DATA HIDING IN MULTIMEDIA AND MOBILE DEVICES 9

History of Secret Writing - Steganography - Multimedia Data Hiding - Data Hiding in Digital Audio and Video - Data Hiding Among Android Mobile Devices - StegDroid- Apple iOS Data Hiding - Mobile Device Data Hiding Applications.

UNIT II DATA HIDING IN OPERATING SYSTEMS AND NETWORKS 9

Operating System Data Hiding - Data Hiding in Windows and Linux - Virtual Data Hiding - Data Hiding in Network Protocols - Forensics and Anti-Forensics - Mitigation Strategies.

UNIT III BASICS OF ETHICAL HACKING 9

Introduction to Ethical Hacking, Ethics, and Legality - Reconnaissance - Foot printing - Social Engineering - Scanning - Enumeration - Password Cracking - Escalating Privileges - Hiding Files.

UNIT IV NETWORK SNIFFING AND WEB HACKING 9

Trojans, Backdoors, Viruses, and Worms – Sniffers - Denial of Service - Session Hijacking - Hacking Web Servers - Web Application Vulnerabilities - Web-Based Password Cracking Techniques.

UNIT V SYSTEM HACKING 9

SQL Injection and Buffer Overflows - Wireless Hacking - Physical Security - Linux Hacking - Evading IDSs, Honeypots, and Firewalls – Cryptography - Penetration Testing Methodologies.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Michael Raggo, Chet Hosmer, “Data Hiding - Exposing Concealed Data in Multimedia, Operating Systems, Mobile Devices and Network Protocols”, Syngress, 2013
2. Kimberly Graves, “CEH: Certified Ethical Hacker Study Guide”, Wiley Publishing Inc., 2010.
3. Kimberly Graves, “CEH: Official Certified Ethical Hacker Review Guide”, Wiley Publishing Inc., 2007
4. Rafay Baloch, “Ethical Hacking and Penetration Testing Guide”, CRC Press (Taylor & Francis Group), 2015.
5. Patrick Engebretson, “The Basics of Hacking and Penetration Testing - Ethical Hacking and Penetration Testing Made Easy”, Syngress, 2011.

15CM02E	VLSI SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO 1: Explain the concepts of pipelining, parallel processing. (K1- K3)

CO 2: Apply optimization techniques to design IIR and FIR filters. (K1- K3)

CO 3: Discuss scaling and round-off noise issues and their impact on performance. (K1- K2)

CO 4: Explain the concepts of numerical strength reduction and wave pipelining. (K1- K3)

UNIT I DSP SYSTEMS, PIPELINING AND PARALLEL PROCESSING 9

Introduction – Representations of DSP algorithms - Iteration Bound - data flow graph representations, loop bound and iteration bound, Longest path Matrix algorithm; Pipelining and parallel processing - Pipelining of FIR digital filters, parallel processing, pipelining and parallel processing for low power.

UNIT II RETIMING, UNFOLDING AND RANK ORDER FILTERS 9

Retiming - definitions and properties; Unfolding - an algorithm for Unfolding, properties of unfolding, parallel processing application; Algorithmic strength reduction in filters and transforms - 2-parallel FIR filter, 2-parallel fast FIR filter, parallel architectures for rank-order filters, Odd- Even Merge- Sort architecture, parallel rank-order filters.

UNIT III FAST CONVOLUTION, PIPELINING AND PARALLEL PROCESSING OF IIR FILTERS 9

Fast convolution - Cook-Toom algorithm, modified Cook-Toom algorithm; Pipelined and parallel recursive filters - inefficient/efficient single channel interleaving, Look Ahead pipelining in first- order IIR filters, Look-Ahead pipelining with power-of-two decomposition, Clustered Look-Ahead pipelining, parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

UNIT IV ROUNDOFF NOISE AND BIT-LEVEL ARITHMETIC ARCHITECTURES 9

Scaling and roundoff noise- scaling operation, roundoff noise, state variable description of digital filters, scaling and roundoff noise computation, roundoff noise in pipelined first-order IIR filters; Bit- Level Arithmetic Architectures- parallel multipliers with sign extension, parallel carry-ripple array multipliers, parallel carry-save multiplier, 4x 4 bit Baugh- Wooley carry-save multiplication, design of Lyon's bit-serial multipliers using Horner's rule.

UNIT V NUMERICAL STRENGTH REDUCTION AND WAVE PIPELINING 9

Numerical Strength Reduction - subexpression elimination, multiple constant multiplications, iterative matching, Two-phase clock generator, clock skew in edge triggered single-phase clocking, two-phase clocking, wave pipelining.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Keshab K.Parhi, “VLSI Digital Signal Processing systems, Design and implementation”,John Wiley, 2009.
2. U. Meyer - Baese, “Digital Signal Processing with Field Programmable Arrays”, Springer, 2nd Edition, 2007.
3. Shoab Khan, “Digital Design of Signal Processing Systems: A Practical Approach”, Wiley, 2011.

15CM03E ADVANCED DIGITAL IMAGE PROCESSING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, students will be able to:

CO 1: Develop new Image Processing algorithms for real-time applications in different domains ((K1- K3)

CO 2: Develop hybrid techniques to solve problems in different applications (K1- K3)

UNIT I DIGITAL IMAGE FUNDAMENTALS AND TRANSFORMS 9

Elements of visual perception - Image sampling and quantization - Basic relationship between pixels - Basic geometric transformations - Color image fundamentals - RGB, HSI models- DFT - Properties of 2D Fourier Transform - FFT - Separable Image Transforms - Walsh - Hadamard - Discrete Cosine Transform, Haar, Slant - Karhunen - Loeve transforms, SVD, Wavelet Transform.

UNIT II IMAGE ENHANCEMENT AND RESTORATION 9

Spatial Domain methods: Basic gray level transformation – Histogram modification and specification techniques Spatial filtering: Smoothing, sharpening filters - Laplacian filters - Frequency domain filters : Smoothing - Sharpening filters - Homomorphic filtering, Color image enhancement. Image Restoration - degradation model - Noise Distributions - Unconstrained and Constrained restoration - Inverse filtering - removal of blur caused by uniform linear motion - Wiener filtering - Geometric transformations - spatial transformations, Gray- Level interpolation.

UNIT III IMAGE SEGMENTATION AND REPRESENTATION 9

Edge detection - Edge linking and boundary detection - Thresholding - Region based segmentation - Region growing - Region splitting and Merging - Segmentation by morphological watersheds - basic concepts - Dam construction - Watershed segmentation algorithm, Boundary representation: chair codes - Polygonal approximation - Boundary segments - boundary descriptors: Simple descriptors - Fourier descriptors - Regional descriptors - Relational descriptors - Texture representation.

UNIT IV PATTERN RECOGNITION 9

Patterns and Pattern classes - Decision Theoretic Methods - Matching - Statistical (Parametric) Decision making - Optimum Statistical Classifiers - 2-D & n-D Decision boundaries - Distance Measures, Non Parametric decision making: Single & K- Nearest neighbor classification - Adaptive decision boundaries - Adaptive discriminant functions - SVM classification - Clustering: Hierarchical clustering - Partitional clustering - K means Algorithm - Iso data algorithm.

UNIT V APPLICATIONS OF IMAGE PROCESSING 9

Image Registration - Image Fusion (Mosaics) - Image Denoising - Object Detection - Target detection and tracking - Content based image retrieval- Water marking- Steganography - Stegnalysis - Video Motion Analysis.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Rafael C. Gonzalez, Richard E.Woods, “Digital Image Processing”, Pearson Education, Inc., 3rd Edition, 2009.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, Brooks/Cole, Thomas Learning, 2nd Edition, 2001

3. Anil K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India, 5th Edition, 2007.
4. Earl Gose, Richard Johnson Baugh and Steve Jost, “Pattern Recognition and Image Analysis: PHI, 1st Edition, 2009.
5. William K.Pratt, “Digital Image Processing”, John Wiley, New York, 4th Edition, 2011.
6. Sid Ahmed, M.A., “Image Processing Theory, Algorithms and Architectures”, McGrawHill, 1st Edition, 1995.
7. Tania Stathaki, “Image Fusion : Algorithms and Applications”, Academic Press, 1st Edition, 2008

15CM04E MULTIMEDIA COMPRESSION TECHNIQUES **L T P C**
(Common to CS and CN) **3 0 0 3**

COURSE OUTCOMES

Upon completion of this course, students will be able to:

CO 1: Describe fundamentals concepts and characteristics of text audio, image and video. (K1- K3)
CO 2: Analyze various types of text compression techniques (K1- K4)
CO 3: Express several types of audio and speech compression techniques. (K1- K3)
CO 4: Compare the different image compression techniques. (K1- K4)
CO 5: Illustrate the principles and standards for video compression. (K1- K4)

UNIT I INTRODUCTION **9**

Special features of Multimedia, Graphics and Image Data Representations, Fundamental Concepts in Video and Digital Audio, Storage requirements for multimedia applications, Need for Compression, Taxonomy of compression techniques, Overview of source coding, source models, scalar and vector quantization theory.

