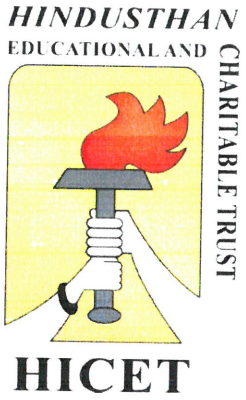
HINDUSTHAN COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai)

(AICTE, New Delhi, Accredited by NAAC with 'A' Grade)

Coimbatore-641 032.

M.E. COMMUNICATION SYSTEMS



Curriculum & Syllabus

2018-2019

VISION AND MISSION OF THE INSTITUTION

VISION

To become a premier institution by producing professionals with strong technical knowledge, innovative research skills and high ethical values.

MISSION

IM1: To provide academic excellence in technical education through novel teaching methods.

IM2: To empower students with creative skills and leadership qualities.

IM3: To produce dedicated professionals with social responsibility.

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ECE - HiCET

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VISION AND MISSION OF THE DEPARTMENT

VISION

To nurture Electronics and Communication Professionals with exemplary technical skills adorned with ethical values.

MISSION

M1. To expand frontiers of knowledge through the provision of inspiring learning environment

M2. To develop the intellectual skills towards employability by fostering innovation, and creativity in learning.

M3. To provide a quality system for wholesome learning to achieve progress and prosperity in life along with moral values

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PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

PO 1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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PO 6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10.**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports anddesign documentation, make effective presentations, and give and receive clear instructions.

PO11.**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12.**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1. Graduates will be able to provide solutions for real time embedded systems using Internet of Things to meet the global needs.

PSO 2. Graduates will have the perseverance to design and develop products using cutting edge technologies in Signal processing and Communication systems.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1. To prepare the graduates to solve, analyze and develop real time engineering products by providing strong foundation in the fundamentals of Electronics and Communication Engineering.

PEO 2. To prepare the graduates to succeed in multidisciplinary dimensions by providing adequate trainings and exposure to emerging technologies.

PEO 3. To prepare the graduates to become a successful leader and innovator following ethics with the sense of social responsibility for providing engineering solutions.

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CURRICULUM

HINDUSTHAN EDUCATIONAL AND CHARITABLE TRUST
HICET

Hindusthan College of Engineering and Technology

(An Autonomous Institution, Affiliated to Anna University, Chennai
Approved by AICTE, New Delhi& Accredited by NAAC with 'A' Grade)
Coimbatore, Tamil Nadu.

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DETAILS OF CHANGES CARRIED OUT IN CURRICULUM & SYLLABUS
CBCS PATTERN
POST GRADUATE PROGRAMMES
M.E. COMMUNICATION SYSTEMS

REGULATION-2016

For the students admitted from 2018-19 onwards

SEMESTER I

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16MA1121	Advanced Applied Mathematics	3	1	0	4	40	60	100
2	16CM1201	Advanced Radiation Systems	3	1	0	4	40	60	100
3	16CM1202	Global Positioning Systems	3	0	0	3	40	60	100
4	16CM1203	Optical Communications Network	3	0	0	3	40	60	100
5	16CM1204/ 16EN1204	Advanced Wireless Communications and Networks	3	0	0	3	40	60	100
6	16CM1205	Coding and Compression Techniques	3	0	0	3	40	60	100
PRACTICAL									
7	16CM1001	Communication System Design Laboratory	0	0	4	2	50	50	100
Total			**18**	**2**	**4**	**22**	**290**	**410**	**700**

SEMESTER II

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16CM2201	802.XX Wireless Networks	3	0	0	3	40	60	100
2	16CM2202	Signal Processing and Baseband Techniques	3	0	0	3	40	60	100
3	16CM2203/ 16EN2203	RF MEMS for Wireless Communication	3	0	0	3	40	60	100
4	16CM23XX	Professional Elective I	3	0	0	3	40	60	100
5	16CM23XX	Professional Elective II	3	0	0	3	40	60	100
6	16CM23XX	Professional Elective III	3	0	0	3	40	60	100
PRACTICAL									
7	16CM2801	Algorithms Simulation Laboratory	0	0	4	2	50	50	100
Total			**18**	**0**	**4**	**20**	**290**	**410**	**700**

For the students admitted from 2017-18 onwards

SEMESTER III

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16CM33XX	Professional Elective IV	3	0	0	3	40	60	100
2	16CM33XX	Professional Elective V	3	0	0	3	40	60	100
3	16CM33XX	Professional Elective VI (OR)	3	0	0	3	40	60	100
	16XX34XX	Open Elective (Optional)	3	0	0	3	40	60	100
PRACTICAL									
4	16CM3901	Project Phase - I	0	0	12	6	50	50	100
Total			**9**	**0**	**12**	**15**	**170**	**230**	**400**

SEMESTER IV

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
PRACTICAL									
1	16CM4902	Project Phase - II	0	0	30	15	100	100	200
Total			**0**	**0**	**30**	**15**	**100**	**100**	**200**

LIST OF PROFESSIONAL ELECTIVES

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
1	16CMX301	RFIC Design	3	0	0	3	40	60	100
2	16CMX302/ 16ENX303	Broad Band Access Technologies and Distribution Systems	3	0	0	3	40	60	100
3	16CMX303/ 16ENX304	Electromagnetic Interference and Compatibility	3	0	0	3	40	60	100
4	16CMX304	Digital Communication Receivers	3	0	0	3	40	60	100
5	16CMX305/ 16ENX305	Communication Protocol Engineering	3	0	0	3	40	60	100
6	16CMX306/ 16ENX307	Network Routing Algorithms	3	0	0	3	40	60	100
7	16CMX307	Communication Network Security	3	0	0	3	40	60	100
8	16CMX308	Real Time Operating Systems	3	0	0	3	40	60	100
9	16CMX309	High Performance Computer Networks	3	0	0	3	40	60	100

10	16CMX310	Advanced Digital Image Processing	3	0	0	3	40	60	100
11	16CMX311	Signal Integrity for High Speed Design	3	0	0	3	40	60	100
12	16CMX312	Orthogonal Frequency Division Multiplexing	3	0	0	3	40	60	100
13	16CMX313/ 16ENX306	High Speed Switching Architecture	3	0	0	3	40	60	100
14	16CMX314/ 16ENX317	Modeling and Simulation of Wireless Communication Systems	3	0	0	3	40	60	100
15	16CMX315	Wavelet Transforms and its Applications	3	0	0	3	40	60	100
16	16CMX316	Spread Spectrum Communications	3	0	0	3	40	60	100
17	16CMX317/ 16ENX312	Wireless Sensor Networks	3	0	0	3	40	60	100
18	16CMX318	Speech and Audio Processing	3	0	0	3	40	60	100
19	16CMX319	Smart Antennas	3	0	0	3	40	60	100
20	16CMX320	Signal Detection and Estimation	3	0	0	3	40	60	100
21	16CMX321	Green Computing	3	0	0	3	40	60	100
22	16CMX322	Pattern Recognition	3	0	0	3	40	60	100
23	16CMX323/ 16ENX328	Networks on Chip	3	0	0	3	40	60	100
24	16CMX324/ 16ENX327	System on Chip Design	3	0	0	3	40	60	100
25	16CMX325	Cloud computing	3	0	0	3	40	60	100
26	16CMX326/ 16ENX324	Cyber Security	3	0	0	3	40	60	100
27	16CMX327/ 16ENX326	Software Defined Radio	3	0	0	3	40	60	100
28	16CMX328/ 16ENX318	Microwave Integrated Circuits	3	0	0	3	40	60	100
29	16CMX329/ 16ENX320	ASIC Design	3	0	0	3	40	60	100
30	16CMX330/ 16ENX330	Robotics	3	0	0	3	40	60	100

LIST OF OPEN ELECTIVES

S.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
1	16CMX401 /16ENX311	Network Management	3	0	0	3	40	60	100
2	16CMX402 /16ENX313	Radar and Navigational Aids	3	0	0	3	40	60	100

CREDIT DISTRIBUTION

Semester	I	II	III	IV	TOTAL
Credits	22	20	15	15	72

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COIMBATORE - 641 032

SYLLABUS

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	16MA1121	ADVANCED APPLIED MATHEMATICS (COMMON TO M.E APPLIED ELECTRONICS, M.E ECE & M.E CS)	3	1	0	4

Course Objective

1. Apply testing of hypothesis to infer outcome of experiments.
2. Formulate and construct a mathematical model for a linear programming problem in real life situation.
3. Understand the network modeling for planning and scheduling the project activities.
4. Develop the ability to use the concepts of Linear Algebra and Special functions for solving problems related to networks.
5. Acquire knowledge of Fuzzy logic and Fuzzy Algebra.

Unit	Description	Instructional hours
I	**TESTING OF HYPOTHESES** Sampling distributions -Type I and Type II errors - Tests based on Normal, t, Chi-Square and F distributions for testing of mean, variance and proportions -Tests for Independence of attributes and Goodness of fit.	12
II	**LINEAR PROGRAMMING** Formulation - Graphical solution - Simplex method - Artificial variable Techniques -Transportation and Assignment Models	12
III	**SCHEDULING BY PERT AND CPM** Network Construction - Critical Path Method - Project Evaluation and Review technique -Resource Analysis in Network Scheduling.	12
IV	**LINEAR ALGEBRA** Vector spaces – norms - Inner Products - Eigen values using QR Factorization - generalized eigenvectors - Canonical forms - singular value decomposition and applications -pseudo inverse - least square approximations -Toeplitz matrices and some applications.	12
V	**FUZZY LOGIC AND FUZZY ALGEBRA** Basic principles of Fuzzy logic - Fuzzy sets of operations - Fuzzy membership Matrix.	12
	Total Instructional Hours	**60**

Course outcome

CO1: Acquire the basic concepts of Probability and Statistical techniques for solving mathematical problem which will be useful in solving engineering problems.
CO2: Apply transportation and assignment models to find optimal solution in warehousing and travelling.
CO3: Prepare project scheduling using PERT and CPM.
CO4: Achieve an understanding of the basic concepts of algebraic equations and method of solving.
C05: Apply the Fuzzy logic in power system problems.

TEXT BOOK

T1 -Richard Bronson, Gabriel B.Costa, "Linear Algebra", Academic Press, Second Edition,2007.
T2 -Richard Johnson, "Miller & Freund's Probability and Statistics for Engineers", Prentice –Hall, 7th Edition, 2007.
T3 - Taha H.A,"Operations Research, An Introduction " 8th Edition, Pearson Education, 2008.

REFERENCE BOOKS

R1 -Gupta S.C. and Kapoor V.K."Fundamentals of Mathematical Statistics", Sultan and Sons,2001.
R2 -Prem Kumar Gupta,D.S.Hira,"Operations Research," S.Chand &Company Ltd, New Delhi,3rd edition,2008.
R3- Panner Selvam. R, "Operations Research", Prentice Hall of India, 2002.
R4- George J. Klir and Yuan, B., Fuzzy sets and fuzzy logic, Theory and applications, Prentice Hall of India Pvt.Ltd., 1997.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CM1201	ADVANCED RADIATION SYSTEMS	3	1	0	4

Course Objective

1. To learn the fundamentals of antenna radiation
2. To enhance the students knowledge in the area of Aperture and Reflector antenna design
3. To design various broad band antennas
4. To learn basics of microstrip antennas and its radiation analysis
5. To study the applications of various antennas

Unit	Description	Instructional Hours
I	**CONCEPTS OF RADIATION** Physical Concept of Radiation: Radiation from surface and line current distributions -radiation pattern - near and far field regions - reciprocity - directivity and gain – effective aperture - polarization - input impedance - efficiency - Friss transmission equation – radiation integrals and auxiliary potential functions.	12
II	**APERTURE AND REFLECTOR ANTENNAS** Huygens's principle - radiation from rectangular and circular apertures – design considerations - Babinets principle - radiation from sectoral - pyramidal - conical and corrugated horns - design concepts of parabolic reflectors and cassegrain antennas.	12
III	**BROADBAND ANTENNAS** Principles - design and properties of log periodic - yagi-uda - frequency independent antennas - loop antenna - helical antennas - biconical antennas - broadcast antenna - spiral antenna and slot antennas.	12
IV	**MICROSTRIP ANTENNAS** Microstrip Antennas: Radiation mechanism - parameters and applications - feeding methods -method of analysis - design of rectangular and circular patch - impedance matching of microstrip antennas.	12
V	**APPLICATIONS** Antennas for biomedical applications - smart antennas for mobile communications – antenna for infrared detectors - marine applications - plasma antennas.	12
	Total Instructional Hours	60

Course Outcome

CO1: Analyze from fundamentals to recent techniques in antenna technology
CO2: Design and assess the performance of various Aperture and Reflector antennas
CO3: Analyze various broadband antennas and design techniques
CO4: Design a Micro strip antenna
CO5: Analyze various applications of antennas

REFERENCE BOOKS:

R1-Jordan E.C, "Electromagnetic Waves and Radiating Systems", Prentice Hall of India,2003.
R2- Balanis C.A, "Antenna Theory", 2nd Edition, Wiley, 2003
R3- J.D. Krauss, "Antennas", Tata McGraw Hill, 2006.
R4-Elliot, "Antenna Theory and Design", IEEE press, 2003.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CM1202	GLOBAL POSITIONING SYSTEMS	3	0	0	3

Course Objective

1. To understand the basics of GPS
2. To know the concepts of different coordinate system and its services
3. To learn various codes and range models
4. To understand the concepts of GPS propagation
5. To study the various applications of GPS

Unit	Description	Instructional Hours
I	**INTRODUCTION TO GPS** History of GPS – BC-4 System – HIRAN – NNSS – NAVSTAR GLONASS and GNSS Systems – GPS Constellation – Space Segment – Control Segment – User Segment – Single and Dual Frequency – Point – Relative – Differential GPS – Static and Kinematic Positioning – 2D and 3D – reporting Anti Spoofing (AS); Selective Availability (SA) – DOP Factors.	9
II	**COORDINATE SYSTEMS AND SERVICES** Coordinate Systems – Geo Centric Coordinate System – Conventional Terrestrial Reference System – Orbit Description – Keplerian Orbit – Kepler Elements – Satellite Visibility – Topocentric Motion – Disturbed Satellite Motion – Perturbed Motion – Disturbing Accelerations - Perturbed Orbit – Time Systems – Astronomical Time System – Atomic Time – GPS Time – Need for Coordination – Link to Earth Rotation – Time and Earth Motion Services.	9
III	**CODES AND MODELS** C/A code; P-code; Y-code; L1, L2 Carrier frequencies – Code Pseudo Ranges – Carries Phases – Pseudo Ranges – Satellite Signal Signature – Navigation Messages and Formats – Undifferenced and Differenced Range Models – Delta Ranges – Signal Processing and Processing Techniques – Tracking Networks – Ephemerides – Data Combination: Narrow Lane; Wide Lane – OTF Ambiguity.	9
IV	**PROBAGATION CONCEPTS** Propagation Media – Multipath – Antenna Phase Centre – Atmosphere in brief – Elements of Wave Propagation – Ionospheric Effects on GPS Observations – Code Delay – Phase Advances – Integer Bias – Clock Error – Cycle Slip – Noise-Bias – Blunders – Tropospheric Effects on GPS Oberservables – Multipath Effect – Antenna Phase Centre Problems and Correction.	9
V	**APPLICATONS** Inter Disciplinary Applications – Crystal Dynamics – Gravity Field Mapping – Atmospheric Occulation – Surveying – Geophysics – Air borne GPS – Ground Transportation – Space borne GPS – Metrological and Climate Research using GPS.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Analyze the basics of GPS
CO2: Demonstrate the impact of various coordinate system and its services
CO3: Analyze the various codes and range models
CO4: Describe the concepts of GPS propagation
CO5: Analyze the various applications of GPS

REFERENCE BOOKS:

R1-B.Hoffman - Wellenhof, H.Lichtenegger and J.Collins, "GPS: Theory and Practice", 4th revised edition, Springer, Wein, New york, 1997.

R2-A.Leick, "GPS Satellites Surveying", 2nd edition, John Wiley& Sons,NewYork,1995.

R3-B.Parkinson, J.Spilker, Jr.(Eds), "GPS: Theory and Applications", Vol.I & Vol.II, AIAA, 370 L'Enfant Promenade SW, Washington, DC 20024, 1996.

R4-A.Kleusberg and P.Teunisen(Eds), "GPS for Geodesy", Springer-Verlag, Berlin,1996.

R5-L.Adams, "The GPS - A Shared National Asset", Chair, National Academy Press, Washington, DC, 1995

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CM1203	OPTICAL COMMUNICATIONS NETWORKS	3	0	0	3

Course Objective

1. To study the operation of various optical system components
2. To learn the fundamentals of different optical network architectures
3. To know the concepts of wavelength routing networks and its characteristics
4. To understand the concepts of various packet switching and access networks
5. To design the network with different parameters and study the issues in network management

Unit	Description	Instructional Hours
I	**OPTICAL SYSTEM COMPONENTS** 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.	9
II	**OPTICAL NETWORK ARCHITECTURES** Introduction to Optical Networks; SONET / SDH, Metropoliton-Area Networks, Layered Architecture; Broadcast and Select Networks – Topologies for Broadcast Networks, Media-Access Control Protocols, Testbeds for Broadcast & Select WDM; Wavelength Routing Architecture.	9
III	**WAVELENGTH ROUTING NETWORKS** The optical layer, Node Designs, Optical layer cost tradeoff, Routing and wavelength assignment,Virtual topology design, Wavelength Routing Testbeds, Architectural variations.	9
IV	**PACKET SWITCHING AND ACCESS NETWORKS** Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing, Synchronisation, Broadcast OTDM networks, Switch-based networks; Access Networks – Network Architecture overview, Future Access Networks, Optical Access Network Architectures; and OTDM networks.	9
V	**NETWORK DESIGN AND MANAGEMENT** 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. N	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Equipped from fundamentals to recent various optical system components
CO2: Analyze various optical network architectures
CO3: Describe the concepts of wavelength routing networks and its characteristics
CO4: Demonstrate the impact of various packet switching and access networks
CO5: Independently design and assess the performance of a network

REFERENCE BOOKS:

R1- C. Siva Ram Moorthy and Mohan Gurusamy, "WDM Optical Networks: Concept, Design and Algorithms", Prentice Hall of India, Ist Edition, 2002.
R2- Vivek Alwayn, "Optical Network Design and Implementation", Pearson Education, 2004.
R3- Hussein T.Mouftab and Pin-Han Ho, "Optical Networks: Architecture and Survivability", Kluwer Academic Publishers, 2002.
R4- Biswanath Mukherjee, "Optical Communication Networks", McGraw Hill, 1997.
R5- P.E. Green, Jr., "Fiber Optic Networks", Prentice Hall, NJ, 1993
R6- Rajiv Ramaswami and Kumar N. Sivarajan, "Optical Networks : A Practical Perspective", Harcourt Asia Pvt Ltd., Second Edition 2004

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CM1204 / 16EN1204	ADVANCED WIRELESS COMMUNICATIONS AND NETWORKS	3	0	0	3

Course Objective

1. To understand the basics multipath propagation and its characteristics
2. To know the concepts and performance of OFDM and OFDMA systems
3. To learn the block diagram of transmitter and receiver of MC-CDMA, MIMO and LTE systems
4. To understand the concepts of cognitive radio and its applications
5. To study the various wireless networks and its characteristics

Unit	Description	Instructional Hours
I	**MULTIPATH FADING CHANNELS AND DIVERSITY** Multipath Propagation-Fading-intersymbol Interference-Spectrum Limitations-Fast Fading Wireless Channel Modeling-Rayleigh and Ricean Fading Channels-BER Performance in Fading Channels - Frequency Selective and Frequency Nonselective Fading Channels - Examples of Multipath Fading Channels- Diversity modeling for Wireless Communications- BER Performance Improvement with diversity.	9
II	**OFDM AND OFDMA SYSTEMS** Basic principles of OFDM – Block diagram of transmitter and receiver in OFDM system- Effect of multipath on OFDM symbols, cyclic prefix and zero padding – BER performance of OFDM scheme – Performance of Coded OFDM System - Synchronization for OFDM - Effect of CFO- Introduction to PAPR- PAPR Reduction Techniques.Introduction to OFDMA - Block diagram of OFDMA uplink and downlink transmission – Resource Allocation - Resource Allocation Algorithms - Scheduling- Quality of Service- OFDMA based Mobile WiMax (IEEE 802.16e.)	9
III	**MC-CDMA, MIMO AND LTE** Introduction to MC-CDMA System – Block diagram of Transmitter and receiver of MC-CDMA -Bit Error Rate of MC-CDMA System- Variants Based on MC-CDMA Scheme. Introduction to MIMO– Channel Capacity and Information rates of noisy, AWGN and fading channels –MIMO for multi-carrier systems (MIMO-OFDM) – MIMO Diversity (Alamouti, OSTBC); Motivation and Targets for LTE- Overview of LTE- LTE network architecture – LTE Advanced- Architecture of LTE Radio Protocol Stacks.	9
IV	**COGNITIVE RADIO AND ITS APPLICATIONS** Introduction to Cognitive Radio-Motivation and Purpose – Spectrum Allocation in Cognitive Radio Networks - Cognitive Transceiver architecture- Radio Resource Allocation for Cognitive Radio - Spectrum Sensing – Spectrum Sharing – Spectrum Mobility – Spectrum Management – Regulatory issues – Implications of Cognitive radio network- Emerging Cognitive Radio Applications in Cellular Networks.	9
V	**WIRELESS NETWORKS** Networking Basics - Development of Computer Networks: An Overview- Network Types- Peer-to-Peer Networks- Local Area Networks (LANs)- Wide Area Networks (WANs)- Personal Area Networks (PANs)- The Internet- Virtual Private Networks (VPNs) - Network Topologies- Choosing the Right Topology- Network Hardware	9

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and Software- Networking Components- Networking Software- Networking Protocol: TCP/IP, Wireless LANs evolution- Basic architecture – WLAN Adopters – Access Points- WLAN Configurations- WLAN Standards, Architecture and specifications , WiMAX, WiBro, and WiFi.

Total Instructional Hours **45**

Course Outcome

CO1:Analyze the basics of multipath propagation and its characteristics
CO2:Compare and contrast the performance of OFDM and OFDMA systems
CO3:Describe the operation of transmitter and receiver of MC-CDMA, MIMO and LTE systems
CO4:Demonstrate the impact of cognitive radio and its applications
CO5:Analyze the various wireless networks and its characteristics

REFERENCE BOOKS:

R1- Andreas F. Molisch, Wireless Communications, 2nd Edition, John Wiley & Sons Ltd, 2011.
R2- Yong Soo Cho, Jaekwon Kim, Won Young Yang and Chung G. Kang, MIMO-OFDM Wireless Communications with MATLAB, John Wiley & Sons (Asia) Pte Ltd, 2010.
R3- Shinsuke Hara and Ramjee Prasad, "Multicarrier Techniques for 4G Mobile Communications", 2003
R4- Harri Holma and Antti Toskala, "LTE for UMTS –OFDMA and SC-FDMA Based Radio Access", John Wiley & Sons Ltd., 2009.
R5- Tao Jiang, Lingyang Song and Van Zhang, "Orthogonal Frequency Division Multiple Access Fundamentals and Applications" Taylor and Francis Group, 2010.
R6- Tolga M. Duman and Ali Ghrayeb, "Coding for MIMO Communication Systems", John Wiley & Sons Ltd, 2007

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CM1205	CODING AND COMPRESSION TECHNIQUES	3	0	0	3

Course Objective

1. Provide fundamental knowledge about the need and types of compression.
2. Analyze various lossless compression techniques suitable for text.
3. Compare and contrast various audio compression algorithms.
4. Analyze the lossy and lossless image compression algorithms.
5. Understand the concepts of video compression standards.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Multimedia data - features — Storage requirements for multimedia – Need for Compression - Taxonomy of compression – Metrics – Quantitative and Qualitative techniques - Overview of source coding – Scalar quantization - Adaptive - Vector quantization.	9
II	**TEXT COMPRESSION** Characteristics of text data – RLE, Huffmann coding – Adaptive Huffmann Coding – Arithmetic coding — Dictionary techniques – static and adaptive- digram coding – LZW algorithm - GIF, TIF, Digitized documents, JBIG, JBIG2.	9
III	**AUDIO COMPRESSION** Fundamental concepts of digital audio - Audio compression techniques –μ Law and A- Law companding - PCM, DPCM, DM, ADM - sub-band coding – Application to speech coding – G.722 – MPEG audio – MP3 - Model based coding – Channel Vocoders – LPC - Formant and CELP coders.	9
IV	**IMAGE COMPRESSION** Image data representation - Predictive techniques – DPCM: Optimal Predictors and Optimal Quantizers –Transform Coding – JPEG Standard – Sub-band coding – QMF Filters - Wavelet based compression – EZW, SPIHT coders – JPEG 2000 standard – File formats.	9
V	**VIDEO COMPRESSION** Fundamental concepts of video – digital video signal - video formats – video compression techniques and standards - AVI, FLV, MP4, Real media - Motion estimation and compensation Techniques, Block matching- Full search motion estimation methods – MPEG Video Coding : MPEG – 1 and 2, MPEG – 4, 7 and 21 — H.26X Standard - Packet Video.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Recognize the suitable compression algorithm for text, audio and video applications.
CO2: Investigate the text compression standards and can develop the coding with good compression ratio.
CO3: Apply the appropriate audio compression technique.
CO4: Develop the suitable compression technique and can apply in medical images.
CO5: Implement the video compression algorithms for motion capturing and detection.

REFERENCE BOOKS:

R1- Khalid Sayood, " Introduction to Data Compression", Morgan Kauffman Harcourt India, 2nd Edition, 2000.
R2-David Salomon, " Data Compression – The Complete Reference", Springer Verlag New York Inc., 2nd Edition, 2001.
R3-I.E.G. Richardson, "Video codec design", John Wiley & Sons Ltd, 2002 Edition.
R4-Yun Q.Shi, Huifang Sun, " Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms & Standards", CRC press, 2003.
R5-Peter Symes , "Digital Video Compression", McGraw Hill Pub., 2004.
R6-Mark Nelson , "Data compression", BPB Publishers, New Delhi,1998.
R7-Mark S.Drew, Ze-Nian Li, " Fundamentals of Multimedia", PHI, 1st Edition, 2003.
R8-Watkinson,J, " Compression in Video and Audio", Focal press,London.1995.
R9-Jan Vozer , "Video Compression for Multimedia", AP Profes, NewYork, 1995

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
M.E.	16CM1001	COMMUNICATION SYSTEM DESIGN LABORATORY	0	0	4	2

Course Objective

1. To analyze S-parameter estimation of Microwave devices.
2. To design and test a Microstrip coupler and simulation of microstrip antennas.
3. To design channel equalizer, performance evaluation of digital modulation schemes.

Expt. No.	Description of the Experiments
1.	S-parameter estimation of Microwave devices.
2.	Design and testing of a Microstrip coupler.
3.	Simulation of Microstrip Antennas.
4.	Antenna Radiation Pattern measurement.
5.	Carrier and Symbol timing Synchronization using SDR platform.
6.	Channel equalizer design (LMS, RLS).
7.	Performance Evaluation of digital modulation schemes.
8.	Design and performance analysis of error control encoder and decoder. (Block and Convolutional Codes)
9.	Simulation of Turbo coding.
10.	CDMA signal generation and RAKE receiver design.

Total Practical Hours 45

Course Outcome

CO1: Analyze S-parameter estimation of Microwave devices.
CO2: Design and test a Microstrip coupler and simulation of microstrip antennas.
CO3: Design channel equalizer, performance evaluation of digital modulation schemes.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CM2201	802.XX WIRELESS NETWORKS	3	0	0	3

Course Objective

1. Analyze the propagation mechanisms of radio waves.
2. Provide a WLAN performance evaluation experience.
3. Learn how to design and analyze various medium access and authentication techniques.
4. Understand the power conservation and management operations.
5. Analyze and deploy the wireless network.

Unit	Description	Instructional Hours
I	**WIRELESS NETWORKS INTRODUCTION** IEEE 802- Wireless LANs- A brief history of 802.11- RF spectrum- Radio waves- Direct path- Absorption-Reflection- Diffraction- Refraction- scattering- Multipath- Radio frequency regulations- spectrum Management- IEEE 802 network technology family tree- 802.11 nomenclature and design- 802.11 Network operations- Mobility support.	9
II	**802.11 MAC** Challenges for the MAC- MAC access mode and timing- Contention based access using DCF- Fragmentation and reassembly- Frame format- encapsulation of higher layer protocols within 802.11- Contention based data service.	9
III	**FRAMING AND WEP** 802.11 framing in detail- Data frames- Control frames- Management frames- Frame transmission, Association and authentication- Wired Equivalent Privacy(WEP)- Cryptographic Background to WEP- WEP Cryptographic Operations- Problems with WEP- The Extensible Authentication Protocol- 802.1x: Network Port Authentication- 802.1x on Wireless LANs	9
IV	**MANAGEMENT OPERATIONS** Management Architecture- Scanning - Authentication- Association- Power Conservation- Timer Synchronization- Contention-Free Access Using the PCF- Detailed PCF Framing- Power Management and the PCF.	9
V	**PHYSICAL LAYER AND NETWORK DEPLOYMENT** Physical-Layer Architecture-The Radio Link- RF and 802.11- 802.11 FH PHY- 802.11 DS PHY- 802.11b:HR/DSSS PHY- 802.11a: 5-GHz OFDM PHY- Orthogonal Frequency Division Multiplexing (OFDM)- OFDM as Applied by 802.11a- OFDM PLCP- OFDM PMD- Characteristics of the OFDM PHY; 802.11 Network deployment topology- Project planning- The site survey- Installation and the final roll-out.	9
	Total Instructional Hours	45

Course Outcome

Develop the concept of mobile and wireless systems
Analyze various propagation mechanisms and implement the low loss wireless network.
Apply the necessary authentication algorithm.
Analyze power conservation and management operations.
Identify the topology and deploy the wireless network.