UNIT II TEXT COMPRESSION **9**

Compression techniques, Shannon-Fano coding, Huffman coding, Adaptive Huffman Coding, Arithmetic coding, Dictionary techniques, LZW family algorithms.

UNIT III AUDIO COMPRESSION **9**

Audio compression techniques - μ- Law and A- Law companding, Basic sub-band coding, Design of Filter banks, Application to speech coding-G.722, Application to audio coding-MPEG audio, Silence compression, Speech compression techniques-Vocoders – Channel Vocoders, Formant Vocoders, Linear Predictive Coder, CELP.

UNIT IV IMAGE COMPRESSION **9**

Prediction in DPCM, Adaptive DPCM, Delta Modulation, Transform Coding, Wavelet based compression: Implementation using filters, EZW, SPIHT coders, Image Compression standards-JPEG, JPEG 2000, JBIG, JBIG2.

UNIT V VIDEO COMPRESSION **9**

Video compression Principles, Motion estimation and compensation techniques, Video Compression standards - MPEG Video Coding I: MPEG - 1 and 2, MPEG Video Coding II: MPEG – 4 and 7, H.261 Standard, DVI technology, PLV performance, DVI real time compression, Packet Video.

L: 45 TOTAL: 45 PERIODS

REFERENCES

1. Khalid Sayood, “Introduction to Data Compression”, Morgan Kauffman Harcourt India, 2nd Edition, 2000.
2. David Salomon, “Data Compression – The Complete Reference”, Springer Verlag New York Inc., 2nd Edition, 2007.
3. Mark S.Drew, Ze-Nian Li, “Fundamentals of Multimedia”, PHI, 1st Edition, 2003.
4. John F. Buford, “Multimedia Systems”, 6th Edition, Pearson Education, 2009.

15CM05E SPARSE THEORY AND APPLICATION **L T P C**

3 0 0 3

COURSE OUTCOMES

Upon completion of this course, students will be able to:

CO 1: Determine the Sparse representation (K1- K3)
CO 2: Analyze Nonlinear Multiscale Transforms for sparsity (K1- K4)
CO 3: Develop an in-depth understanding in Compressive sensing (K1- K4)

UNIT I SPARSITY AND WAVELET 9

Sparse Representation: Sparsity, Sparsity Terminologies, Underdetermined Linear Systems - Regularization - Convexity - L_1Minimization - Moving to Sparse Solutions - The L_0 Norm and Implications - The P0 Problem in sparse signal processing. Fourier to Wavelets, From Wavelets to Over complete Representations - The Discrete Wavelet Transform.

UNIT II WAVELET PACKETS AND REDUNDANT WAVELET TRANSFORM 9

The Undecimated Wavelet Transform - Partially Decimated Wavelet Transform - The Dual-Tree Complex Wavelet Transform - Starlet Transform - Nonorthogonal Filter Bank Design: Positive Reconstruction Filters - Reconstruction from the HaarUndecimated Coefficients.

UNIT III NONLINEAR MULTISCALE TRANSFORMS 9

Decimated Nonlinear Transform - Multiresolution Based on the Median Transform - Guided Numerical Experiments - The Ridgelet and Curvelet Transforms: The Continuous Ridgelet Transform - The Rectopolar Ridgelet Transform - The Orthonormal Finite Ridgelet Transform - Sparse Representation by Ridgelets - The First-Generation Curvelet Transform - Sparse Representation by First-Generation Curvelets.

UNIT IV LINEAR INVERSE PROBLEMS 9

Sparsity-Regularized Linear Inverse Problems - Monotone Operator Splitting Framework - Selected Problems and Algorithms - Sparsity Penalty with Analysis Prior - Other Sparsity Regularized Inverse Problems General Discussion: Sparsity, Inverse Problems and Iterative Thresholding.

UNIT V COMPRESSIVE SENSING 9

Incoherence and Sparsity, Sensing Protocol Stable Compressed Sensing Designing Good Matrices: Random Sensing Sensing with Redundant Dictionaries Compressed Sensing in Space Science Guided Numerical Experiments.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Jean-Luc Starck, Fionn Murtagh and Jalal M. Fadili, “Sparse image and signal processing Wavelets, Curvelets, Morphological Diversity”, Cambridge University press, 1st Edition, 2010.
2. Michael Elad, “Sparse and Redundant Representations: From Theory to Applications in Signal and image processing”, Spinger Science, Kindle Edition, 2010.
3. Do, M. N., and Vetterli, M and G. V. Welland (eds.), “Contourlets Beyond Wavelets”, in J. Stoeckler, Academic, San Diego, CA, 1st Edition, 2003.
4. Mallat, S, A Wavelet Tour of Signal Processing, The Sparse Way, Academic, San Diego, CA, 3rd Edition, 2008.

15CM06E VIDEO SURVEILLANCE SYSTEMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, students will be able to:

CO 1:Distinguish different image sensors and different cameras used video surveillance systems (K1- K4)

CO 2: Analyze various segmentation and detection techniques in video surveillance. (K1- K4)

CO 3: Apply video tracking algorithms for intelligent surveillance applications (K1-K3)

CO 4: Compare several video analyzing techniques (K1- K4)

CO 5: Describe several video surveillance applications. (K1- K2)

UNIT I DIGITAL VIDEO HARDWARE 9

Worldwide Video Standards (NTSC, PAL, SECAM), Interlaced and Progressive Scan, Resolution, Color models in video - YUV, YIQ, YCbCr, Refraction, optics, F-Stop, Shutter speed, Depth of field, Digital image sensors - CCD vs CMOS, Manual, auto focus, power requirements, Day and night cameras, Infra-red and thermal technologies, Indoor/ Outdoor cameras, Fixed/PTZ/ Moving cameras, CCTV.

UNIT II MOTION SEGMENTATION AND DETECTION 9

Scene Change detection, Spatiotemporal Change detection - Change detection using two frames - Temporal integration - Combination with spatial segmentation - Motion Segmentation - Dominant Motion Segmentation - Multiple Motion Segmentation-Motion estimation algorithm - Global motion estimation- Block matching Phase correlation Optical flow - MAP Estimation of Dense motion.

UNIT III FRAMEWORK FOR VIDEO ANALYSIS 9

Image and Video features- Statistical, Content based, Compressed domain- Video Shot analysis- Shot boundary detection, key frame extraction, Play/Break segmentation, Audio Marker detection, Video Marker Detection, Video representation for scripted and unscripted contents.

UNIT IV VIDEO TRACKING AND BEHAVIOUR ANALYSIS 9

Video Tracking**-** Design of Video Tracker- Challenges- Main Components- Single Target Tracking- Multiple Target Tracking- Interactive vs automated target tracking Behaviour Analysis of individuals**-**Learning based behavior analysis- SVM learning- Behaviour analysis of human groups- People count and crowd density estimation.

UNIT V VIDEO SURVEILLANCE SYSTEMS APPLICATIONS 9

Architecture of Automated video surveillance system- Components of knight multi camera surveillance system for applications -Robotics and unmanned vehicles, Human face recognition and Gait Analysis.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Al Bovik, “Essential Guide to Video Processing”, Academic Press, 1st Edition, 2009
2. Anthony C Caputo, “Digital Video Surveillance and security” Elsevier Inc, 2nd Edition, 2010
3. Emilio Maggio and Andrea Cavallaro, “Video Tracking - Theory and Practice”, John Wiley and Sons Pvt Ltd, 1st Edition, 2011

4. Huihuan Qian, Xinyu Wu and Yangsheng Xu, “Intelligent Surveillance Systems”, Springer, 2011
5. Keith Jack, “Video Demystified”, Fifth edition, A Handbook for the digital engineer, Newren publications, 2006
6. Allan C.Bowik, “Handbook of image and video processing”, Elsevier Academic press, 2nd edition,2005

15CM07E	**COGNITIVE RADIO TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

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

CO 1: Discuss the basic fundamental concept, design and application of Software Defined Radio. (K1- K2)

CO 2: Describe the basic fundamentals of Cognitive Radio and its Challenges. (K1- K2)

CO 3: Identify different Spectrum sensing methods in Cognitive Radio. (K1- K2)

UNIT I SOFTWARE DEFINED RADIO 9

Basic SDR – Software and Hardware Architecture of an SDR – Spectrum Management – Managing unlicensed spectrum – Noise Aggregation.

UNIT II SDR AS PLATFORM FOR COGNITIVE RADIO 9

Introduction – Hardware and Software architecture – SDR development process and Design – Application software – Component development – Waveform development – cognitive waveform development.

UNIT III COGNITIVE RADIO TECHNOLOGY 9

Introduction – Radio flexibility and capability – Aware – Adaptive – Comparison of Radio capabilities and Properties – Available Technologies – IEEE 802 Cognitive Radio related activities – Application.

UNIT IV CR- TECHNICAL CHALLENGES 9

Design Challenges associated with CR – Hardware requirements – Hidden primary user problem – detecting spread spectrum primary users – sensing duration and frequency – security.

UNIT V SPECTRUM SENSING 9

Overview – Classification - Matched filter – waveform based sensing – cyclostationary based sensing – Energy detector based sensing – Radio Identifier – Cooperative sensing-other sensing methods.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Huseyin Arslan , “Cognitive Radio, Software Defined Radio and Adaptive wireless system”, Springer, 1st edition ,September 24, 2007
2. Bruce A Fette, “Cognitive Radio Technology”, Academic Press, 2009.
3. Mitola, J. and J. Maguire, G. Q., “Cognitive radio: making software radios more personal”, IEEE Personal Commun. Mag., vol. 6, no. 4, pp. 13–18, Aug. 1999.
4. Tevfik Y¨ucek and H¨useyin Arslan, “A Survey of Spectrum Sensing Algorithms for Cognitive Radio Applications” , IEEE Communications Surveys & Tutorials, Vol. 11, No.1, First Quarter 2009, Pp 116-130.

15CM08E MULTI USER DETECTION

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Discuss the major interference of multi-access channels, and the key signal processing techniques to overcome them. (K1- K2)

CO 2: Identify and describe the main components of multiuser detectors present in existing and emerging wireless systems. (K1- K2)

CO 3: Apply the various multiuser signal processing techniques to research work. (K1- K3)

CO 4: Design new methodologies based on the underlying principles of multiuser techniques, and evaluate the performance of various designs. (K1- K4)

CO 5: Implement the advanced detection techniques for industry, solving social problems etc. (K1- K4)

UNIT I MULTIPLE ACCESS AND SINGLE USER DETECTION 9

Multi-access communication – FDMA, TDMA, CDMA – Synchronous and asynchronous CDMA models – Signature waveforms – spreading factor, signature sequences, long sequences – General classification of multiuser receivers – Discrete time synchronous and asynchronous receiver models –Probability of error of matched filter for synchronous users – Optimum detector for two user synchronous channel.

UNIT II LINEAR MULTIUSER DETECTION 9

Limits of single user detection – Single user versus multiuser receivers – Requirements and complexity of multiuser detection algorithms –Decorrelating detector in synchronous and asynchronous channel – Probability of error for synchronous case –MMSE detector in synchronous channel – BER comparison of single user and linear detectors.

UNIT III ADAPTIVE LINEAR MULTIUSER DETECTION 9

Trained and blind detectors – Advantages of adaptive linear detection - Trained adaptive MMSE linear multiuser detection – Canonical representation of linear multiuser detectors – Blind adaptive MMSE multiuser detection – gradient descent algorithm, signature waveform mismatch –BER comparison with batch and adaptive estimation – exact MMSE, blind DMI, blind subspace.

UNIT IV DECISION-DRIVEN MULTIUSER DETECTION 9

Linear versus nonlinear multiuser detection – Successive cancellation – SIC and PIC schemes – Multistage detection – conventional first stage, decorrelating first stage – Decision feedback multiuser detection – Asynchronous decision feedback.

UNIT V MULTIUSER DETECTION FOR WIRELESS NETWORKS 9

Overview of future generation wireless networks – Cross layer design – Multiuser detection for next generation wireless networks – Multiuser detection in cross layer design – Introduction to radio resource allocation – Access control, power control and multiuser detection – Multiuser detection in adhoc networks.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Cristina Comaniciu, Narayan B. Mandayam, H. Vincent Poor," Wireless Networks Multiuser Detection in Cross-Layer Design", Springer Science+Business Media, Inc. 2005

2. Piero Castoldi," Multiuser Detection in CDMA Mobile Terminals", Artech House, INC. 2002
3. Michael L. Honig," Advances in Multiuser Detection", John Wiley & Sons, Inc. 2009
4. Sergio Verdu, "Multiuser Detection", Cambridge University Press, 1998
5. Sergio Verdu, "Recent Progress in Multiuser Detection Advances in Communication and Control Systems", IEEE Press, 1993.

15CM09E NON LINEAR FIBER OPTICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Discuss different nonlinearities in Optical fiber. (K1- K2)

CO 2: Illustrate the importance of phase modulation in nonlinear fiber optics. (K1-K3)

CO 3: Compare different types of optical Solitons. (K1- K3)

CO 4: Summarize the applications of Solitons in optical communication system. (K1-K3)

UNIT I FIBER NONLINEARITIES 9

Introduction, Nonlinear Refraction, Maxwell's Equations, Fiber Modes, Eigen value Equations Single Mode Condition, Nonlinear pulse Propagation, Higher Order Nonlinear Effects.

UNIT II GROUP VELOCITY DISPERSION AND PHASE MODULATION 9

Gaussian Pulse, Chirped Gaussian Pulse, Higher Order Dispersions, Self Phase Modulation- Non-linear Phase Shift, Changes in pulse spectra, Effect of Group Velocity Dispersion, Self Steepening, Polarization effects- Non-linear Birefringence, Optical Kerr Effect, Pulse Shaping, Cross Phase Modulation (XPM)- Coupling between Waves of Different Frequencies.

UNIT III OPTICAL SOLITONS 9

Soliton Stability, Fiber Solitons, Dark Solitons, Dispersion Managed Solitons, Bistable Solitons-, Effect of Birefringence in Solitons, Higher order effects in optical Solitons, Solitons based Fiber Optic Communication System.

UNIT IV SOLITON LASERS 9

Fiber Lasers – Non linear Fiber Loop Mirrors, Fiber Amplifiers – Erbium doped fiber amplifier, Soliton Lasers, Fiber Raman Lasers, Fiber Raman Amplifiers, Fiber Raman Solitons.

UNIT V APPLICATIONS OF SOLITONS 9

DMS for single channel transmission, WDM transmission, Pulse compression, Soliton Switching, Solitons in fibers with gratings, Fiber interferometers, Soliton Light wave systems.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Govind P. Agrawal, “Nonlinear Fiber Optics”, 5th Edition, Academic Press, 2013.
2. A.Hasegawa and M. Matsumoto, “Optical Solitons in Fibers”, 3rd revised Edition, Springer, Berlin, 2003.
3. Govind P. Agrawal, “Applications of Nonlinear Fiber Optics”, 2nd Edition, Academic Press, 2008.
4. M. Lakshmanan and S. Rajasekar, “Nonlinear Dynamics: Integrability, Chaos and Patterns”, Springer, Berlin, 2003.