REFERENCE BOOKS:

R1- Matthew Gast , 802.11® Wireless Networks: The Definitive Guide, O'Reilly. 2002.
R2- Alan Holt, Chi-Yu Huang, 802.11Wireless Networks, Springer 2010.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CM2202	SIGNAL PROCESSING AND BASEBAND TECHNIQUES	3	0	0	3

Course Objective

1. To enable the student to understand the basic principles of random signal processing.
2. To understand the concept of spectral estimation methods.
3. To enable the student to understand the adaptive filter algorithms and their applications.
4. To enable the student to understand the different signal detection and estimation methods used in communication system design.
5. To understand the various synchronization methods for proper functioning of the system.

Unit	Description	Instructional Hours
I	**DISCRETE RANDOM SIGNAL PROCESSING** Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Autocovariance, Autocorrelation, Parseval's theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes, Special types of Random Processes – ARMA, AR, MA – Yule-Walker equations.	9
II	**SPECTRAL ESTIMATION** Estimation of spectra from finite duration signals, Nonparametric methods – Periodogram, Modified periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric methods – ARMA, AR and MA model based spectral estimation, Solution using Levinson-Durbin algorithm.	9
III	**ADAPTIVE FILTERS** FIR adaptive filters – Steepest descent method- LMS algorithm, LMS algorithm, RLS adaptive algorithm – Application: channel equalization, noise cancellation, prediction.	9
IV	**DETECTION AND ESTIMATION** Detection criteria : Bayes detection techniques, MAP, ML,– detection of M-ary signals, Neyman Peason, minimax decision criteria. Estimation: linear estimators, non-linear estimators, Bayes, MAP,ML, properties of estimators, phase and amplitude estimation.	9
V	**SYNCHRONIZATION** Signal parameter estimation, carrier phase estimation, symbol timing estimator, joint estimation of carrier phase and symbol timing.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Demonstrate an understanding of the basic principles of random signal processing.
CO2: Know the various spectral estimation methods.
CO3: Analyze the various adaptive filter algorithms and their applications.
CO4: Apply the different signal detection and estimation methods used in communication system design.
CO5: Know the implications of proper synchronization methods for proper functioning of the system.

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REFERENCE BOOKS:

R1- Monson H. Hayes, 'Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 2002

R2- John J. Proakis, Dimitris G. Manolakis, 'Digital Signal Processing', Pearson Education, 2002.

R3- John G. Proakis., 'Digital Communication', 4 th edition, Mc Graw Hill Publication, 2001.

R4- Bernard Sklar and Pabitra Kumar Roy, Digital Communications: Fundamentals & Applications, 2/E, Pearson Education India, 2009

R5- John G. Proakis, Masoud Salehi, "Communication Systems Engineering", PH, 1994.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CM2203/16EN2203	RF MEMS FOR WIRELESS COMMUNICATION	3	0	0	3

Course Objective

1. Understand the concept of wireless standards and the challenges faced in wireless environment.
2. Analyze the fabrication mechanisms of RF MEMs devices
3. Develop the basic knowledge for RF MEMs devices.
4. Learn how to design micromachined filters and RF antennas
5. Design a RF MEMs based circuit.

Unit	Description	Instructional Hours
I	**WIRELESS SYSTEMS AND ELEMENTS OF RF CIRCUIT DESIGN** Introduction, spheres of wireless activities, the home and office, the ground fixed/ mobile platform, the space platform, wireless standards, systems and architectures, wireless standards, conceptual wireless systems, wireless transceiver architectures, power and bandwidth-efficient wireless systems & challenges, MEMS based wireless appliances enable ubiquitous connectivity. Physical aspects of RF circuit design, skin effect, transmission lines on thin substrates, self-resonance frequency, quality factor packaging, practical aspects of RF circuit design, dc biasing, impedance mismatch effects in RF MEMS.	9
II	**MICROFABRICATION AND ACTUATION MECHANISMS IN MEMS** Introduction to Microfabrication Techniques- Materials properties, Bulk and surface micromachining, Wet and dry etching, Thin-film depositions (LPCVD, Sputtering, Evaporation), other techniques (LIGA, Electroplating) Actuation Mechanisms in MEMS- Piezoelectric, Electrostatic, Thermal, Magnetic.	9
III	**RF MEMS SWITCHES, INDUCTOR AND CAPACITOR** RF MEMS relays and switches. Switch parameters. Actuation mechanisms. Bistable relays and micro actuators. Dynamics of switching operation. MEMS inductors and capacitors. Micromachined inductor. Effect of inductor layout. Modeling and design issues of planar inductor. Gap tuning and area tuning capacitors. Dielectric tunable capacitors.	9
IV	**MICROMACHINED RF FILTERS, ANTENNAS AND MEMS PHASE SHIFTER** Micromachined RF filters. Modeling of mechanical filters. Electrostatic comb drive. Micromechanical filters using comb drives. Electrostatic coupled beam structures. Micromachined antennas. Microstrip antennas – design parameters. Micromachining to improve performance. Reconfigurable antennas. MEMS phase shifters. Types. Limitations. Switched delay lines. Micromachined transmission lines. Coplanar lines. Micromachined directional coupler and mixer.	9
V	**RF MEMS BASED CIRCUIT DESIGN AND CASE STUDIES** Phase shifters - fundamentals, X-Band RF MEMS Phase shifter for phased array applications, Ka- Band RF MEMS Phase shifter for radar systems applications, Film bulk acoustic wave filters - FBAR filter fundamentals, FBAR filter for PCS applications, RF MEMS filters - A Ka-Band millimeter-wave Micromachined tunable filter, A High-Q 8-MHz MEM Resonator filter, RF MEMS Oscillators - fundamentals, A 14-GHz MEM Oscillator, A Ka - Band Micromachined cavity oscillator, A 2.4 GHz MEMS based voltage controlled oscillator.	9
	Total Instructional Hours	**45**

Course Outcome	CO1: Develop the RF MEMs devices to be used in today's mobile communication and satellite system. CO2: Fabricate the RF MEMs devices. CO3: Model and Design the RF MEMs switches and relays. CO4: Design the micromachined RF devices to improve the performance. CO5: Design and implement a RF MEMs based circuit.

REFERENCE BOOKS:

R1- Vijay K.Varadan, K.J. Vinoy, K.A. Jose., "RF MEMS and their Applications", John Wiley and sons, LTD, 2003.
R2- H.J.D.Santos, "RF MEMS Circuit Design for Wireless Communications", Artech House,2002.
R3- G.M.Rebeiz , "RF MEMS Theory , Design and Technology",Wiley , 2003.
R4- S. Senturia, "Microsystem Design" , Kluwer, Springer, 2001.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CM2801	ALGORITHMS SIMULATION LABORATORY	0	0	4	2

Course Objective

1. Analyze the appropriate audio and video compression algorithm.
2. Understand the lossless coding techniques.
3. Analyze the image processing algorithm and quality performance of the network.

Expt.No.	Description of the Experiments
1.	Simulation of Audio compression algorithms
2.	Simulation of EZW Image coding algorithm.
3.	Simulation of SPIHT Image coding algorithm.
4.	Programming in MATLAB for Arithmetic coding, Huffman coding.
5.	Implementation of image segmentation by median filters.
6.	Deblurring of image by using wiener filters.
7.	Implementation of an edge detection algorithm in MATLAB.
8.	Noise Removal by median filters.
9.	Implementation of Shortest Path Routing/ Sliding Window Protocol.
10.	Implementation of Distance Vector routing/ Link State routing Algorithms using Network Simulation software.
	Total Practical Hours **45**

Course Outcome

CO1: Implement the text, audio and video compression algorithm for a suitable application
CO2: Design a image processing algorithm which provides high SNR, efficient segmentation
CO3: Implement a lossless network.

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PROFESSIONAL ELECTIVES

Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX301	RFIC DESIGN	3	0	0	3

Course Objective

1. To understand the concepts and principles of RFIC.
2. To inculcate the understanding of various transistors.
3. To impart knowledge to deal with the issues of designing the technologies for RFICs.
4. To understand the functionality and characteristics of passive elements.
5. To understand the functionality and characteristics of active elements.

Unit	Description	Instructional Hours
I	**RFIC BASICS** Low Frequency Analog design and Microwave design versus RFIC design- impedance levels for microwave and low frequency analog design- RFICs used in a communication transceiver. Issues in RFIC design- noise, noisepower, noise figure- linearity and distortion in RF circuits- dynamic range- filtering issues.	9
II	**TECHNOLOGY FOR RFICs** Transistor and Integrated circuit invention- charge transport in transistors- materials used- types of transistors used-MOSFET, MESFET, HEMT, BJT, HBT, BiCMOS. _ Current dependence in BJT, small signal model and small signal parameters- high frequency effects-unity gain frequency-types of noises-thermal noise, shot noise, 1/f noise.	9
III	**IMPEDANCE MATCHING** Review of Smith chart- signal flow analysis- S parameters- parameter conversion- impedance matching- conversion between series and parallel RL and RC circuits- tapped capacitors and inductors- mutual inductance- matching using transformers- tuning a transformer- impedance transformation- bandwidth of impedance transformation network quality factor of an LC resonator- transmission lines.	9
IV	**PASSIVE CIRCUIT ELEMENTS IN RFIC** Technology back end and metallization in IC technologies- sheet resistance and skin effect- parasitic capacitance parasitic inductance- resistors and types- capacitors and types- varactors- design of inductors and transformers- Q factor and characterization of inductor- multilevel inductor- packaging- signal pads- wiring- simple filters combiners and dividers.	9
V	**ACTIVE CIRCUITS IN RFIC** Amplifiers- topologies- stabilization networks- bias supply- design strategies- narrowband and wideband design of LNA- power amplifier- choice of topology, current source based amplifiers, switched amplifiers- amplitude control and switches- attenuators and switches, variable gain amplifiers- phase shifters-reflective type and digitally adjustable phase shifters- vector modulators.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Identify the method of design of RFIC for specific application.
CO2: Analyze the performance of the circuit design procedures.
CO3: Analyze the issues in RFIC design.
CO4: Examine the design effectiveness of transistors in the integrated circuits.
CO5: Apply the knowledge of active, passive devices and components in the design of RFIC.

REFERENCE BOOKS:

R1- John Rogers and Calvin Plett, "Radio Frequency Integrated Circuit Design", Artech House, 2003.
R2- Franck Ellinger, "Radio Frequency Integrated Circuits and Technologies", Springer, 2007.
R3- Richard C. Li , *RF Circuit Design* John wiley & sons,2012

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX302/ 16ENX303	BROAD BAND ACCESS TECHNOLOGIES AND DISTRIBUTION SYSTEMS	3	0	0	3

Course Objective

1. To understand the basics of broadband access technologies.
2. To facilitate the knowledge of distribution systems.
3. To examine the different kinds cable access networks.
4. To analyze the construction, characteristics and properties of digital cable systems.
5. To obtain the knowledge of different access networks.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO BROADBAND ACCESS TECHNOLOGIES** History, Overview, Applications requirements, Introductory comparisons of access technologies :Legacy systems,Limitations of Twisted Pair wires, XDSL systems, HFC systems, Wireless Access, Fiber Access/FTTP/FTTH,Gigabit, 10 Gigabit Ethernet, and 100Gbit Ethernet, Economic considerations ,Layered view of the system.	9
II	**FUNDAMENTALS OF BROADBAND DISTRIBUTION SYSTEMS** **Coaxial Cable-** Types, Impedance, Attenuation, Return Loss, and Shielding, Amplifiers, Passive Coaxial Components, Power Supplies, System Design: CNR, BER vs. System Design ,Distortion ,Signal level stability and management **Linear Fiber Optic Signal Transport-**Optical basics ,Multimode and Single Mode Fibers ,Network Passives Components ,Linear Optical Transmitters, Optical Amps and Receivers, Subcarrier Multiplexing Techniques ,Interactions and End to End Link Performance.	9
III	**CABLE ACCESS NETWORKS** **Physical level-**Current HFC Cable Networks and Examples, Physical System Design: CNR, BER vs. System Design, Distortion, Signal level stability and management, Downstream Channel: Noise and Distortion Allocations,Upstream Channel: Interference Signals in the Return Path ,Physical Channel Models for Upstream andDownstream Cable **Services Level-**Telephony systems on HFC plant: TDM vs IP , Quality of Service ,Program Denial Technologies,Open Cable and other ,Digital Video Standards ,Home Gateway **Network Level-**Network Access Technology for HFC Channels, Requirements for voice, video and data, MAC Protocols for centralized shared access media ,Performance characterization.	9
IV	**DIGITAL CABLE TELEVISION SYSTEMS** Cable TV frequency plans (HRC, IRC, and STD),Digitization of Video, Digital Compression, Packetized multiprogram Data stream ,Modulation ,Error Correction ,Signal Quality ,Legacy (analog) Cable TV: Head end Signal Reception and processing ,Program Denial Technologies, Open Cable and other Digital Video Standards ,Cable Digital Data Transport :Modulation Methods, Spectrum Sharing and Capacity Issues ,Advanced PHY Specification:FA-TDMA/S-CDMA combination ,Receiver Design Examples ,Performance Evaluation vs. Channel Models, MAC Protocols for centralized shared access media ,Performance characterization and traffic modeling ,System management and adaptation to changes in traffic, physical channel.	9

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V	**ALTERNATE BROADBAND ACCESS NETWORKS** Comparison to Alternate Broadband Access Networks, ADSL/xDSL Access Networks, **Wireless Access Networks-** Fixed wireless media characteristics., Different physical layer options for wireless,WiFi, WiMax, LTE and WiMedia,60GHz wireless over Fiber networks . **Fiber Access Networks-**Example architectures : Point-to-point Optical Networks, Passive Optical Networks, ActiveOptical Networks.Design of the physical channel :CWDM, Optical multiplexers, Overlay channels ,Cost comparisons ,Design of a PON link, Access Protocols (general) ,PON protocols, architectural consideration,Dynamic Bandwidth Allocation, APON, BPON, GPON, EPON and Other architectures ,IPTV ,Wireless over FiberTechnologies and Applications	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Explain the concepts of broadband networks.
CO2: Design and analyze the different distribution systems.
CO3: Analyze the various levels of network systems.
CO4: Design the digital cable communication systems.
CO5: Compare the various broadband access networks.

REFERENCE BOOKS:

R1- W. Ciccora, J. Farmer, and D. Large. Modern Cable Television Technology, Video, Voice and DataCommunications ,Elsevier 2nd edition,2004.
R2- Glen Kramer ,Ethernet Passive Optical Networks, McGraw Hill Professional,2005.
R3- Houda Labiod, Hossam Afifi, Costantino de Santis ,WiFi, Bluetooth, Zigbee, andWimax,Springer,2010.
R4- Paul E. Green ,Fiber to the Home, John Wiley & sons,2006.
R5- Phillip Golden, Implementation and Applications of DSL Technology,Auerbach Publications,Taylor &Francis Group,2008.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX303/ 16ENX304	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	3	0	0	3

Course Objective

1. To understand the basics of EMI and to study EMI Sources
2. To understand EMI problems
3. To analyze the design methods in PCB
4. To study the various EMI control techniques.
5. To understand Measurement technique for immunity

Unit	Description	Instructional Hours
I	**EMI ENVIRONMENT** EMI/ EMC Concepts and Definitions: Sources of EMI - conducted and radiated EMI -transient EMI - time domain vs frequency domain EMI - units of measurement parameters.	9
II	**EMI COUPLING PRINCIPLES AND STANDARDS** Principles: Conducted, radiated and transient coupling - common impedance ground coupling - radiated common mode and ground loop coupling - radiated differential mode coupling – near and far field cable to cable coupling - power mains and power supply coupling - units of specifications; Civilian Standards: FCC - CISPR - IEC - EN; Military Standards: MIL STD 461D/ 462.	9
III	**EMI MEASUREMENTS** EMI Test Instruments/ Systems: EMI shielded chamber - open area test site - TEM cell -sensors/ Injectors/ Couplers - test beds for ESD and EFT.	9
IV	**EMI CONTROL TECHNIQUES** Techniques: Shielding - filtering - grounding - bonding - isolation transformer – transient suppressors - cable routing - signal control - component selection and mounting.	9
V	**EMC DESIGN OF PCBS** Design: PCB traces cross talk - impedance control - power distribution decoupling - zoning -motherboard designs and propagation delay performance models.	9
	Total Instructional Hours	**45**

COURSE OUTCOME

CO1: Setup an environment for analyzing EMI systems.
CO2: Summarize the coupling principles and standards.
CO3: Handle the different EMI testing instruments and systems.
CO4: Design the PCBs based on EMC.
CO5: Compare the various EMI control techniques.