15CM10E OPTICAL NETWORK AND PHOTONIC SWITCHING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Discuss the basic elements of optical fiber transmission link, fiber modes configurations and structures. (K1-K2)

CO 2: Discuss the different kind of losses, signal distortion in optical wave guide. (K1-K2)

CO 3: Demonstrate various optical source materials, LED structures and fiber optical receivers such as PIN, APD diodes, operational principles of WDM and Solitons. (K1-K4)

CO 4: Identify the errors in the Fiber and measure the attenuation. (K1-K2)

UNIT I INTRODUCTION TO OPTICAL NETWORKS 9

Introduction: Multiplexing Techniques – First and Second Generation Optical networks – Telecom Networks Overview, Telecom Business Models, Roles of three fields in Optical Networking- TE vs, NE vs, NP Wave length – Division Multiplexing – Intermodal dispersion – Chromatic dispersion – non Linear effects.

UNIT II OPTICAL NETWORK COMPONENTS 9

Couplers – Isolators and Circulators, Multiplexers and filters, Fiber gratings, MZ interferometers – arrayed waveguide gratings – optical amplifiers: SOA, EDFA and Raman Amplifier – switches and wavelength converters – Add/Drop Multiplexer – optical cross connect.

UNIT III OPTICAL ACCESS NETWORKS 9

Introduction – Overview of PON Technologies – Ethernet PON (EPON) – access Networks, Fiber to the Cuyb (FTTC) – SONET/SDH, archiecture of optical transport networks (OTNs).

UNIT IV ROUTING AND WAVELENGTH ASSIGNMENT 9

Introduction – Fixed Routing , Fixed-Alternate Routing, Adaptive Routing, Fault – Tolerant routing – Routing and wavelength assignment - LTD and RWA problems.

UNIT V PHOTONIC SWITCHING 9

Photonic Packet Switching, OTDM, Multiplexing and Demultiplexing, Synchronization, Broadcast OTDM networks, Switch-based networks. Header and Packet Format, Typical Contention Resolution in OPS Networks, Test beds KEOPS, NTT's Optical ATM switches.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. John M. Senior, “Optical Fiber Communication”, Pearson Education, 2nd Edition, 2007.
2. Gerd Keiser, “Optical Fiber Communication”, Mc Graw Hill, 4th Edition, 2010.
3. Rajiv Ramaswami.Kumar, N.Sivaranjan, “Optical Networks A Practical Perspective”, 2nd Edition, Elsevier,2009
4. R.P. Khare, “Fiber Optics and Optoelectronics”, Oxford University Press, 2007

15CM11E	WIRELESS SENSOR NETWORKS (Common to CS and C&I)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO 1: Discuss the design issues in sensor networks. (K1-K2)
CO 2: Explain the different types of MAC protocols. (K1-K2)
CO 3: Discuss the different types of routing protocols. (K1-K2)
CO 4: Expose to the protocol stack issues in sensor networks. (K1-K3)
CO 5: Describe the architecture and protocols of wireless sensor networks. (K1-K2)

UNIT I INTRODUCTION 9

Fundamentals of Wireless Communication Technology – The Electromagnetic Spectrum – Radio propagation Mechanisms – Characteristics of the Wireless Channel- Difference between mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs) - Applications of Ad Hoc and Sensor Networks.

UNIT II ARCHITECTURES 9

Single node architecture – Hardware components – Energy consumption of sensor nodes – Network architecture – Sensor network scenarios – Design challenges in wireless sensor networks – Optimization goals and Figure of merit – Gateway concepts.

UNIT III NETWORKING OF SENSORS 9

Physical layer and Transceiver design considerations – MAC protocols for wireless sensor networks – Low duty cycle protocols and wake up radio concepts – Schedule based protocols – Contention based protocols.

UNIT IV INFRASTRUCTURE ESTABLISHMENT 9

Topology control – Clustering – Time synchronization – Localization and Positioning – Sensor tasking and control.

UNIT V SENSOR NETWORK PLATFORMS AND TOOLS 9

Operating systems for wireless sensor networks – Tiny OS – Programming challenges – Sensor node examples: EYES, Berkeley and Mica Motes – Case study: Forest fire detection, Habitat monitoring and Medical applications.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Holger Karl & Andreas Willig, “Protocols and Architectures for Wireless sensor networks”, John Wiley 2008.
2. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols ", Prentice Hall Professional Technical Reference, 2008.
3. Wayne Tomasi “Introduction to data communication and Networking”, Pearson Education, 2007.

15CM12E MULTICASTING TECHNIQUES IN MANET

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Discuss the fundamentals of Communication Paradigms in MANETs. (K1-K2)

CO 2: Discuss the various multicast routing protocols and routing techniques in MANETs. (K1-K2)

CO 3: Evaluate the Energy Management techniques in MANETs. (K1-K5)

UNIT I ROUTING IN MANETS **9**

Introduction – Flooding - Classification of Routing Protocols - Study and Performance of Routing Protocols – Routing Modeling and Mathematical Analysis.

UNIT II COMMUNICATION TECHNIQUES **9**

Types of Communication – Multicast vs. Unicast – Scalability – Application of Group Communication – Characteristics of Group – Special Aspects of Group Communication – Support Within the Communication System.

UNIT III MULTICAST ROUTING PROTOCOL **9**

Introduction – Multicast Protocols in Wired Networks – Multicast routing protocols in mobile ad hoc networks – MAODV, source based tree, core based tree, multicast mehs and location based multicast - multicast Routing Algorithms – protocol Comparisons – issues.

UNIT IV ENERGY MANAGEMENT **9**

Introduction-Need for energy management-Classification of Energy Management schemes - Battery Management Schemes: Device-Dependent Schemes-Data Link Layer Solutions-Network Layer Solutions-Transmission Power Management Schemes: Data Link Layer Solutions-Network Layer Solutions-Higher Layer Solutions-System Power Management Schemes: Processor Power Management Schemes-Device power Management Schemes.

UNIT V CASE STUDIES **9**

Multicast Trees- Stateless Multicasting- Scalable Multicasting- Genetic Algorithm in Multicast routing- Location based multicast address.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. C.K.Toh, “Ad Hoc Mobile Wireless Networks”, Pearson Education, 2002.
2. Ralph Wittmann, Martina Zitterbart. “Multicast Communication: Protocols, Programming, & Applications”, Morgan Kaufmann Publishers, 2001.
3. C.Siva Ram Murthy and B.Smanoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004
4. George Aggelou, “Mobile Ad hoc Networks from wireless LANS to 4G Networks”, Tata McGraw-Hill Edition 2009.
5. Mounir Frikha, “Ad hoc Networks Routing, QoS and optimization”, Willey publication, 2011.

15CM13E FPGA BASED COMMUNICATION SYSTEM DESIGN

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Write HDL program for the given task. (K1-K3)
CO 2: Discuss the concepts of programmable logic devices. (K1-K2)
CO 3: Explain the architecture of various FPGAs (K1-K2)
CO 4: Design FPGA based DSP and Communication algorithms. (K1-K6)

UNIT I INTRODUCTION TO HDL 9

Introduction to VHDL – Behavioral modeling – Data Flow Modeling – Structural Modeling. Introduction to Verilog – Gate Level Modeling – Data Flow Modeling – Behavioral Modeling.

UNIT II PROGRAMMABLE LOGIC DEVICES 9

Basic Concepts, Programming Technologies – Progrmmable Logic Array (PLA), Programmable Array Logic (PAL) , Programmable Logic Array (PLA), Design of State Machine using ASM Chart as a design Tool.

UNIT III FIELD PROGRAMMABLE GATE ARRAYS 9

Introduction – FPGA Technology – DSP Technology Requirement – Design Implementation – FPGA Architectures – Xilinx – Altera Flex – Design Principles using FPGAs – Implementing DSP Functions in FPGA - Applications of FPGA to Software Radio.

UNIT IV DIGITAL SIGNAL PROCESSING WITH FPGAS 9

Design of Binary Adders, Multipliers and Dividers- Design of FIR Filters – Design of IIR Filters – Multirate Signal Processing – Decimation – Interpolation – Polyphase Decomposition – Multistage Decimator – Filter Banks – DFT and FFT Algorithms – Error Control and Cryptography – Modulation and Demodulation – FPGA design of LMS Algorithm.

UNIT V SOFTWARE RADIO 9

Block Diagram of Software Radio –Numerically controlled oscillator – Digital Up converters – Digital Down Converters and demodulators – Universal Modulator and Demodulator using CORDIC. Incoherent Demodulation – digital approach for I and Q generation, Special Sampling Schemes. CIC filters, Residue number system and high speed filters using RNS. Down Conversion using discrete Hilbert Transform. Undersampling receivers, Coherent Demodulation Schemes.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Samir Palnitkar, " Verilog HDL: A Guide to Digital Design and Synthesis", Prentice Hall, 2003.
2. Volnei A Pedroni, "Circuit Design with VHDL", Prentice Hall, 2004.
3. Uwe Meyer Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, 2004.
4. Jeffrey H Reed, "Software Radio: A Modern Approach to Radio Engineering", Pearson Education Asia, 2002.
5. James Tsui, "Digital Techniques for Wideband Receivers", PHI 2005.
6. Mitra S K, "Digital Signal Processing", McGraw Hill, 1998.
7. Bob Zeidman, "Designing with CPLDs and FPGAs", CMP, 2002.

15CM14E SPEECH PROCESSING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Describe different representation of speech waveform (K1-K2)

CO 2: Categorize time domain and frequency domain methods for speech processing. (K1-K4)

CO 3: Summarize linear predictive analysis of speech. (K1-K5)

CO 4: Explain in various applications of speech and audio signal processing. (K1-K4)

UNIT I MECHANICS OF SPEECH 9

Speech production: Mechanism of speech production, Acoustic phonetics – Digital models for speech signals - Representations of speech waveform: Sampling speech signals, basics of quantization, delta modulation, and Differential PCM – Auditory perception: psycho acoustics.

UNIT II TIME DOMAIN METHODS FOR SPEECH PROCESSING 9

Time domain parameters of Speech signal – Methods for extracting the parameters Energy, Average Magnitude, Zero crossing Rate – Silence Discrimination using ZCR and energy – Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function.

UNIT III FREQUENCY DOMAIN METHOD FOR SPEECH PROCESSING 9

Short Time Fourier analysis: Fourier transform and linear filtering interpretations, Sampling rates - Spectrographic displays - Pitch and formant extraction - Analysis by Synthesis - Analysis synthesis systems: Phase vocoder, Channel Vocoder - Homomorphic speech analysis: Cepstral analysis of Speech, Formant and Pitch Estimation, Homomorphic Vocoders.

UNIT IV LINEAR PREDICTIVE ANALYSIS OF SPEECH 9

Basic Principles of linear predictive analysis – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm, – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.

UNIT V APPLICATION OF SPEECH AND AUDIO SIGNAL PROCESSING 9

Algorithms: Dynamic time warping, K-means clusering and Vector quantization, Gaussian mixture modeling, hidden Markov modeling - Automatic Speech Recognition: Feature Extraction for ASR, Deterministic sequence recognition, Statistical Sequence recognition, Language models - Speaker identification and verification – Voice response system – Speech synthesis: basics of articulatory, source-filter, and concatenative synthesis – VOIP.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing", John Wiley and Sons Inc., Singapore, 2004
2. L.R.Rabiner and R.W.Schaffer "Digital Processing of Speech signals" PH, 1979
3. L.R. Rabiner and B. H. Juang, "Fundamentals of Speech Recognition", PH, 1993.
4. Jacob Benesty, M.M.Sondhi Huang, "A Handbook of Speech Processing" Springer, 2008

15CM15E	PATTERN RECOGNITION TECHNIQUES AND APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO 1: Identify the applications of Neural Networks (K1-K2)

CO 2: Apply Image Understanding concepts to Recognition (K1-K3)

CO 3: Analyze the Classification and Segmentation Problems (K1-K4)

UNIT I PATTERN RECOGNITION CONCEPTS 9

Patterns and Pattern Recognition, Pattern Recognition System- significance, Configurations. Representation of Patterns and Machine Recognition, Machine Intelligence, Computing Methods, Applications.

UNIT II SUPERVISED, SEMI SUPERVISED LEARNING 9

Non-Parametric Classification: Decision theoretic Classification-Decision Surfaces, Discriminant Functions and their types, Potential Functions. Discriminant Function Training-Weight Space, Training Procedure, Training Methods, Statistical Discriminant Functions-Statistical Design Theory-Problem Formulation, Optimal functions, Semi Supervised methods- Transductive Support Vector Machines (TSVMs), Semi- Supervised Learning in Structured Output Spaces

UNIT III CLUSTERING ANALYSIS AND UNSUPERVISED LEARNING, DIMENSIONALITY REDUCTION 9

Introduction to Clustering, Clustering with Unknown Number of Classes and Known Number of Classes, Evaluation of Clustering Results, Graph Theoretical Methods, Mixture Statistics and Unsupervised Learning. Dimensionality Reduction: Feature Selection for Multivariate Gaussian Data, Feature Ordering, Canonical Analysis, Optimum Classification, Non-parametric Feature Selection.

UNIT IV NEURAL NETWORKS 9

Multilayer Perceptron-Preliminaries, Pattern Mapping. Radial Basis Function Networks-Training, Formulation for Pattern Classification, Comparison of RBF with Multilayer Perceptron, Hamming Net and Kohonen Self-Organizing Feature Map, Hopfield Model.

UNIT V IMAGE UNDERSTANDING CONTROL STRATEGIES 9

Image Understanding Control Strategies - Parallel and Serial Processing Control, Hierarchical Control, Bottom Up Control Strategies, Model Based Control Strategies, Combined Control Strategies, Non- hierarchical Control, Active Contour Models, Point Distribution Models, Pattern Recognition Methods in Image Understanding, Scene Labeling and Constraint Propagation, Semantic Image Segmentation and Understanding.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Sing-tze Bow, “Pattern Recognition and Image Preprocessing”, Marcel Dekker, Inc, 2nd Edition, 2002.
2. Milan Sonka, Vaclav Hiavac, Roger Boyle, “Image Processing, Analysis and Machine Vision”, Cengage Learning, 4th Edition, 2014.
3. Earl Gose, R.Johnson Baugh and Steve Jost, “Pattern Recognition and image Analysis”, Prentice Hall, 1st Edition, 2007.
4. Richard O.Duda, Peter E.Hart and David G.Stork, “Pattern Classification”, Wiley-Interscience, 2nd Edition, 2000.

15CM16E LTE FOR MOBILE BROADBAND

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of the course students able to

CO 1: Describe time-frequency structure, and duplex schemes. (K1-K2)
CO 2: Illustrate about synchronization signals and reference signals. (K1-K3)
CO 3: Apply different channel coding schemes in LTE. (K1-K3)
CO 4: Determine spatial multiplexing and transmission modes in LTE. (K1-K4)
CO 5: Design propagation channel models. (K1-K6)

UNIT I PHYSICAL TRANSMISSION RESOURCES 9

Overview of Time-Frequency Structure, Duplex Schemes: Frequency-Divison Duplex, Time-Divison Duplex, Channel structure and Bandwidths: Channel bandwidths, User Equipment(UE) radio access capabilities, Frame and Slot structure: Physical resource block, slot structure, Downlink distributed transmission.

UNIT II CELL SEARCH AND REFERENCE SIGNALS 9

Downlink frame structure, Synchronization signals: Primary synchronization signal, secondary synchronization, Zadoff-Chu sequences, Downlink reference signals: Cell-specific reference signals, MBSFN refence signals, UE-specific reference signals, PN sequence, PN sequence generation in LTE, Channel Estimation and detection methods.

UNIT III CHANNEL CODING AND LINK ADAPTATION 9

Channel Coding: LDPC codes, Channel coding schemes in LTE, Cyclic redundancy Check, Codebook segmentation, Turbo coding, Tail-biting convolutional code, Circular-buffer rate matching for Turbo code, Codebook concatenation, Channel interleaver, Link Adaptation: CQI feedback in LTE.

UNIT IV TRANSMISSION MODES IN LTE 9

Codewords and Layer mapping, Downlink transmission modes, Single antenna mode – Space Frequency block code, MIMO Precoding, CDD-based precoding, open-loop and closed loop spatial multiplexing – Beamforming, Link Adaptation: CQI feedback in LTE.