REFERENCE BOOKS:

R1-V. P. Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE Press, 1996.
R2-Henry W. Ott, "Noise Reduction Techniques in Electronic Systems", Wiley, 1988.
R3- C. R. Paul, "Introduction to Electromagnetic Compatibility", Wiley, 1992.
R4- Bernhard Keiser, "Principles of Electromagnetic Compatibility", 3rd Edition, Artech house, 1986.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX304	DIGITAL COMMUNICATION RECEIVERS	3	0	0	3

Course Objective

1. To review the digital communication systems.
2. To analyze the noise effects in the receivers.
3. To understand the digital communication detection methods.
4. To study the design methods of the receivers.
5. To improve the quality of the signal in t he digital receivers.

Unit	Description	Instructional Hours
I	**REVIEW OF DIGITAL COMMUNICATION TECHNIQUES** Base band communication; signal space representation, linear and nonlinear modulation techniques, Error tracking and Spectral characteristics of digital modulation.	9
II	**OPTIMUM RECEIVERS FOR AWGN CHANNEL** Correlation demodulator, matched filter , maximum likelihood sequence detector,optimum receiver for CPM signals, M-ary orthogonal signals, envelope detectors for Maryand correlated binary signals.	9
III	**RECEIVERS FOR FADING CHANNELS** Characterization of fading multiple channels, statistical models, flat and frequency selective fading, diversity technique, Optimal receivers for data detection and synchronization parameter estimation, coded waveform for fading channel.	9
IV	**SYNCHRONIZATION TECHNIQUES** Carrier and signal synchronization, carrier phase estimation-PLL, Decision directedloops, symbol timing estimation, maximum likelihood and non-decision directed timing estimation, joint estimation.	9
V	**ADAPTIVE EQUALIZATION** Zero forcing algorithm, LMS algorithm, adaptive decision-feedback equalizer and Equalization of Trellis-coded signals. Kalman algorithm, blind equalizers and stochastic gradient algorithm	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Explain the different receiving methodologies in digital communication.
CO2: Significantly remove the noise in the receiver end.
CO3: Compare and analyze the effectiveness of receivers
CO4: Design the synchronized receivers.
CO5: Implement the equalization algorithm.

REFERENCE BOOKS:

R1-Heinrich Meyer, Mare Moeneclacy, Stefan.A.Fechtel, " Digital communication receivers ", Vol I & Vol II, John Wiley, New York, 1997.
R2- U.Mengali & A.N.D'Andrea, Synchronization Techniques for Digital Receivers, Kluwer, 1997.
R3- John.G.Proakis, "Digital communication "4th Edition, McGraw-Hill, New York, 2001.
R4- E.A.Lee and D.G. Messerschmitt, "Digital communication ",2nd Edition,Allied Publishers,New Delhi,1994.
R5- Simon Marvin, "Digital communication over fading channel; An unified approach to performance Analysis ", John Wiley, New York, 2000.
R6- H.Meyr & G.Ascheid, Synchronization in Digital Communications, John Wiley, 1990.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX305 /16ENX305	COMMUNICATION PROTOCOL ENGINEERING	3	0	0	3

Course Objective

1. To review the network reference models.
2. To understand the various protocol specifications..
3. To study the methods of protocol validation.
4. To test the efficiency of the protocols.
5. To implement the protocols for the specific applications.

Unit	Description	Instructional Hours
I	**NETWORK REFERENCE MODEL** Communication model-software, subsystems, protocol, protocol development methods, Protocol engineering process, Layered architecture, Network services and Interfaces, Protocol functions, OSI model, TCP/IP protocol suite.	9
II	**PROTOCOL SPECIFICATIONS** Components of protocol, Specifications of Communication service, Protocol entity, Interface, Interactions, Multimedia protocol, Internet protocol, SDL, SDL based protocol- other protocol specification languages.	9
III	**PROTOCOL VERIFICATION/VALIDATION** Protocol verification, Verification of a protocol using finite state machines, Protocol validation approaches, protocol design errors, SDL based protocol verification validation.	9
IV	**PROTOCOL CONFORMANCE/PERFORMANCE TESTING** Conformance testing methodology and frame work, Conformance test architectures, Test sequence generation methods, Distributed architecture by local methods, Conformance testing with TTCN, systems with semi controllable interfaces - RIP,SDL based tools for conformance testing, SDL based conformance testing of MPLS Performance testing, SDL based performance testing of TCP and OSPF, Interoperability testing, SDL based interoperability testing of CSMA/CD and CSMA/CA protocol using Bridge, Scalability testing.	9
V	**PROTOCOL SYNTHESIS AND IMPLEMENTATION** Protocol synthesis, Interactive synthesis algorithm, Automatic synthesis algorithm, Automatic synthesis of SDL from MSC, Protocol Re-synthesis; Requirements of protocol implementation, Object based approach to protocol implementation, Protocol compilers, Tool for protocol engineering.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Explain the network reference model.
CO2: Suggest and design the various protocols.
CO3: Evaluate the effectiveness of protocols with respect to different specifications.
CO4: Apply the testing tools to compare the protocols.
CO5: Synthesis and implement the protocols designed for the specific purposes.

REFERENCE BOOKS:

R1- Pallapa Venkataram and Sunilkumar S.Manvi, "Communication protocol Engineering", Eastern Economy edition, 2004
R2- Richard Lai and Jirachiefpattana, "Communication Protocol Specification and Verification", Kluwer Publishers, Boston, 1998.
R3- Tarnay, K., "Protocol Specification and Testing", Plenum, New York, 1991.
R4- Mohamed G. Gouda, "Elements of Network Protocol Design", John Wiley & Sons, Inc. New York, USA, 1998
R5- V.Ahuja, "Design and Analysis of Computer Communication networks", McGraw-Hill, London,1982.
R6- G.J.Holtzmann, "Design and validation of Computer protocols", Prentice Hall, New York, 1991.

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Programme	Course code	Name of the course	L	T	P	C
ME	16CMX306/ 16ENX307	NETWORK ROUTING ALGORITHMS	3	0	0	3

Course Objective

1. Students will learn the Architecture of ISO OSI Layer and Classification of routing.
2. Students will learn the Interior and Exterior Routing Protocols.
3. Students will learn RWA algorithms and Rerouting methods.
4. Students will learn Macro and Micro-mobility protocols.
5. Students will learn different Routing algorithms.

Unit	Description	Instructional Hours
I	**INTRODUCTION** ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Routing in telephone networks, Dynamic Non hierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing, Link state routing, Hierarchical routing.	9
II	**INTERNET ROUTING** Interior protocol : Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Bellman Ford Distance Vector Routing. Exterior Routing Protocols: Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). Multicast Routing: Pros and cons of Multicast and Multiple Unicast Routing, Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), MBONE, Core Based Tree Routing.	9
III	**ROUTING IN OPTICAL WDM NETWORKS** Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength Rerouting- Benefits and Issues, Lightpath Migration, Rerouting Schemes, Algorithms- AG, MWPG.	9
IV	**MOBILE - IP NETWORKS** Macro-mobility Protocols, Micro-mobility protocol: Tunnel based : Hierarchical Mobile IP, Intra domain Mobility Management, Routing based: Cellular IP, Handoff Wireless Access Internet Infrastructure (HAWAII).	9
V	**MOBILE AD –HOC NETWORKS** Internet-based mobile ad-hoc networking communication strategies, Routing algorithms –Proactive routing: destination sequenced Distance Vector Routing (DSDV), Reactive routing: Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV), Hybrid Routing: Zone Based Routing (ZRP).	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Understand the Architecture of ISO OSI Layer and different routing .
CO2: Learn the concept of Routing algorithms and different routing techniques.
CO3: Analyze the basics of RWA algorithms and Rerouting methods.
CO4: Describe the Macro and Micro-mobility protocols.
CO5: Analyze different Routing algorithms.

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REFERENCE BOOKS:

R1- William Stallings, ' High speed networks and Internets Performance and Quality of Service',IInd Edition, Pearson Education Asia. Reprint India 2002

R2- M. Steen Strub, ' Routing in Communication network, Prentice –Hall International,Newyork,1995.

R3- S. Keshav, 'An engineering approach to computer networking' Addison Wesley 1999.

R4- William Stallings, 'High speed Networks TCP/IP and ATM Design Principles, Prentice- Hall,New York, 1995

R5- C.E Perkins, 'Ad Hoc Networking', Addison – Wesley, 2001

R6- Ian F. Akyildiz, Jiang Xie and Shantidev Mohanty, " A Survey of mobility Management inNext generation All IP- Based Wireless Systems", IEEE Wireless CommunicationsAug.2004, pp 16-27.

Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX307	COMMUNICATION NETWORK SECURITY	3	0	0	3

Course Objective

1. To understand the basics of Encryption techniques.
2. To know the concepts of public key encryption and HASH & MAC algorithms.
3. To understand authentication services and e-mail security.
4. To know the concepts of IP security and web security.
5. To understand the different types of system security.

Unit	Description	Total Instructional Hours
I	**CONVENTIONAL ENCRYPTION** Introduction, Conventional Encryption Model, Data Encryption Standard, Block cipher, Encryption algorithms, Confidentiality, Key Distribution.	9
II	**PUBLIC KEY ENCRYPTION AND HASH & MAC ALGORITHMS** Principles of public key cryptosystems, RSA Algorithm, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography, Message Authentication and Hash Functions, Hash and MAC Algorithms, Digital Signatures and Digital Signature Standard.	9
III	**AUTHENTICATION SERVICES AND E-MAIL SECURITY** Kerberos, X.509 Directory Service, Pretty Good Privacy, Secure Multipurpose Internet Mail Extension.	9
IV	**IP SECURITY AND WEB SECURITY** IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Security Associations, Key Management, Web Security Requirements, Secure Sockets Layer, Transport Layer Security, Secure Electronic Transaction Layer, Dual Signature.	9
V	**SYSTEM SECURITY** Intruders, Intrusion Detection Techniques, Malicious Software, Viruses and Antivirus Techniques,Digital Immune Systems, Firewalls-Design goals, Limitations, Types and Configurations, Trusted Systems.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Analyze the basics of Encryption techniques.
CO2: Demonstrate the impact of public key encryption and HASH & MAC algorithms.
CO3: Analyze authentication services and e-mail security.
CO4: Analyze concepts of IP security and web security.
CO5: Implement the different types of system security.

REFERENCE BOOKS:

R1- William Stallings, *"Cryptography and network security"*, 5th Edition, Pearson Education, 2011.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX308	REAL TIME OPERATING SYSTEMS	3	0	0	3

Course Objective

1. To develop a comprehensive understanding of operating systems .
2. To study the distributed operating systems.
3. To study the different real time models.
4. To learn about real time models.
5. To learn about application domains of RTOS.

Unit	Description	Total Instructional Hours
I	**REVIEW OF OPERATING SYSTEMS** Basic Principles – System Calls – Files – Processes – Design and Implementation of processes – Communication between processes – Operating System structures.	9
II	**DISTRIBUTED OPERATING SYSTEMS** Topology – Network types – Communication – RPC – Client server model – Distributed file system – Design strategies.	9
III	**REAL TIME MODELS AND LANGUAGES** Event Based – Process Based and Graph based Models – Petrinet Models – Real Time Languages – RTOS Tasks –RT scheduling - Interrupt processing – Synchronization – Control Blocks – Memory Requirements.	9
IV	**REAL TIME MODELS** Principles – Design issues – Polled Loop Systems – RTOS Porting to a Target – Comparison and study of RTOS VX works and COS – Case studies.	9
V	**RTOS APPLICATION DOMAINS** RTOS for Image Processing – Embedded RTOS for voice over IP – RTOS for fault Tolerant Applications – RTOS for Control Systems.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Learn the concept of operating systems
CO2: Analyze the distributed operating systems.
CO3: Learn the different real time models and real time languages.
CO4: Analyze the different real time models.
CO5: Know the application domains of RTOS.

REFERENCE BOOKS:

R1- Charles Crowley, "Operating Systems-A Design Oriented approach", McGraw Hill 1997.
R2- C.M. Krishna, Kang, G.Shin, "Real Time Systems", McGraw Hill, 1997.
R3- Tanenbaum, "Distributed Operating Systems", Pearson Education.
R4- Raymond J.A.Bhur, Donald L.Bailey, "An Introduction to Real Time Systems", PHI 1999.

Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX309	HIGH PERFORMANCE COMPUTER NETWORKS	3	0	0	3

Course Objective

1. To develop a comprehensive understanding of switching networks.
2. To study the different types of multimedia networking applications.
3. To study the types of VPN and tunneling protocols for security.
4. To learn about packet queues and delay analysis.
5. To learn about network security in many layers and network management.

Unit	Description	Total Instructional Hours
I	**SWITCHING NETWORKS** Switching – Packet switching - Ethernet, Token Ring, FDDI, DQDB, Frame Relay, SMDS, Circuit Switched – SONET, DWDM, DSL, Intelligent Networks – CATV, ATM – Features, Addressing Signaling & Routing,Header Structure, ATM Adaptation layer, Management control, BISDN, Internetworking with ATM.	9
II	**MULTIMEDIA NETWORKING APPLICATIONS** Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, RSVP- differentiated services.	9
III	**ADVANCED NETWORKS CONCEPTS** VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN.MPLS-operation,Routing, Tunneling and use of FEC, Traffic Engineering, and MPLS based VPN, overlay networks-P2P connections.-IPv4 vs. V6.	9
IV	**PACKET QUEUES AND DELAY ANALYSIS** Little's theorem, Birth and Death process, queueing discipline- Control & stability -, Markovian FIFO queueing system, Non-markovian - Pollaczek-Khinchin formula and M/G/1, M/D/1, self-similar models and Batch-arrival model, Networks of Queues – Burke's theorem and Jackson Theorem.	9
V	**NETWORK SECURITY AND MANAGEMENT** Principles of cryptography – Elliptic-AES- Authentication – integrity – key distribution and certification – Access control and: fire walls – DoS-attacks and counter measures – security in many layers. Infrastructure for network management – The internet standard management framework – SMI, MIB,SNMP, Security and administration – ASN.1.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Learn the concept of switching networks.
CO2: Analyze the types of multimedia networking applications.
CO3: Use of VPN and tunneling protocols for security
CO4: Analyze packet queues and delay analysis.
CO5: Know the network security in many layers and network management.