UNIT V PRACTICAL DEPLOYMENT ASPECTS 9

The Radio Propagation Environment - SISO and SIMO Channel Models, MIMO Channel. Radio Frequency Aspects - Transmitter RF Requirements - Interference Issues in Unpaired Spectrum - Half-Duplex System Design Aspects - Reciprocity**.**

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Erik Dahlman, Stefan Parkvall and Johan Skold, "4G LTE/LTE-Advanced for Mobile Communication", Elsevier publications First Edition 2011.
2. Farooq Khan," LTE for 4G Mobile Broadband ", Cambridge University Press 2009.
3. Stefania Sesia, Issam Toufik, Matthew Baker, “LTE-The UMTS Long Term Evolution From theory to practice", John Wiley & Sons Ltd., Second Edition, 2011.
4. 3GPP TS 36.212: "Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding", 2011.
5. 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures", 2011

15CM17E MICRO ELECTRO MECHANICAL SYSTEMS **L T P C**
3 0 0 3

COURSE OUTCOMES

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

CO 1: Discuss the principles of micro fabrication to the development of micromechanical devices and the design of micro systems (K1- K2)

CO 2: State the principles of energy transduction, sensing and actuation on a microscopic scale. (K1- K2)

CO 3: Appreciate the effects of scaling, and the similarities and differences between micromechanical assemblies and macroscopic machines. (K1- K4)

CO 4: Analyze and model the behavior of micro electromechanical devices and systems (K1- K4)

UNIT I INTRODUCTION TO MEMS **9**

MEMS and Microsystems, Miniaturization, Typical products, Micro sensors, Micro actuation, MEMS with micro actuators, Micro accelerometers and Micro fluidics, MEMS materials, Micro fabrication

UNIT II MECHANICS FOR MEMS DESIGN **9**

Elasticity, Stress, strain and material properties, Bending of thin plates, Spring configurations, torsional deflection, Mechanical vibration, Resonance, Thermo mechanics – actuators, force and response time, Fracture and thin film mechanics.

UNIT III ELECTRO STATIC DESIGN **9**

Electrostatics: basic theory, electro static instability. Surface tension, gap and finger pull up, Electro static actuators, Comb generators, gap closers, rotary motors, inch worms, Electromagnetic actuators. bistable actuators.

UNIT IV CIRCUIT AND SYSTEM ISSUES **9**

Electronic Interfaces, Feedback systems, Noise , Circuit and system issues, Case studies – Capacitive accelerometer, Peizo electric pressure sensor, Modeling of MEMS systems, CAD for MEMS.

UNIT V INTRODUCTION TO OPTICAL AND RF MEMS **9**

Optical MEMS, - System design basics – Gaussian optics, matrix operations, resolution. Case studies, MEMS scanners and retinal scanning display, Digital Micro mirror devices. RF Memes – design basics, case study – Capacitive RF MEMS switch, performance issues.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Stephen Santuria," Microsystems Design", Kluwer publishers, 2000.
2. Nadim Maluf," An introduction to Micro electro mechanical system design", Artech House, 2000
3. Mohamed Gad-el-Hak, editor," The MEMS Handbook", CRC press Baco Raton, 2000.
4. Tai Ran Hsu," MEMS & Micro systems Design and Manufacture" ,Tata McGraw Hill, New Delhi, 2002.

15CM18E MULTIMEDIA COMMUNICATION SECURITY

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Discuss the fundamentals and operation of Next generation TV Networks. (K1 – K2)

C O2: Describe the various models and standards of IPTV. (K1 – K2)

CO 3: Deploy IPTV techniques on various networks. (K1 – K4)

CO 4: Discuss various security attacks on IPTV (K1 – K2)

CO 5: Evaluate various real time IPTV models. (K1 – K5)

UNIT I NEXT GENERATION TV NETWORK 9

Introduction - IPTV Architecture: High-level Architecture , Functional Architecture for the IPTV Service , Head End (IPTV Service Provider), Transport and Aggregation Network , IPTV Standards and Solutions: The Open ITPV Forum Architecture, The ETSI IPTV Standard - Interactive, Personal IPTV: Home Connectivity, The Set-top Box for IPTV, Channel Switching, Dynamic Creation of Interactive Television , Profiles to Adapt, Design of Interaction Objects, Generic Interaction Models , Designing Menus and Text.

UNIT II DIGITAL RIGHTS MANAGEMENT 9

Digital Rights Management: Exceptions to Copyright, Attaching Strings to Copyright Gifts, Legal Constraints for users, Simple Philosophy, Complicated Mechanism, Standards for DRM – Identities: Managing and Federating User Profiles XDMS, PGM, Data Format, Lists and Profiles, Advertising and Presence - Beyond the EPG : Social Software, Presence and Personalized EPG, Metadata Types and Models , Metadata and the EPG: TV-Anytime - Protocols for Interaction: HTTP,VoD,SIP,SDP - IPTV Encoding: MPEG-2, MPEG-4, Transporting the MPEG Stream.

UNIT III SERVICES AND TECHNOLOGIES 9

Network Distribution Technologies : Broadband Distribution Network Types, IPTV over a Fiber Access Network, IPTV over an ADSL Network, IPTV over Cable TV Networks, IPTV over Wireless Networks, IPTV over the Internet, IPTV Backbone Technologies, Network Factors Associated with Deploying IPTV - Real-Time Encoding and Transportation: Compression Methods, Packetizing and Encapsulating Video Content - Broadcasting over IPTV: Video Components of an End-to-End IPTV System, Streaming IPTV Content, Multicasting across an IPTV Network - IPTV Multicasting Networking Architecture: Multicasting IPTV over IPV6 Networks - IPTV Devices: Residential Gateways.

UNIT IV MULTIMEDIA SECURITY 9

General Mechanisms for Content Protection : CPS , CAS , VCPS , CPRM/CPPM (CPSA) - Open DRM: SDMI, OMA, DRM DMP - Interoperability Proposals : Watermarking and Fingerprinting - Threats to IPTV Implementations: IPTV Service Provider Head End - IPTV Network Provider: Protocol Vulnerabilities, Content Distribution Service, Multicast Content Propagation, QoS Signaling, Connection Management Service - Countering the Threats : Hardening Operating Systems , Intrusion Detection/Intrusion Prevention , Network Firewalls, Fraud Prevention , Head End (IPTV Service Provider) , Aggregation and Transport Network, Home End .

UNIT V CASE STUDY 9

IPTV - Household Structures - P2P - VoD - Cloud computing Environment - Channel Navigation- Channel Switching - Zapping Delay - Resource Allocation for wireless environment- SAMP - EPON

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Johan Hjelm , “Why IPTBack Rest Revolving chair with wheelV? Interactivity, Technologies and Services”, John Wiley and Sons, Ltd, Publication 2008
2. Gerard O’driscoll, “Next Generation IPTV Services and Technologies”, John Wiley & Sons, Inc., Publication, 2008
3. David Ramirez, “IPTV Security Protecting High-Value Digital Contents”, John Wiley & Sons, Inc., Publication, 2008
4. Dixin Luo, Hongteng Xu, "You Are What You Watch and When You Watch: Inferring Household Structures From IPTV Viewing Data " IEEE Transactions On Broadcasting, VOL. 60, NO. 1, pp 61 - 72 MARCH 2014
5. Yunyoung Nam, Hyung Ju Park, "An Interactive IPTV System With Community Participation in Cloud Computing Environments", IEEE Systems Journal, Vol. 8, NO. 1, pp 174 - 183 MARCH 2014
6. Fernando M. V. Ramos, " Mitigating IPTV Zapping Delay", IEEE Communications Magazine, pp128 - 133, August 2013.
7. Wen-Hsing Kuo, Wanjiun Liao, "Adaptive Resource Allocation for Layer-Encoded IPTV Multicasting in IEEE 802.16 WiMAX Wireless Networks", IEEE Transactions On Multimedia, Vol. 13, NO. 1 pp 116 - 124, February 2011.

15CM19E	ADAPTIVE SIGNAL PROCESSING (Common to CS and CN)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO 1: Describe the fundamentals of adaptive filtering (K1 – K2)

CO 2: Design the LMS filter for different applications (K1 – K4)

CO 3: Design an adaptive filter based on conventional RLS algorithm (K1 – K4)

CO 4: Design an adaptive filter based on fast traversal, adaptive lattice and QR decomposition based RLS algorithms (K1 – K4)

UNIT I FUNDAMENTALS OF ADAPTIVE FILTERING 9

Signal Representation - Correlation Matrix – Wiener Filter - Linearly Constrained Wiener Filter – Mean Square Error Surface – Bias and Consistency – Newton Algorithm – Steepest Descent Algorithm – Applications: System Identification, Signal Enhancement, Signal Prediction, Channel Equalization.

UNIT II THE LMS ALGORITHM 9

The LMS algorithm – properties – Behavior in nonstationary environments – Applications - LMS Newton Algorithm –Normalized LMS – Transform Domain LMS – Affine Projection Algorithm.

UNIT III CONVENTIONAL RLS ALGORITHM 9

Recursive Least Squares Algorithm – Properties: Orthogonality principle, Relation between Least Squares and Wiener Solutions, Influence of the Deterministic Autocorrelation Initialization, Steady state behavior of coefficient vector, Coefficient-Error-Vector Covariance Matrix, Behavior of the Error Signal, Excess mean square error and Misadjustment – Behavior in Nonstationary Environments

UNIT IV ADAPTIVE LATTICE BASED RLS ALGORITHMS 9

Recursive Least Square Prediction – Order updating Equations – Time updating Equations – Joint Process Estimation – Time recursions of the Least Squares Error – Normalized Lattice RLS algorithm – Error Feedback Lattice RLS Algorithm

UNIT V FAST TRANSVERSAL AND QR DECOMPOSITION BASED RLS ALGORITHM 9

Stabilized Fast Transversal RLS Algorithm – Triangularization using QR Decomposition: Initalization Process, Input data matrix triangularization, QR Decomposition RLS algorithm – Systolic Array Implementation – Implementation Issues - Fast QR-RLS Algorithm

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Paulo S.R.Diniz," Adaptive Filtering: Algorithm and Practical Implementation", 4th Edition, Springer, 2012.

2. Bernard Widrow, Samuel D.Strearns, "Adaptive Signal Processing", 1st Edition, Pearson Education,2005.

3. Simon Haykin, "Adaptive Filter Theory", 5th Edition, PE Asia, 2013.

4. Sophocles. J. Orfamadis, "Optimum signal processing: An introduction", 2nd Edition, McGraw-Hill, New York, 2007.

5. James V. Candy, "Signal Processing: A Modern Approach", McGraw-Hill, International Edition, 1988.

15CM20E	MEDICAL IMAGE PROCESSING	L	T	P	C
	(Common to CS and CSE)	3	0	0	3

COURSE OUTCOMES

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

CO 1: Describe the Medical image fundamentals and its reconstruction (K1-K2)
CO 2: Describe medical image formats and its processing (K1-K2)
CO 3: Discuss the image registration and visualization (K1-K2)
CO 4: Classify the medical image segmentation procedures (K1-K3)
CO 5: Explain ultrasound, PET and SPECT imaging methods (K1-K4)

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; dose Basic principles of CT; reconstruction methods; artifacts; CT hardware. Magnetic Resonance Imaging (MRI), Mathematics of MR; spin physics; NMR spectroscopy; imaging principles and hardware.

UNIT II STORAGE AND PROCESSING 9

Medical Image Storage, Archiving and Communication Systems and 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 IMAGE REGISTRATION AND VISUALIZATION 9

Rigid body visualization, Principal axis registration, Interactive principal axis registration, Feature based registration, Elastic deformation based registration, Medical image fusion, Image visualization –2D display methods, 3D display methods, virtual reality based interactive visualization. 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.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Atam P.Dhawan, “Medical Image Analysis”, Wiley Interscience Publication, NJ, USA 2003.
2. Paul Suetens, "Fundamentals of Medical Imaging", 2nd Edition, Cambridge University Press, 2009.
3. J. Michael Fitzpatrick and Milan Sonka, "Handbook of Medical Imaging, Medical Image Processing and Analysis", SPIE Publications, Volume 2, 2009.
4. Kayvan Najarian and Robert Splinter, "Biomedical Signal and Image Processing", 2nd Edition, CRC Press, 2005.
5. Geoff Dougherty, "Digital Image Processing for Medical Applications", 1st Edition,Cambridge University Press, 2009.
6. Jerry L. Prince and Jonathan Links, "Medical Imaging Signals and Systems", 1st Edition, Prentice Hall, 2005.
7. John L. Semmlow, "Biosignal and Medical Image Processing", 2nd Edition, CRC Press, 2008.

15CM21E WAVELET AND MULTIRESOLUTION PROCESSING **L T P C**
(Common to CS and CSE) **3 0 0 3**

COURSE OUTCOMES

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

CO 1: Choose the desired transforms for different image processing application. (K1-K3)

CO 2: Analyze Wavelet Packets. (K1 –K4)

CO 3: Design Wavelets for specific application. (K1- K5)

UNIT I VECTOR SPACES AND SIGNAL SPACES 9

Vector Spaces - properties - dot product - basis - dimension, orthogonality and orthonormality - relationship between vectors and signals - Signal spaces - concept of Convergence - Hilbert spaces for energy signals - Generalised Fourier Expansion.

UNIT II MULTI RESOLUTION ANALYSIS 9

Definition of Multi Resolution Analysis (MRA) - Haar basis - Construction of general orthonormal MRA-Wavelet basis for MRA - Continuous time MRA interpretation for the DTWT - Discrete time MRA- Basis functions for the DTWT - PRQMF filter banks.

UNIT III CONTINUOUS WAVELET TRANSFORMS 9

Wavelet Transform - definition and properties - concept of scale and its relation with frequency - Continuous Wavelet Transform (CWT) - Scaling function and wavelet functions (Daubechies, Coiflet, Mexican Hat, Sine, Gaussian, Bi-Orthogonal) - Tiling of time -scale plane for CWT.

UNIT IV DISCRETE WAVELET TRANSFORMS 9

Filter Bank and sub band coding principles - Wavelet Filters - Inverse DWT computation by Filter banks - Basic Properties of Filter coefficients - Choice of wavelet function coefficients - Derivations of Daubechies Wavelets - Mallat's algorithm for DWT - Multi-band Wavelet transforms. Lifting Scheme: Wavelet Transform using Polyphase matrix Factorization - Geometrical foundations of lifting scheme - Lifting scheme in Z-domain.

UNIT V WAVELET APPLICATIONS 9

Signal Compression - Image Compression techniques: EZW-SPIHT Coding - Image denoising techniques: Noise estimation - Shrinkage rules - Shrinkage Functions - Edge detection and object Isolation, Image Fusion, and Object Detection. Curve and Surface Editing- Variational modeling and finite element method using wavelets.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Rao.R.M and A.S.Bopardikar, "Wavelet Transforms: Introduction to theory and Applications", Prentice Hall PTR, 1st Edition, 1998.
2. K.P.Soman and K.I.Ramachandran, "Insight into Wavelets - From Theory to practice", PHI Learning Private Limited, 3rd Edition, 2013.
3. Strang G and Nguyen T, "Wavelets and Filter Banks", Wellesley College,2nd Edition, 1996
4. Vetterli M, Kovacevic J, "Wavelets and Sub-band Coding", Create Space Independent Publishing Platform, 1st Edition, 2013
5. Mallat S, "A Wavelet Tour of Signal Processing", Academic Press, 3rd Edition, 2008

15CM22E	MOBILE ADHOC NETWORKS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO 1: Explain the MAC address spoofing concepts and basics of networks. (K1 –K2)
CO 2: Describe the routing principles and Adhoc network types. (K1 –K2)
CO 3: Discuss the operation principles of WSN. (K1 –K2)
CO 4: Explain the routing principles of WSN. (K1 –K2)
CO 5: Describe the IEEE standards, MESH networks and its heterogeneous models. (K1 –K2)

UNIT I ADHOC MAC **9**

Introduction – Issues in Adhoc Wireless Networks – MAC Protocols – Issues – Classifications of MAC protocols – Multi channel MAC and Power control MAC protocol.

UNIT II ADHOC NETWORK ROUTING AND TCP **9**

Issues – Classifications of routing protocols – Hierarchical and Power aware. Multicast routing – Classifications, Tree based, Mesh based. Adhoc Transport Layer Issues. TCP Over Adhoc – Feedback based, TCP with explicit link, TCP-BuS, Adhoc TCP, and Split TCP.

UNIT III WSN – MAC **9**

Introduction – Sensor Network Architecture – Data dissemination – Data Gathering. MAC Protocols– Self-organizing, Hybrid TDMA/FDMA and CSMA based MAC.