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REFERENCE BOOKS:

R1. Aunurag Kumar, D. Manjunath, Joy Kuri, "Communication Networking", Morgan Kaufmann Publishers, 2011.

R2. J.F. Kurose & K.W. Ross, "Computer Networking- A Top Down Approach Featuring the Internet",Pearson, 2nd Edition, 2003.

R3. Nader F.Mir, "Computer and Communication Networks", Pearson Education, 2009.

R4. Walrand J. Varatya, "High Performance Communication Network", Morgan Kaufmann – Harcourt Asia Pvt. Ltd., 2nd Edition, 2000.

R5. Hersent Gurle & petit, "IP Telephony, Packet Pored Multimedia Communication Systems", Pearson Education 2003.

R6. Fred Halsall and Lingana Gouda Kulkarni, "Computer Networking and the Internet", Fifth Edition,Pearson Education, 2012.

Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX310	ADVANCED DIGITAL IMAGE PROCESSING	3	0	0	3

Course Objective

1. To understand the image fundamentals and mathematical transforms necessary for image processing and to study the image enhancement techniques.
2. To understand image enhancement and restoration techniques.
3. To understand how image are analyzed using morphological operations.
4. To introduce the concepts of texture analysis.
5. To analyze the constraints in image communication.

Unit	Description	Total Instructional Hours
I	**IMAGE REPRESENTATION AND TRANSFORMS** Image representation - Gray scale and color Images, image sampling and quantization. Two dimensional orthogonal transforms - DFT, FFT, Haar transform, KLT, DCT.	9
II	**IMAGE ENHANCEMENT AND RESTORATION** Filters in spatial and frequency domains, histogram-based processing, homomorphic filtering. Image Restoration - PSF, circulant and block-circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods.	9
III	**MORPHOLOGICAL OPERATIONS AND EDGE DETECTION** Edge detection - Non parametric and model based approaches, LOG filters, localization problem. Mathematical morphology - binary morphology, dilation, erosion, opening and closing, duality relations, gray scale morphology, applications such as hit-and-miss transform, thinning and shape decomposition	9
IV	**TEXTURE ANALYSIS AND COMPUTER TOMOGRAPHY** Computer tomography - parallel beam projection, Radon transform, and its inverse, Backprojection operator, Fourier-slice theorem, CBP and FBP methods, ART, Fan beam projection. Image texture analysis - co-occurrence matrix, measures of textures, statistical models for textures - Hough Transform, boundary detection, chain coding and segmentation, thresholding methods.	9
V	**IMAGE COMMUNICATION** JPEG, MPEGs and H.26x standards, packet video, error concealment.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: To understand image formation and the role human visual system plays in perception of gray and color image data.
CO2: To apply image enhancement and restoration techniques in both the spatial and frequency domains.
CO3: To analyze image using morphological operations the methodologies.
CO4: To conduct independent study and analysis of texture analysis.
CO5: To analyze the constraints in image communication.

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REFERENCE BOOKS:

R1- Rafael C. Gonzalez and Richard E. Woods, "*Digital Image Processing*", Pearson education, 2nd Edition,2002.

R2- A. K. Jain, "Fundamentals of digital image processing", Prentice Hall of India, 1989.

R3- R.M. Haralick, and L.G. Shapiro, "Computer and Robot Vision", Vol-1, Addison Wesley, Reading, MA, 1992.

R4- R. Jain, R. Kasturi and B.G. Schunck, "Machine Vision", McGraw-Hill International Edition, 1995.

Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX311	SIGNAL INTEGRITY FOR HIGH SPEED DESIGN	3	0	0	3

Course Objective

1. To understand the basics of signal propagation on transmission lines.
2. To know the concepts of Multi-conductor transmission-lines and cross talk.
3. To understand non-ideal effects in high speed design.
4. To know the concepts of power considerations in high speed system design.
5. To understand the types of clock distribution and clock oscillators for high speed design.

Unit	Description	Instructional Hours
I	**SIGNAL PROPAGATION ON TRANSMISSION LINES** Transmission line equations, wave solution, wave *vs.* circuits, initial wave, delay time, Characteristic impedance , wave propagation, reflection, and bounce diagrams Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.	9
II	**MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK** Multi-conductor transmission-lines, coupling physics, per unit length parameters, Near and far-end cross-talk, minimizing cross-talk (stripline and microstrip) Differential signalling, termination, balanced circuits ,S-parameters, Lossy and Lossles models.	9
III	**NON-IDEAL EFFECTS** Non-ideal signal return paths – gaps, BGA fields, via transitions , Parasitic inductance and capacitance , Transmission line losses – Rs, tanδ, routing parasitic, Common-mode current,differential-mode current , Connectors.	9
IV	**POWER CONSIDERATIONS AND SYSTEM DESIGN** SSN/SSO , DC power bus design , layer stack up, SMT decoupling ,, Logic families, power consumption, and system power delivery , Logic families and speed Package types and parasitic,SPICE, IBIS models Bit streams, PRBS and filtering functions of link-path components , Eyediagrams , jitter , inter-symbol interference Bit-error rate, Timing analysis.	9
V	**CLOCK DISTRIBUTION AND CLOCK OSCILLATORS** Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, canceling parasitic capacitance, Clock jitter.	9
	TOTAL INSTRUCTIONAL HOURS	**45**

COURSE OUTCOME

CO1: Analyze the basics of signal propagation on transmission lines.
CO2: Demonstrate the impact of Multi-conductor transmission-lines.
CO3: Reduce non-ideal effects in high speed design.
CO4: Analyze power considerations in high speed system design.
CO5: Design & analysis of clock distribution and clock oscillators for high speed design.

REFERENCE BOOKS:

R1- H. W. Johnson and M. Graham, High-Speed Digital Design: A Handbook of Black Magic,PrenticeHall, 1993.
R2- Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR , 2003.
R3- S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices, Wiley-Interscience, 2000.
R4- Eric Bogatin , Signal Integrity – Simplified , Prentice Hall PTR, 2003.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX312	ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING	3	0	0	3

Course Objective

1. To study the basic concepts of OFDM.
2. To analyze the various system modeling in OFDM.
3. To learn various synchronization and signal processing techniques.
4. To study PAPR and hybrid concepts.
5. To learn various LTE standards.

Unit	Description	Instructional Hours
I	**FUNDAMENTALS** Histroy of OFDM, orthogonal signals and vectors, quadrature modulation and demodulation, AWGN channel,detection of signals in noise, SNR, linear modulation schemes-ASK, QAM, PSK and DPSK.Channel model for OFDM systems-Introduction- characterization of mobile radio channel- Frequency Division (FD)channel modeling- FD channel simulation- application to millimeter-wave radio channels.	9
II	**SYSTEM MODELING** Concept of multicarrier transmission, OFDM as multicarrier transmission, Implementation of OFDM by FFT,OFDM with guard interval. OFDM introduction and block diagram, design of OFDM signal, OFDM system model,synchronization errors, performance of uncoded OFDM system-mathematical modeling, analytical evaluation of the BER and performance results.	9
III	**SYNCHRONIZATION** Synchronization and signal processing aspects of OFDM-spectral shaping, sensitivity of OFDM signal against nonlinearities. Synchronization and channel estimation aspects - time and frequency synchronization, OFDM with pilot symbols for channel estimation- Wiener estimator and Wiener filtering for OFDM.	9
IV	**PAPR AND HYBRID CONCEPTS** Distribution of PAP ratio, clipping and peak windowing, peak cancellation, PAP reduction codes- generating complementary codes, minimum distance of complementary codes, Maximum-Likelihood decoding of complementary codes, suboptimal decoding of complementary codes, large code lengths- symbol scrambling.Hybrid OFDM concept- structure of various multiple access schemes, comparison to MC-CDMA – analytical performance of fading channels- with perfect estimation and realistic estimation.	9
V	**LTE STANDARDS** Requirements for mobile radio channel, time and frequency interleavers, diversity spectrum of a widebandmulticarrier channel. OFDM systems with convolutional coding and QPSK, convolutional coding and M2-QAM,convolutionally coded QAM with real channel estimation and imperfect interleaving, antenna diversity for convolutionally coded QAM multicarrier systems.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Demonstrate the concepts of OFDM.
CO2: Design of various systems modeling in OFDM.
CO3: Design of synchronization and signal processing techniques.
CO4: Understand PAPR and hybrid concepts.
CO5: Understand various LTE standards.

REFERENCE BOOKS:

R1- Ramjee Prasad, OFDM for Wireless Communication Systems, Artech House,Inc, 2004.

R2- Henrik Schulze and Christian Luders, Theory and Applications of OFDM and CDMA- Wideband Wireless Communications, John Wiley & Sons Ltd, 2005.

R3- RichardvanNee, Ramjee Prasad ,OFDM for wireless multimedia communications, Artech House, 2000.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX313/ 16ENX306	HIGH SPEED SWITCHING ARCHITECTURE	3	0	0	3

Course Objective

1. To understand the need for Broadband Networking
2. To learn to the various switching concepts.
3. To understand the concepts and architectures of High speed networks.
4. To understand various queuing model concepts.
5. To study the current trends in IP switching.

Unit	Description	Instructional Hours
I	**BROADBAND NETWORKING** Hierarchy of switching networks - Switching in telecommunication networks, Evolution of networks - The path to Broadband networking - Network evolution through ISDN to B-ISDN - The protocol reference model -Transfer Mode and Control of the B-ISDN-ATM Standards, ATM adaptation layers.	9
II	**SWITCHING CONCEPTS** Switch Forwarding Techniques, Switch Path Control, LAN Switching, Cut through Forwarding, Store and forward, Virtual LANs.	9
III	**SWITCHING ARCHITECTURES** Issues and performance analysis - Banyan and knockout switches - Single & Multistage networks -Shuffle switch tandem banyan.	9
IV	**QUEUING MODELS** SS7 Signaling - Traffic and queuing models - Input Queuing- Output Queuing - Shared Queuing-Performance analysis of Input, Output & Multiple shared Queuing.	9
V	**IP SWITCHING** Addressing Model, IP switching types, Flow driven and topology driven solutions, IP over ATM,Address and next hop resolution Multicasting, IPV6 over ATM.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Analyze the issues and challenges pertaining to Broadband Networking.
CO2: Apply switching concepts to manage practical networks.
CO3: Formulate possible architectures for managing high speed networks.
CO4: Use queuing models for managing the network.
CO5: Identify the various IP switching techniques.

REFERENCE BOOKS:

R1- Achille Pattavina, "Switching Theory Architectures and performance in Broadband ATM networks", John wiley & sons Ltd,New York, 1998.

R2- Christopher Y Metz, "IP Switching Protocols & Architectures", McGraw Hill Professional Publishing, New York, 1999.

R3- Ranier Handel. Manfred N Huber, Stefab Schrodder," ATM Networks - Concepts, Protocols, Application"s, 3rd edition, Adisson Wesley, New York 1999.

R4- Thiggarajan Viswanathan, "Tele Communication Switching System and Networks", Prentice Hall of India, Pvt.Ltd., New Delhi, 2004.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX314/ 16ENX317	MODELING AND SIMULATION OF WIRELESS COMMUNICATION SYSTEMS	3	0	0	3

Course Objective

1. To develop a comprehensive understanding of simulation of wireless communication systems.
2. To study the concepts of generating and processing random signals.
3. To learn methodology for simulating a wireless system.
4. To analyze the various modeling and simulation techniques for time-varying systems.
5. To learn efficient simulation techniques for FDM and CDMA applications.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Role of Simulation: Examples of complexity - multidisciplinary aspects of simulation - models - deterministic and stochastic simulations; Simulation methodology - aspects of methodology - performance estimation; Fundamental Concepts and Techniques: Sampling - quantizing - reconstruction and interpolation - simulation sampling frequency - low pass simulation models for band pass – low pass complex envelope for bandpass signals – linear bandpass systems - multicarrier signals - nonlinear and time - varying systems.	9
II	**GENERATING AND PROCESSING RANDOM SIGNALS** Stationary and Ergodic Processes: Uniform random number generators - mapping uniform RVs to an arbitrary PDF - generating uncorrelated Gaussian random numbers – generating correlated Gaussian random numbers - PN sequence generators; Establishing a PDF and a PSD Post Processing: Basic graphical techniques - estimation - coding.	9
III	**METHODOLOGY FOR SIMULATING A WIRELESS SYSTEM** Monte Carlo Simulation Fundamental Concepts: Applications and integration - two Monte Carlo examples; Semi Analytic Techniques System: Level simplifications and sampling rate considerations - overall methodology; Modeling and Simulation of Nonlinearities: Introduction - modeling and simulation of memory less nonlinearities - modeling and simulation of nonlinearities with memory - techniques for solving nonlinear differential equations.	9
IV	**MODELING AND SIMULATION OF TIME-VARYING SYSTEMS** Introduction: Models for LTV systems - random process models - simulation models for LTV systems; Wired and guided wave - radio channels - multipath fading channels – modeling multipath fading channels; Random process models - simulation methodology; Discrete Channel Models: Discrete memory less channel models - Markov models for discrete channels with memory- example HMMs - Gilbert and Fritchman models - estimation of Markov model parameters.	9
V	**EFFICIENT SIMULATION TECHNIQUES** Tail Extrapolation: PDF estimators- importance sampling; Case study of a cellular radio system; Cellular radio system - simulation methodology - modeling co-channel interference - two example simulations; A code-division multiple access system - FDM system with a nonlinear satellite transponder - preprocessors for CDMA application.	9
	TOTAL INSTRUCTIONAL HOURS	**45**

Course Outcome

CO1: Analyze the various simulation techniques of wireless communication systems.
CO2: Apply the concepts for generating and processing random signals.
CO3: Use the methodology for simulating a wireless system.

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CO4: Understand the various modeling and simulation techniques for time-varying systems.
CO5: Identify the various simulation techniques for FDM and CDMA applications.

REFERENCE BOOKS:

R1- William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport and Kurt L. Kosbar "Principles of Communication Systems Simulation with Wireless Applications", Prentice Hall, Upper Saddle River, 2003.
R2- M. C. Jeruchim, Philip Balaban and K.Sam shanmugam. "Simulation of Communication Systems", Plenum Press, 2007.
R3- M. Law and W. David Kelton , "Simulation Modelling and Analysis", McGraw Hill, 2008.
R4- K. Hayes, "Modelling and Analysis of Computer Communication Networks", Plenum Press, 1984.
R5- Banks, J. S. Carson, Nelson and D. M. Nicol, "Discrete Event System Simulation", 4th Edition, Prentice Hall of India, 2005.

Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX315	WAVELET TRANSFORMS AND APPLICATIONS	3	0	0	3

Course Objective

1. To study the basics of signal representation and Fourier theory
2. To understand Multi Resolution Analysis and Wavelet concepts
3. To study the wavelet transform in both continuous and discrete domain
4. To understand the design of wavelets using Lifting scheme
5. To understand the applications of Wavelet transform

Unit	Description	l Instructional Hours
I	**FUNDAMENTALS** 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- Fourier Theory: Fourier series expansion, Fourier transform, Short time Fourier transform, Time-frequency analysis.	9
II	**MULTI RESOLUTION ANALYSIS** 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.	9
III	**CONTINUOUS WAVELET TRANSFORMS** 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, Sinc, Gaussian, Bi Orthogonal)– Tiling of Time – Scale Plane for CWT.	9
IV	**DISCRETE WAVELET TRANSFORM** 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 – eometrical Foundations of Lifting Scheme – Lifting Scheme in Z –Domain.	9
V	**APPLICATIONS** Wavelet methods for signal processing- Image Compression Techniques: EZW– SPHIT Coding –Image Denoising Techniques: Noise Estimation – Shrinkage Rules – Shrinkage Functions –Edge Detection and Object Isolation, Image Fusion, and Object Detection.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Use Fourier tools to analyze signals
CO2: Gain knowledge about MRA and representation using wavelet bases
CO3:Acquire knowledge about various wavelet transforms
CO4: Design wavelet transform for various applications
CO5: Apply wavelet transform for various signal & image processing applications

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REFERENCE BOOKS:

R1- Rao R M and A S Bopardikar, —Wavelet Transforms Introduction to theory and Applications, Pearson Education, Asia, 2000.

R2- L.Prasad & S.S.Iyengar, Wavelet Analysis with Applications to Image Processing, CRC Press, 1997.

R3- J. C. Goswami and A. K. Chan, "Fundamentals of wavelets: Theory, Algorithms and Applications" WileyInterscience Publication,John Wiley & Sons Inc., 1999.

R4- M. Vetterli, J. Kovacevic, "Wavelets and subband coding" Prentice Hall Inc, 1995.

R5- Stephen G. Mallat, "A wavelet tour of signal processing" 2 nd Edition Academic Press, 2000.

R6- Soman K P and Ramachandran K I, —Insight into Wavelets From Theory to practice, Prentice Hall, 2004.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX316	SPREAD SPECTRUM COMMUNICATIONS	3	0	0	3

Course Objective

1. Students will learn the principles of spread spectrum systems, including the global techniques.
2. Students will learn how to design and implement the principles of various convolutional codes and Viterbi algorithms for decoders.
3. Students will learn how to design and implement the principles of various algorithms for sequential coding and error correcting codes for multiple errors.
4. Students will learn how to modulate the codes with trellis algorithm.
5. Students will learn to control errors with various protocols for noiseless channel

Unit	Description	Instructional Hours
I	**SPREAD SPECTRUM OVERVIEW** Definition and Beneficial attributes of a spread spectrum system – Catalog of spreading techniques -Pseudonoise sequences – Direct-sequence spread-spectrum systems and applications.	9
II	**CONVOLUTIONAL CODES AND VITERBI DECODING ALGORITHM** Linear convolutional encoders – Structural properties of convolutional codes – State diagrams – Transparent convolutional codes – Receiver phase offset and Differential decoding – Trellis diagrams – Viterbi algorithm – Performance analysis – Design and Implementation of Viterbi decoder – Punctured convolutional codes.	9
III	**SEQUENTIAL DECODING ALGORITHMS & BURST ERROR CORRECTING CODE** Tree diagrams – The Fano algorithm – The Stack algorithm – Performance analysis for Sequentialdecoders – Burst error correcting codes – Decoding of single burst error correcting cyclic codes –Fire interleaved codes – Phased burst error correcting codes – Concatenated codes.	9
IV	**TRELLIS CODED MODULATION(TCM) AND TURBO CODE** M-ary signaling – One and Two-dimensional TCM – Multiple TCM – Decoding and performance analysis – Implementational considerations – Turbo codes – Encoding – Performance Evaluation using bounding techniques – BCJR algorithm for decoding – Applications.	9
V	**ERROR CONTROL FOR CHANNELS WITH FEEDBACK** Pure ARQ Protocols – Noisy feedback channels – Type I Hybrid ARQ Protocols – Type II Hybrid ARQ Protocols and Packet combining.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Define spread spectrum system and spreading techniques.
CO2: Use convolutional codes and Viterbi for various decoding.
CO3: Estimate the error probabilities in various decoding techniques.
CO4: Distinguish various Terlis and Turbo codes and select appropriate system for the application.
CO5: Construct error free channels using acknowledgement in various models.

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REFERENCE BOOKS:

R1- Stephen B. Wicker, "Error control systems for Digital communication and storage", Prentice Hall, Upper Saddle River, NJ, 1995.

R2- Shu Lin, Daniel Costello, "Error control coding – Fundamentals and Applications", Second Edition, Prentice Hall, Upper Saddle River, NJ, 2004.

R3- Sklar, B., "Digital Communications: Fundamentals and Applications", Prentice Hall Inc., NJ, 2001.

R4- E. Biglieri, et al. "Introduction to Trellis coded modulation with Applications", Macmillan Publishers, 1991.

R5- R. Johannesson and K.S. Zigangirov, "Fundamentals of Convolutional coding", IEEE Series on Digital and Mobile Communication, Wiley-IEEE Press, 1999.

Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX317/16ENX312	WIRELESS SENSOR NETWORKS	3	0	0	3

Course Objective

1. To learn the basics of wireless sensor networks with their technology.
2. To learn how to design and implement the wireless sensor networks in various structures to meet the requirements.
3. To learn how to use various protocols in implementing wireless sensors.
4. To learn how to locate and control the sensors in a network.
5. To learntools for designing of wireless sensor networks and usage of hardware's along with software's.

Unit	Description	Instructional Hours
I	**OVERVIEW OF WIRELESS SENSOR NETWORKS** Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference betweenmobile ad-hoc and sensor networks, Applications of sensor networks- Enabling Technologies for Wireless SensorNetworks.	9
II	**ARCHITECTURES** Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts	9
III	**NETWORKING OF SENSORS** Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts,Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.	9
IV	**INFRASTRUCTURE ESTABLISHMENT** Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.	9
V	**SENSOR NETWORK PLATFORMS AND TOOLS** Operating Systems for Wireless Sensor Networks, Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: To Define wireless sensor networks for various applications.
CO2: To Design multiple architectures to build wireless sensor networks.
CO3: To Estimate the protocols to ensure proper message transfer between nodes.
CO4: To Construct wireless sensor networks in exact positions with proper control over it.
CO5: To Choose a proper hardware with software to build sensor network with multiple tools

REFERENCE BOOKS:

R1- Holger Karl and Andreas Willig, Protocols And Architectures for Wireless Sensor Networks , John Wiley,2005.

R2- Feng Zhao and Leonidas J. Guibas, Wireless Sensor Networks - An Information Processing Approach, Elsevier, 2007.

R3- Kazem Sohraby, Daniel Minoli and Taieb Znati, Wireless Sensor Networks-Technology, Protocols, And Applications, John Wiley, 2007

R4- Anna Hac, Wireless Sensor Network Designs, John Wiley, 2003.

R5- Bhaskar Krishnamachari, Networking Wireless Sensors, Cambridge Press, 2005.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX318	SPEECH AND AUDIO PROCESSING	3	0	0	3

Course Objective

1. Students will learn the basics of speech, audio with in-depth analysis.
2. Students will learn how to analyze, filter and transform the speech signals.
3. Students will learn how to use various coding techniques to represent the speech signals.
4. Students will learn how to process various parameters in multiple domains.
5. Students will learn how to separate speech and excitation for enhancing the features.

Unit	Description	Instructional Hours
I	**MECHANICS OF SPEECH AND AUDIO** Introduction - Review Of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds –Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features.Absolute Threshold of Hearing - Critical Bands- Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Nonsimultaneous Masking - Perceptual Entropy – Basic measuring philosophy -Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.	9
II	**TIME-FREQUENCY ANALYSIS: FILTER BANKS AND TRANSFORMS** Introduction -Analysis-Synthesis Framework for M-band Filter Banks-Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters- Tree- Structured QMF and CQF M-band Banks - Cosine Modulated "Pseudo QMF" M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banksand the Modified Discrete Cosine Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Pre echo Control Strategies.	9
III	**AUDIO CODING AND TRANSFORM CODERS** Lossless Audio Coding-Lossy Audio Coding- ISO-MPEG-1A,2A,2A Advaned , 4AudioCoding - Optimum Coding in the Frequency Domain - Perceptual Transform Coder -Brandenburg-Johnston Hybrid Coder - CNET Coders - Adaptive Spectral Entropy Coding -Differential Perceptual Audio Coder - DFT Noise Substitution -DCT with Vector Quantization -MDCT with Vector Quantization.	9
IV	**TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING** Time domain parameters of Speech signal – Methods for extracting the parameters :Energy,Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCRand energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods Homomorphic Speech Analysis:Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders.	

V	**LINEAR PREDICTIVE ANALYSIS OF SPEECH** Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods –Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Define allthe components in a speech or audio signal.
CO2: Design various filters and analyze time and frequency domains.
CO3: Construct lossless and lossy compression and coding techniques for audios.
CO4: Analyze the audio in time and frequency domain and estimate various parameters.
CO5: Choose a proper method to enhance the audio parameters.

REFERENCE BOOKS:

R1- Digital Audio Signal Processing, Second Edition, Udo Zolzer, A John Wiley& sons Ltd Publicatioons
R2- Applications of Digital Signal Processing to Audio And Acoustics Mark Kahrs, Karlheinz Brandenburg, KLUWER ACADEMIC PUBLISHERS NEW YORK, BOSTON, DORDRECHT, L ONDON , MOSCOW
R3- Digital Processing of Speech signals – L.R.Rabiner and R.W.Schaffer - Prentice Hall --1978

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX319	SMART ANTENNAS	3	0	0	3

Course Objective

1. Students will learn the basics of antennas and their parameters.
2. Students will learn narrow band and wide band processing of signal.
3. Students will learn how to use adaptive processing with various algorithms.
4. Students will learn how to estimate the direction of a signal from the received signals.
5. Students will learn to combine multiple signals due to diversity.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Historical development of smart antennas- Antenna gain, Antenna Pattern, Antenna boresight, Phased array antenna,power pattern, beamsteered and weighted arrays, beamsteered circular arrays, rectangular planar arrays, fixed beamarrays, retro directive arrays, degree of freedom, optimal antenna, adaptive antennas, smart antenna -key benefits ofsmart antenna technology, wide band smart antennas, Digital radio receiver techniques and software radio for smart antennas.	9
II	**NARROW AND BROAD BAND PROCESSING** Signal model conventional beamformer, null steering beamformer, optimal beamformer, Optimization using reference signal, beam space processing. Tapped delay line structure, Partitioned realization, Derivative constrained processor, Digital beam forming, Broad band processing using DFT method.	9
III	**ADAPTIVE PROCESSING** Sample matrix inversion algorithm, unconstrained LMS algorithm, normalized LMS algorithm, Constrained LMS algorithm, Perturbation algorithms, Neural network approach, Adaptive beam space processing, Implementation issues.	9
IV	**DIRECTION OF ARRIVAL ESTIMATION METHODS** Fundamentals of matrix algebra- array correlation matrix- AOA estimation methods- Spectral estimation methods- Bartlett method and Capon method, linear prediction method, Maximum entropy method, Maximum likelihood method, PHD method, Min-norm method, Eigen structure methods, Music algorithm -root music and cyclic music algorithm, the ESPRIT algorithm.	9
V	**DIVERSITY COMBINING** Spatial diversity selection combiner, switched diversity combiner, equal gain combiner, maximum ratio combiner, optical combiner.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Define all the basics of antenna and their parameters.
CO2: Compute beam former in narrow and broad band.
CO3: Construct algorithms for adaptive processing.
CO4: Analyze the received signal to estimate the direction of arrival of the signal.
CO5: Choose a proper method to combine the beams due to diversity.

REFERENCE BOOKS:

R1- Lal Chand Godara, Smart Antennas CRC press, 2004
R2-Joseph C Liberti.Jr and Theodore S Rappaport, Smart Antennas for Wireless Communication: IS-95 and Third Generation CDMA Applications, Prentice Hall 1999.
R3-Frank B.Gross, " Smart Antennas for Wireless Communications", McGraw Hill, 2005
R4- Balanis, Antennas, John Wiley and Sons, 2005
R5- IEEE Transaction on Antenna and Wave Propagation

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX320	SIGNAL DETECTION AND ESTIMATION	3	0	0	3

Course Objective

1. Students will learn the basics of random process for signal processing.
2. Students will learn to estimate the spectrum of signals using various criteria.
3. Students will learn how to detect parameters of signals.
4. Students will learn how to obtain synchronization between signal parameters.
5. Students will learn to demodulate, filter and detect the faded signals from channels.

Unit	Description	Instructional Hours
I	**DISCRETE RANDOM SIGNAL PROCESSING** Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation,Auto covariance, Autocorrelation, Parseval's theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes, Special types of Random Processes – ARMA, AR, MA – Yule-Walker equations.	9
II	**SPECTRAL ESTIMATION** Estimation of spectra from finite duration signals, Nonparametric methods – Periodogram, Modified periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric methods –ARMA, AR and MA model based spectral estimation, Solution using Levinson-Durbin algorithm.	9
III	**DETECTION AND ESTIMATION CRITERIA** Detection criteria : Bayes detection techniques, MAP, ML,– detection of M-ary signals, Neyman Peason, minimax decision criteria. Estimation: linear estimators, non-linear estimators, Bayes, MAP,ML, properties of estimators, phase and amplitude estimation.	9
IV	**SYNCHRONIZATION** Signal parameter estimation, carrier phase estimation, symbol timing estimator, joint estimation of carrier phase and symbol timing.	9
V	**RECEIVERS FOR AWGN AND FADING CHANNELS** Optimum receivers for AWGN channel -Correlation demodulator, matched filter, maximum likelihood sequence detector, envelope detectors for M-ary signals; Characterization of fading multipath channels, RAKE demodulator, Multiuser detection techniques.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Define all the basics of random process for signal processing.
CO2: Estimate the spectrum using various models.
CO3: Identify various parameters of signals.
CO4: Generate synchronization between signal parameters.
CO5: Construct a proper receiver to receive the signals from noise affected and faded channels and to get back the message

REFERENCE BOOKS:

R1- Monson H. Hayes, 'Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 2002
R2- John J. Proakis, Dimitris G. Manolakis, : Digital Signal Processing', Pearson Education, 2002.
R3- John G. Proakis., 'Digital Communication', 4 th edition, Mc Graw Hill Publication, 2001.
R4- Bernard Sklar and Pabitra Kumar Roy, Digital Communications: Fundamentals & Applications, 2/E, Pearson Education India, 2009
R5- John G. Proakis, Masoud Salehi, "Communication Systems Engineering", Prentice Hall, 1994.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX321	GREEN COMPUTING	3	0	0	3

Course Objective

1. To understand the basics of Green Computing.
2. To know the concepts of Material Recycling.
3. To know the role of material recycling.
4. To visualize the frame work for green data centre.
5. To run Environmental responsible business.