UNIT IV WSN ROUTING, LOCALIZATION AND QoS **9**

Issues in WSN routing – OLSR, AODV, DSR, DSDV. Localization – Indoor and Sensor Network Localization. QoS in WSN.

UNIT V MESH NETWORKS **9**

Necessity for Mesh Networks – MAC enhancements – IEEE 802.11's Architecture – Opportunistic routing – Self configuration and Auto configuration – Capacity Models – Fairness – Heterogeneous Mesh Networks – Vehicular Mesh Networks.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. C.Siva Ram Murthy, B.S. Manoj, "Adhoc Wireless Networks: Architectures and Protocols", 1st Edition, Pearson Education, 2004.
2. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks", 1st Edition, Morgan Kaufman Publishers, 2004.
3. C.K.Toh, "Adhoc Mobile Wireless Networks", 1st Edition, Pearson Education, 2002.
4. Thomas Krag and Sebastin Buettrich, "Wireless Mesh Networking", 2nd Edition, O'Reilly Publishers, 2007.
5. C K Toh, "Adhoc mobile wireless networks, Protocols and Systems", 2nd Edition, Pearson Education, 2009.
6. Azzedine Boukerche, "Handbook of algorithms for wireless Networking and Mobile computing", 2nd Edition, CRC Press, 2006.

15CM23E	DESIGN AND DEPLOYMENT OF WIRELESS SENSOR NETWORK	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO 1: Describe the deployment approach and clustering in detail. (K1- K2)

CO 2: Explain the various sensor coverage models and optimization problems for coverage control. (K1- K2)

CO 3: Discuss the critical Sensor Density, Activity Scheduling and Movement strategy problem in WSN. (K1- K2)

CO 4: Examines the barrier Coverage problems and Energy harvesting in WSN. (K1- K4)

CO 5: Apply knowledge of wireless sensor networks to various application areas. (K1- K3)

UNIT I DEPLOYMENT MECHANISMS AND CLUSTERING TECHNIQUES 9

Learning from Deployment Experience - Designing for Deployment**:** The Design for Deployment Process, Key Design Parameters, Iterative Deployment, Lessons from the Field.

Topology Discovery and Clusters in Sensor Networks - Adaptive Clustering with Deterministic Cluster -Head Selection - Sensor Clusters' Performance – Power Aware Functions in Wireless Sensor Networks - Efficient Flooding With Passive Clustering.

UNIT II COVERAGE CONTROL AND TARGET COVERAGE PROBLEMS 9

Sensor coverage Models: Boolean Sector Coverage Models, Boolean Disk Coverage Models, Attenuated Disk Coverage Models, Truncated Attenuated Disk Models, Detection Coverage Models, Estimation Coverage Models – Coverage control in protocol architecture Design issues of Network coverage control.

Node Placement Optimization: Node Placement as the set-Covering Problem – Optimal Sensor Placement Problem. Coverage Lifetime Maximization: Maximization Target Coverage Lifetime – Maximizing connected Target Coverage Lifetime.

UNIT III AREA COVERAGE PROBLEMS 9

Critical Sensor Density: Deterministic Node Placement – Random Node Placement. Sensor Activity and Scheduling: Preserving Complete Coverage - Preserving Partial Coverage – Preserving area coverage and Network Connectivity. Node Movement Strategy: Healing Coverage Hole – Optimizing Area Coverage – Improving Event Coverage.

UNIT IV BARRIER COVERAGE PROBLEMS AND ENERGY EFFICIENCY 9

Barrier Coverage Problems**:** Build in Intrusion Barriers – Find the Penetration Paths.
Energy Harvesting in WSN: Energy harvesting, Harvesting techniques, Energy harvesting storage devices, Power management for EH-WSN.

UNIT V CASE STUDIES 9

Volcano Monitoring: Addressing Data Quality through Iterative Deployment - VoxNet: Reducing Latency in High Data Rate Applications - Failure Is Inevitable: The Trade-off between Missing Data and Maintenance, Glacier Monitoring: Deploying Custom Hardware in Harsh Environments.

Energy-efficient border intrusion detection - Multiobjective Optimization for Topology and Coverage Control - Sensor Node Deployment Based on Electromagnetism – Energy Hole Detection and Healing

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Elena Gaura, Lewis Girod, “Wireless Sensor Network - Deployments and Design Frameworks” - Springer Science Business Media, LLC 2010.
2. Bang Wang, “Coverage Control in Sensor Networks”, Springer Science & Business Media, 2010.
3. Oswald Jumira, Sherali Zeadally “Energy Efficiency in Wireless Networks”, John Wiley Publication, Jan 2013.
4. Anna Ha´c, “Wireless Sensor Network Designs”, John Wiley & Sons Ltd, 2003.

15CM24E VEHICULAR ADHOC NETWORKS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO 1: Discuss about the basic principles and challenges of VANET. (K1 –K2)

CO 2: Discuss about link layer protocols and wireless access technologies. (K1 –K2)

CO 3: Build working knowledge on various routing protocols and connectivity techniques. (K1 –K4)

CO 4: Discuss about emerging security issues, Description of modeling issues and mathematical analysis using various encryption schemes techniques in VANET. (K1 –K3)

CO 5: Describe various mobility models and simulation techniques of VANET in wireless Environment. (K1 –K2)

UNIT I INTRODUCTION TO VANET 9

Introduction - VANET architecture - communication domains: Vehicle to Vehicle Communication, Vehicle to Infrastructure - characteristics - Applications: Cooperative Vehicular Safety Applications: Enabling Technologies, Cooperative System Architecture and VANET- enabled Active Safety Applications - VANET Convenience and Efficiency Applications: Communication Paradigms - Probabilistic, Area-based Aggregation - Travel Time Aggregation and limitation.

UNIT II VANET LINK LAYER PROTOCOLS 9

MAC Layer and Scalability Aspects of Vehicular Communication Networks - Survey on Proposed MAC Approaches for VANETs - Communication Based on IEEE 802.11p - Performance Evaluation and Modeling - Aspects of Congestion Control. Wireless Access Technologies - WLAN/Wi-Fi – WiMAX - WAVE.

UNIT III RESEARCH CHALLENGES IN VANET 9

Information Dissemination: Introduction, Information Transport & Geographical Data Aggregation Local and summarizing the measurements - VANET Routing protocols - Topology based routing - proactive - CGSR and reactive protocols - DYMO - Broadcast routing protocol - Connectivity in VANET - performance modeling - Node connectivity -Road side connectivity - connectivity in urban area and highways.

UNIT IV DATA SECURITY IN VANET 9

Data Security: Introduction - security threats - Classification of attacks: Sybil Attack - Impersonation Attack and Masquerade - Timing Attack - Spoofing, Hidden vehicle and Tunnel Attack - Illusion Attack - Denial of Service (DoS) - Challenges of Data Security in Vehicular Networks, Security Infrastructure, Cryptographic Protocols.

UNIT V MOBILITY MODELS AND SIMULATION TECHNIQUES IN VANET 9

Mobility Models: Random Models, Flow Models, Traffic Models, Trace or survey - based Models and Behavioral Model - Overview of Simulators for VANETs - General Features of VANET Simulators - Simulator Architecture - Types of Simulators: Mobility Simulator, Network Simulator, VANET Simulator

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Hannes Hartenstein and Kenneth P.Laberteaux, "VANET:Vehicular Applications and Inter-Networking Technologies", 1st Edition, Wiley publications, 2010.
2. Stephan Olariu,Michele C. Weigle, "Vehicular Network from theory to practice", 1st Edition, CRC Press, 2009.
3. Marco Picone, Stefano Busanelli, Michele Amoretti, Francesco Zanichelli, Gianluigi Ferrari, "Advanced Technologies for Intelligent Transportation Systems", Springer Cham Heidelberg, New york, 1st Edition, 2014.
4. Watfa, Mohamed, "Advances in Vehicular Ad-Hoc Networks: Developments and Challenges", published in USA, Information Science Rreference, 2010.
5. Vinh Hoa LA, Ana Cavalli, "Security attacks and solutions in Vehicular Adhoc Networks:A Survey", International Journal on Adhoc Networking Systems (IJANS) Vol. 4, No. 2, April 2014.