Unit	Description	Instructional Hours
I	**FUNDAMENTALS** Green IT Fundamentals: Business, IT, and the Environment – Green computing: carbon foot print, scoop on power – Green IT Strategies: Drivers, Dimensions, and Goals – Environmentally Responsible Business: Policies, Practices, and Metrics.	9
II	**GREEN ASSETS AND MODELING** Green Assets: Buildings, Data Centers, Networks, and Devices – Green Business Process Management: Modeling, Optimization, and Collaboration – Green Enterprise Architecture – Environmental Intelligence – Green Supply Chains – Green Information Systems: Design and Development Models.	9
III	**GRID FRAMEWORK** Virtualizing of IT systems – Role of electric utilities, Telecommuting, teleconferencing and teleporting – Materials recycling – Best ways for Green PC – Green Data center – Green Grid framework.	9
IV	**GREEN COMPLIANCE** Socio-cultural aspects of Green IT – Green Enterprise Transformation Roadmap – Green Compliance: Protocols, Standards, and Audits – Emergent Carbon Issues: Technologies and Future.	9
V	**CASE STUDIES** The Environmentally Responsible Business Strategies (ERBS) – Case Study Scenarios for Trial Runs – Case Studies – Applying Green IT Strategies and Applications to a Home,Hospital, Packaging Industry and Telecom Sector.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Identify the basics of Green Computing
CO2: Demonstrate the impact of Material Recycling.
CO3: Reduce the use of carbon particles.
CO4: Analyze the green data centre
CO5: Apply Green Strategies in home ,Hospitals,etc...

REFERENCE BOOKS:

R1- Bhuvan Unhelkar, "Green IT Strategies and Applications-Using Environmental Intelligence", CRC Press, June 2011
R2- Woody Leonhard, Katherrine Murray, "Green Home computing for dummies", August 2009.
R3- Alin Gales, Michael Schaefer, Mike Ebbers, "Green Data Center: steps for the Journey", Shoff/IBM rebook, 2011.
R4- John Lamb, "The Greening of IT", Pearson Education, 2009.
R5- Jason Harris, "Green Computing and Green IT- Best Practices on regulations & industry", Lulu.com, 2008.
R6- Carl speshocky, "Empowering Green Initiatives with IT", John Wiley & Sons, 2010.

Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX322	PATTERN RECOGNITION	3	0	0	3

Course Objective

1. To understand the concept of Pattern recognition.
2. To know the concepts of Clustering.
3. To know the role of Fuzzy Systems.
4. To understand the concept of Hidden Markov Models.
5. To understand various transforms related to feature extraction

Unit	Description	Instructional Hours
I	**PATTERN CLASSIFIER** Overview of Pattern recognition – Discriminant functions – Supervised learning –Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions – Minimum distance pattern classifier.	9
II	**CLUSTERING** Clustering for unsupervised learning and classification – Clustering concept – C Means algorithm –Hierarchical clustering – Graph theoretic approach to pattern Clustering – Validity of Clusters.	9
III	**FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION** KL Transforms – Feature selection through functional approximation – Binary selection - Elements of formal grammars - Syntactic description - Stochastic grammars - Structural representation.	9
IV	**HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE** State Machines – Hidden Markov Models – Training – Classification – Support vector Machine –Feature Selection.	9
V	**RECENT ADVANCES** Fuzzy logic – Fuzzy Pattern Classifiers – Pattern Classification using Genetic Algorithms – Case Study Using Fuzzy Pattern Classifiers and Perception.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Solve problems related to Pattern recognition
CO2: Analyze the behavior of Clustering.
CO3: Classify Fuzzy Systems.
CO4: Know the concept of Hidden Markov Models.
CO5: Work with various transforms related to feature extraction

REFERENCE BOOKS:

R1- M. Narasimha Murthy and V. Susheela Devi, "Pattern Recognition", Springer 2011.
R2- S.Theodoridis and K.Koutroumbas, "Pattern Recognition", 4th Ed., Academic Press,2009.
R3- Robert J.Schalkoff, "Pattern Recognition Statistical, Structural and Neural Approaches", John Wiley & Sons Inc., New York, 1992.
R4- C.M.Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
R5- R.O.Duda, P.E.Hart and D.G.Stork, "Pattern Classification", John Wiley, 2001
R6- Andrew Webb, "Stastical Pattern Recognition", Arnold publishers, London,1999.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX323/16ENX328	NETWORKS ON CHIP	3	0	0	3

Course Objective

1. To introduce the concept of 3D NOC, architectures and protocols of 3D NOC.
2. To identify the types of fault and study the testing methods for fault rectification.
3. To identify the types of Energy and Power Issues of NOC.
4. To introduce the concept of micro-architecture NOC.
5. To learn DIMDE router for 3D NOC..

Unit	Description	Instructional Hours
I	**INTRODUCTION TO THREE DIMENSIONAL NOC** Three-Dimensional Networks-on-Chips Architectures. – Resource Allocation for QoS On-Chip Communication – Networks-on-Chip Protocols-On-Chip Processor Traffic Modeling for Networks-on- Chip	9
II	**TEST AND FAULT TOLERANCE OF NOC** Design-Security in Networks-on-Chips-Formal Verification of Communications in Networks-on-Chips- Test and Fault Tolerance for Networks-on-Chip Infrastructures-Monitoring Services for Networks-on- Chips.	9
III	**ENERGY AND POWER ISSUES OF NOC** Energy and Power Issues in Networks-on-Chips-The CHAIN works Tool Suite: A Complete Industrial Design Flow for Networks-on-Chips.	9
IV	**MICRO-ARCHITECTURE OF NOC ROUTER** Baseline NoC Architecture – MICRO-Architecture Exploration ViChaR: A Dynamic Virtual Channel Regulator for NoC Routers- RoCo: The Row-Column Decoupled Router – A Gracefully Degrading and Energy-Efficient Modular Router Architecture for On-Chip Networks. Exploring Fault Tolerant Networks-on-Chip Architectures.	9
V	**DIMDE ROUTER FOR 3D NOC** A Novel Dimensionally-Decomposed Router for On-Chip Communication in 3D Architectures-Digest of Additional NoC MACRO-Architectural Research.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: To Learn the concept of 3D NOC, architectures and protocols of 3D NOC.
CO2: To Understand the types of fault and study the testing methods for fault rectification.
CO3: To know the types of Energy and Power Issues of NOC.
CO4: To Analyze micro-architecture NOC.
CO5: To Know the concept of DimDE router for 3D NOC.

REFERENCE BOOKS:

R1- Chrysostomos Nicopoulos, Vijaykrishnan Narayanan, Chita R.Das" Networks-on - Chip " Architectures A Holistic Design Exploration", Springer.
R2- Fayezgebali, Haythamelmiligi, Hqhahed Watheq E1-Kharashi "Networks-on-Chips theory and practice CRC press.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX324/16ENX327	SYSTEM ON CHIP DESIGN	3	0	0	3

Course Objective

1. To design combinational and sequential logic networks.
2. To learn optimization of power in combinational and sequential logic machines.
3. To learn the concepts of sequential logic machines.
4. To study the design principles of FPGA and PLA.
5. To learn various floor planning methods for system design.

Unit	Description	Instructional Hours
I	**LOGIC GATES** Introduction. Combinational Logic Functions. Static Complementary Gates. Switch Logic. Alternative Gate Circuits. Low-Power Gates. Delay Through Resistive Interconnect. Delay Through Inductive Interconnect.	9
II	**COMBINATIONAL LOGIC NETWORKS** Introduction. Standard Cell-Based Layout. Simulation. Combinational Network Delay. Logic and interconnect Design. Power Optimization. Switch Logic Networks. Combinational Logic Testing.	9
III	**SEQUENTIAL MACHINES** Introduction. Latches and Flip-Flops. Sequential Systems and Clocking Disciplines. Sequential System Design. Power Optimization. Design Validation. Sequential Testing.	9
IV	**SUBSYSTEM DESIGN** Introduction. Subsystem Design Principles. Combinational Shifters. Adders. ALUs. Multipliers. High- Density Memory. FieldProgrammable Gate Arrays. Programmable Logic Arrays. References. Problems.	9
V	**FLOOR-PLANNING** Introduction, Floor-planning Methods – Block Placement & Channel Definition, Global Routing, switchbox Routing, Power Distribution, Clock Distributions, Floor-planning Tips, Design Validation. Off-Chip Connections – Packages, The I/O Architecture, PAD Design.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: To Analyze the combinational and sequential logic networks.
CO2: To Understand the optimization of power in combinational and sequential logic machines.
CO3: To Know the concepts of sequential logic machines.
CO4: To Design of FPGA and PLA.
CO5: To Identify the various floor planning methods for system design.

REFERENCE BOOKS:

R1- Wayne Wolf, "Modern VLSI Design – System – on – Chip Design", Prentice Hall, 3rd Edition 2008.
R2- Wayne Wolf, "Modern VLSI Design – IP based Design", Prentice Hall, 4th Edition , 2008.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX325	CLOUD COMPUTING	3	0	0	3

Course Objective

1. To introduce the basics of cloud computing, the architectural and storage needs and the challenges.
2. To enable the student to understand the different aspects of developing cloud services.
3. To introduce the basics of cloud creation.
4. To understand the storage and BIG data.
5. To enable the student to understand the different aspects deploying tools for cloud computing.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO CLOUD COMPUTING** Cloud Computing – History of Cloud Computing – Cloud Architecture – Cloud Storage – Why Cloud Computing Matters – Disadvantages of Cloud Computing – Microsoft Azure and Elastic Computing – Cloud Services .	9
II	**DEVELOPING CLOUD SERVICES** Web-Based Application – Pros and Cons of Cloud Service Development – Types of Cloud Service Development – Software as a Service – Platform as a Service – Web Services – On-Demand Computing – Discovering Cloud Services Development Services and Tools – Amazon Ec2 – Google App Engine – IBM Clouds .	9
III	**CLOUD CREATION** SOAP and REST services – Virtualization Technology – Multitenant software and Data access control for Enterprise applications – Algorithms and Map Reduce analogy.	9
IV	**STORAGE AND BIG DATA** Collaborating on Calendars, Schedules and Task Management – Exploring Online Scheduling Applications – Big Table – Hbase and Dynamo – Collaborating on Databases – Storing and Sharing Files	9
V	**DEPLOYING TOOLS** Cloud Middleware and Mobile Cloud Computing – Eucalyptus – Open nebula – Apache Virtual Computing Lab – Virtualization techniques KVM, XEN and Implementation – Cloudsim Toolkit IaaS Simulator.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Understand the basics of cloud computing, the architectural and storage needs and the challenges.
CO2: Know the different aspects of developing cloud services.
CO3: Understand the basics of cloud creation.
CO4: Know the concepts of storage and BIG data.
CO5: Identify the various deploying tools for cloud computing

REFERENCE BOOKS:

R1- Enterprise Cloud Computing by Gautam Shroff, Cambridge
R2- Cloud Computing for Dummies by Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper (Wiley India Edition).
R3- Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley-India
R4- Michael Miller, Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, August 2008.
R5- Haley Beard, Cloud Computing Best Practices for Managing and Measuring Processes for 6. On-demand Computing, Applications and Data Centers in the Cloud with SLAs, Emereo Pvt Limited, July 2008.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX326/16ENX324	CYBER SECURITY	3	0	0	3

Course Objective

1. To study the cyber security policy and evaluation.
2. To know about the Security Management Goals.
3. To study about Governance Issues.
4. To understand the concept of Management Issues.
5. To know how to Approach Cyber Security Policy.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Cyber Security – Cyber Security policy – Domain of Cyber Security Policy – Laws and Regulations– Enterprise Policy – Technology Operations – Technology Configuration - Strategy Versus Policy – Cyber Security Evolution – Productivity – Internet – E commerce – Counter Measures Challenges.	9
II	**CYBER SECURITY OBJECTIVES AND GUIDANCE** Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – Security Frameworks – E Commerce Systems – Industrial Control Systems – Personal Mobile Devices –Security Policy Objectives – Guidance for Decision Makers – Tone at the Top – Policy as a Project – Cyber Security Management – Arriving at Goals – Cyber Security Documentation – The Catalog Approach – Catalog Format – Cyber Security Policy Taxonomy.	9
III	**CYBER SECURITY POLICY CATALOG** Cyber Governance Issues – Net Neutrality – Internet Names and Numbers – Copyright and Trademarks – Email and Messaging - Cyber User Issues - Malvertising - Impersonation –Appropriate Use – Cyber Crime – Geo location – Privacy - Cyber Conflict Issues – Intellectual property Theft – Cyber Espionage – Cyber Sabotage – Cyber Welfare.	9
IV	**CYBER MANGEMENT ISSUES** Fiduciary Responsibility – Risk Management – Professional Certification – Supply Chain – Security Principles – Research and Development – Cyber Infrastructure Issue – Banking and finance – Health care – Industrial Control systems.	9
V	**CASE STUDY** A Government's Approach to Cyber Security Policy.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: To apply the evaluation of cyber security
CO2: To frame the Cyber security objectives.
CO3: To analyze the Governance Issues.
CO4: To manage the Issues of cyber security .
CO5: To analyze the Approach to Cyber Security Policy.

REFERENCE BOOKS:

R1- Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss "Cyber Security Policy Guidebook" John Wiley & Sons 2012.
R2- Rick Howard "Cyber Security Essentials" Auerbach Publications 2011.
R3- Richard A. Clarke, Robert Knake "Cyberwar: The Next Threat to National Security & What to Do About It" Ecco 2010
R4- Dan Shoemaker Cyber security The Essential Body Of Knowledge, 1st ed. Cengage Learning 2011.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX327/16ENX326	SOFTWARE DEFINED RADIO	3	0	0	3

Course Objective

1. To study about comprehensive knowledge of most technical aspects of SDR.
2. To understand the operations and applications of SDR
3. To know about up-to-date treatment of the latest technologies.
4. To study the system design implementations.
5. To know more about smart radio for future.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO SOFTWARE DEFINED RADIO** The Need for Software Defined Radios (SDR) - Definition, Characteristics and Benefits of a SDR- Architecture evolution of SDR – Foundations, technology tradeoffs and architecture implications - Antenna for Cognitive Radio - Design Principles of a Software Radio.	9
II	**FUNCTIONAL ARCHITECTURE OF SDR** Basics of SDR - Essential functions of SDR– Goals of architecture of SDR - Hardware and Software architecture of SDR - Computational properties of processing resources- Top level component topology- Interface topologies among plug and play modules - SDR as platform for cognitive radio.	9
III	**COGNITIVE RADIO** Introduction to Cognitive Radio - Motivation and Purpose - Marking radio self aware and cognitive techniques – Organization of Cognitive tasks -Enabling location and environment awareness in cognitive radios- Design Challenges associated with CR. - IEEE 802 Cognitive Radio related activities.	9
IV	**FUNCTIONAL ARCHITECTURE OF COGNITIVE RADIO** Cognitive Radio Capabilities-Cognitive Transceiver architecture - Radio Resource Allocation for Cognitive Radio - Spectrum Allocation in Cognitive Radio Networks -Spectrum Sensing – Spectrum Sharing – Spectrum Mobility – Spectrum Management – Regulatory issues – Emerging Cognitive Radio Applications in Cellular Networks.	9
V	**SMART RADIO FOR FUTURE** Dynamic Spectrum Access- Cognitive Cycle concept- Technologies supporting the Cognitive Radio Concept-Spectrum Awareness- Radio Spectrum models- Spectrum measurement techniques – Concept and architecture of TV White Spaces.	9
	TOTAL INSTRUCTIONAL HOURS	**45**

Course Outcome

CO1: To Analyze technical aspects of SDR.
CO2: To apply the concept of SDR.
CO3: To analyze the latest technologies.
CO4: To design architecture of cognitive radio.
CO5: To apply the smart radio concept.

REFERENCE BOOKS:

R1- Andreas F. Molisch, "Wireless Communications", 2nd Edition, John Wiley & Sons Ltd, 2011.

R2- H. Venkataraman, G. Muntean (editores). Cognitive Radio and its Application for Next Generation Cellular and Wireless Networks. 2013. Spriger, ISBN 978-94-007-1826-5.

R3- Markus Dillinger, "Software Defined Radio: Architectures, Systems and Functions", 2003.

R4- Alexander M. Wyglinski, Maziar Nekovee, And Y. Thomas Hou, " Cognitive Radio Communications And Networks - Principles And Practice", Elsevier Inc. , 2010.

R5- Huseyin Arslan , "Cognitive Radio, Software Defined Radio and Adaptive wireless system,Springer, 1 edition ,September 24, 2007.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX328/16ENX318	MICROWAVE INTEGRATED CIRCUITS	3	0	0	3

Course Objective

1. To study the transmission line of microwave integrated circuits.
2. To know about propagation models.
3. To learn about filter transformations and design.
4. To discuss about microstrip line components.
5. To review the application of microwave stripline.

Unit	Description	Instructional Hours
I	**PLANAR TRANSMISSION LINES** Planar Transmission Lines: Strip line - micro strip line - coplanar waveguide - coplanar strips slot line - fin line and characteristics - properties - design parameters and its applications; Technology of MICs: Monolithic and hybrid substrates - thin and thick film technologies -advantages and applications.	9
II	**MICROSTRIP LINES, ANALYSIS AND DESIGN** Introduction: Propagation models - analysis of micro strip line by conformal transformation - quasi static analysis and their characterization - numerical analysis - hybrid mode analysis - losses in microstrips.	9
III	**PLANAR PASSIVE COMPONENTS AND FILTERS** Lumped Elements in MICs: Planar inductors - capacitors - resistors using micro strip lines;Filters: Introduction - low pass to high Pass - band pass - band stop transformations -(Butterworth and Chebyshev responses) filter design.	9
IV	**MIC COMPONENTS DESIGN** 3dB Hybrid Design: Directional coupler - circulator - power divider - resonator; Realization using Microstrip line components.	9
V	**APPLICATIONS** Applications: Space - defense and wireless; Ferrite phase shifters and other components and Subsystems	9
	TOTAL INSTRUCTIONAL HOURS	**45**

Course Outcome

CO1: To analyze the planar transmission line.
CO2: To analyze the different types of propagation model.
CO3: To fabricate different lumped elements.
CO4: To design nonreciprocal components.
CO5: To apply the different technologies of microwave integrated circuits

REFERENCE BOOKS:

R1- Hoffman R. K., "Handbook of Microwave Integrated Circuits", Artech House, 1987.
R2- Gupta. K. C and R. Garg, "Microstrip Line and Slot Line", Artech House, 1996.
R3- Ravender Goyal, "Monolithic MIC; Technology & Design", Artech House, 1989.
R4- Gupta K.C. and Amarjit Singh, "Microwave Integrated Circuits", John Wiley, 1975.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX329/16ENX320	ASIC DESIGN	3	0	0	3

Course Objective

1. To study the design flow of different types of ASIC.
2. To familiarize the different types of programming technologies and logic devices.
3. To learn the Logic level design of Programmable ASIC.
4. To understand the synthesis, Simulation and testing of systems.
5. To know about different high performance algorithms and its applications in ASICs.

Unit	Description	Instructional Hours
	INTRODUCTION	
I	Preface: Full custom with ASIC - semi custom ASICs - standard cell based ASIC - gate array based ASIC - channeled gate array - channel less gate array - structured gate array -programmable logic device - FPGA design flow.	9
	DATA LOGIC CELLS AND LIBRARY DESIGN	
II	Data Path Elements: Adders - multiplier - arithmetic operator - I/O cell - cell compilers;Logical effort - practicing delay - logical area and logical efficiency logical paths – multistage cells - optimum delay - optimum no. of stages - library cell design.	9
	LOW-LEVEL DESIGN AND SCHEMATIC ENTRY, PROGRAMMABLE ASICs	
III	Hierarchical Design: Cell library - names - schematic - icons & symbols - nets; Schematic entry for ASICs - connections - vectored instances and buses - edit in place attributes - net list - screener - back annotation - programmable ASIC logic cell - ASIC I/O cell.	9
	LOW LEVEL DESIGN LANGUAGE, LOGIC SYNTHESIS	
IV	Introduction to EDIF: PLA tools - introduction to CFI designs representation; Half Gate ASIC: Introduction to synthesis and simulation - two level logic synthesis - high level logic synthesis	9
	CONSTRUCTION FLOOR PLANNING AND PLACEMENT AND ROUTING	
V	Physical Design: CAD tools - system partitioning - estimating ASIC size – partitioning methods; Floor planning tools - I/O and power planning - clock planning – placement algorithms - iterative placement improvement; Time driven placement methods – physical design flow global routing - local routing - detail routing - special routing - circuit extraction and DRC.	9
	TOTAL INSTRUCTIONAL HOURS	**45**

Course Outcome

CO1: To analyze the the design flow of of ASIC.
CO2: To identify the different types of programming technologies and logic devices.
CO3: To design the Programmable ASIC.
CO4: To analyse the synthesis, Simulation and testing of systems.
CO5: To apply the high performance algorithms in ASICs.

REFERENCE BOOKS:

R1- M. J. S .Smith, "Application – Specific Integrated Circuits", Pearson Education, 2003.

R2- Jose E. France and Yannis Tsividis, "Design of Analog Digital VLSI Circuits for Telecommunication and Signal Processing", Prentice Hall, 1994.

R3- Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization," Wiley-Blackwell, 2007.

R4- Roger Woods, John McAllister, Ying Yi and Gaye Lightbod, "FPGA-Based Implementation of Signal Processing Systems", Wiley, 2008.

R5- Nekoogar F, "Timing Verification of Application-Specific Integrated Circuits (ASICs)", Prentice Hall, 1999.

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Programme	Course code	Name of the course	L	T	P	C
M.E.	16CMX330/16ENX330	ROBOTICS	3	0	0	3

Course Objective

1. To understand robot locomotion and mobile robot kinematics.
2. To understand mobile robot localization.
3. To understand mobile robot mapping.
4. To understand simultaneous localization and mapping (SLAM).
5. To understand robot planning and navigation.

Unit	Description	Instructional Hours
I	**LOCOMOTION AND KINEMATICS** Introduction to Robotics – key issues in robot locomotion – legged robots – wheeled mobile robots –aerial mobile robots – introduction to kinematics – kinematics models and constraints – robot maneuverability	9
II	**ROBOT PERCEPTION** Sensors for mobile robots – vision for robotics – cameras – image formation – structure from stereo –structure from motion – optical flow – color tracking – place recognition – range data	9
III	**MOBILE ROBOT LOCALIZATION** Introduction to localization – challenges in localization – localization and navigation – belief representation – map representation – probabilistic map-based localization – Markov localization –EKF localization – UKF localization – Grid localization – Monte Carlo localization – localization in dynamic environments	9
IV	**MOBILE ROBOT MAPPING** Autonomous map building – occupancy grip mapping – MAP occupancy mapping – SLAM – extended Kalman Filter SLAM – graph-based SLAM – particle filter SLAM – sparse extended information filter – fastSLAM algorithm	9
V	**PLANNING AND NAVIGATION** Introduction to planning and navigation – planning and reacting – path planning – obstacle avoidance techniques – navigation architectures – basic exploration algorithms	9
	Total Instructional Hours	**45**

Course Outcome

CO1: To Apply kinematics models and constraints
CO2: To Implement vision algorithms for robotics.
CO3: To Implement robot localization techniques.
CO4: To Implement SLAM algorithms.
CO5: To Planning and navigation in robotics.

REFERENCE BOOKS:

R1- Roland Seigwart, Illah Reza Nourbakhsh, and Davide Scaramuzza, "Introduction to autonomous mobile robots", Second Edition, MIT Press, 2011.

R2- Sebastian Thrun, Wolfram Burgard, and Dieter Fox, "Probabilistic Robotics", MIT Press, 2005.

R3- Howie Choset et al., "Principles of Robot Motion: Theory, Algorithms, and Implementations", ABradford Book, 2005.

R4- Gregory Dudek and Michael Jenkin, "Computational Principles of Mobile Robotics", Second Edition, Cambridge University Press, 2010.

R5- Maja J. Mataric, "The Robotics Primer", MIT Press, 2007.

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OPEN ELECTIVES

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	16CMX401/16ENX311	NETWORK MANAGEMENT	3	0	0	3

Course Objective

1. To know the overview of network management.
2. To know the concepts of SNMP organizational model.
3. To classify types of broadband ATM networks.
4. To understand the concept of Network Management Tools.
5. To understand various Network Management Applications

Unit	Description	Instructional Hours
	OVERVIEW OF NETWORK MANAGEMENT	
I	Network Management: Goals, Organization and Functions, Network and system Management, OSInetwork management model- Organizational model-Information model, Communication model.Abstract Syntax Notation - Encoding Structure, Macros Functional Model CMIP/ CMIS.	9
	SNMP NETWORK MANAGEMENT	
II	SNMP - organizational model - system overview, information model, communication model -Functional model. SNMPv2 system architecture, SNMPv3 architecture, SNMP management: RMON.	9
	BROADBAND ATM NETWORKS	
III	ATM Technology - VP, VC, ATM Packet, Integrated service, ATMLAN emulation, Virtual LAN,ATM Network Management - ATM Network reference model, ATM Management Information base,ATM Management, M1, M2, M3, M4 interface.	9
	NETWORK MANAGEMENT TOOLS AND SYSTEMS	
IV	Network Management Tools, Network Statistics measurement systems, System management.	9
	NETWORK MANAGEMENT APPLICATIONS	
V	Configuration management, Fault management, Performance management, Event Correlation Techniques security management, Accounting management, Report Management, Policy Based Management, Services Level Management.	9
	Total Instructional Hours	45

Course Outcome

CO1: To Learn the concept of network management.
CO2: To Understand the behavior of SNMP organizational model.
CO3: To Classify types of broadband ATM networks.
CO4: To Analyze Network Management Tools.
CO5: To Know the Network Management Applications.

REFERENCE BOOKS:

R1. Mani Subramanian, "Network Management Principles and Practice", 2nd Edition Pearson Education India, 2010.

R2. Salah aiidarons, Thomas Plevayk, "Telecommunications Network Technologies and Implementations", Eastern Economy Edition IEEE press, New Delhi, 1998

R3. Lakshmi G Raman, "Fundamentals of Telecommunication Network Management", Eastern Economy Edition IEEE Press, New Delhi ,1999.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	16CMX402/ 16ENX313	RADAR AND NAVIGATIONAL AIDS	3	0	0	3

Course objective

1. To know about radar.
2. To understand the concept of Doppler Effect.
3. To detect the signal in noise.
4. To understand the mechanism of radio detection and ranges.
5. To understand the satellite navigation system

Unit	Description	Instructional Hours
I	**INTRODUCTION TO RADAR EQUATION** Introduction- Basic Radar –The simple form of the Radar Equation- Radar Block Diagram- Radar Frequencies –Applications of Radar – The Origins of Radar – Detection of Signals in Noise- Receiver Noise and the Signal-to-Noise Ratio- Probability Density Functions- Probabilities of Detection and False Alarm- Integration of Radar Pulses- Radar Cross Section of Targets- Radar cross Section Fluctuations- Transmitter Power-Pulse Repetition Frequency- Antenna Parameters- System losses – Other Radar Equation Considerations.	9
II	**MTI AND PULSE DOPPLER RADAR** Introduction to Doppler and MTI Radar- Delay –Line Cancellers- Staggered Pulse Repetition Frequencies –Doppler Filter Banks – Digital MTI Processing – Moving Target Detector – Limitations to MTI Performance – MTI from a Moving Platform (AMIT) – Pulse Doppler Radar – Other Doppler Radar Topics- Tracking with Radar –Monopulse Tracking –Conical Scan and Sequential Lobing – Limitations to Tracking Accuracy – Low-Angle Tracking – Tracking in Range – Other Tracking Radar Topics -Comparison of Trackers – Automatic Tracking with Surveillance Radars (ADT).	9
III	**DETECTION OF SIGNALS IN NOISE** Matched –Filter Receiver –Detection Criteria – Detectors –-Automatic Detector – Integrators – Constant-False-Alarm Rate Receivers – The Radar operator – Signal Management – Propagation Radar Waves – Atmospheric Refraction -Standard propagation – Nonstandard Propagation – The Radar Antenna – Reflector Antennas – Electronically Steered Phased Array Antennas – Phase Shifters – Frequency-Scan Arrays **Radar Transmitters and Receivers** – Introduction –Linear Beam Power Tubes – Solid State RF Power Sources – Magnetron – Crossed Field Amplifiers – Other RF Power Sources – Other aspects of Radar Transmitter.– The Radar Receiver – Receiver noise Figure – Super heterodyne Receiver – Duplexers and Receiver Protectors- Radar Displays.	9
IV	**RADIO DIRECTION AND RANGES** Introduction – Four methods of Navigation .– The Loop Antenna – Loop Input Circuits – An Aural Null Direction Finder – The Goniometer – Errors in Direction Finding – Adcock Direction Finders – Direction Finding at Very High Frequencies – Automatic Direction Finders – The Commutated Aerial Direction Finder – Range and Accuracy of Direction Finders – The LF/MF Four course Radio Range – VHF Omni Directional Range(VOR) – VOR Receiving Equipment – Range and Accuracy of VOR – Recent Developments. **Hyperbolic Systems of Navigation (Loran and Decca)** – Loran-A – Loran-A Equipment – Range and precision of Standard Loran – Loran-C – The Decca Navigation System -Decca Receivers – Range and Accuracy of Decca – The Omega System	9

V	**SATELLITE NAVIGATION SYSTEM** Distance Measuring Equipment – Operation of DME – TACAN – TACAN Equipment – Instrument Landing System – Ground Controlled Approach System – Microwave Landing System(MLS) The Doppler Effect – Beam Configurations - Doppler Frequency Equations – Track Stabilization – Doppler Spectrum – Components of the Doppler Navigation System – Doppler range Equation – Accuracy of Doppler Navigation Systems. Inertial Navigation – Principles of Operation – Navigation Over the Earth – Components of an Inertial Navigation System – Earth Coordinate Mechanization – Strapped-Down Systems – Accuracy of Inertial Navigation Systems-The Transit System – Navstar Global Positioning System (GPS).	9
	Total Instructional Hours	45

Course Outcome

CO1: To Learn the concept of radar.
CO2: To Understand the behavior of Doppler Effect.
CO3: To Detect the signal in noise.
CO4: To Analyze radio detection and ranges.
CO5: To Know the satellite navigation system.

REFERENCE BOOKS:

R1. Merrill I. Skolnik ," Introduction to Radar Systems", 3rd Edition Tata Mc Graw-Hill 2003.
R2. N.S.Nagaraja, "Elements of Electronic Navigation Systems", 2nd Edition, TMH, 2000.
R3. Peyton Z. Peebles:, "Radar Principles", John Wiley, 2004 2. J.C Toomay, " Principles of Radar", 2nd Edition –PHI, 2004

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