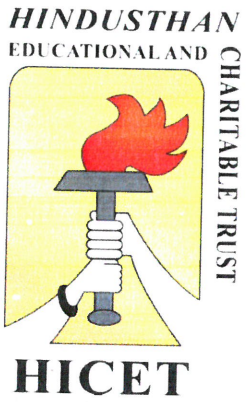
HINDUSTHAN COLLEGE OF ENGINEERING AND TECHNOLOGY

(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

2020-2021

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

ACADEMIC COUNCIL * HINDUSTHAN COLLEGE OF ENGG & TECH * Chairman

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HiCET

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

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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-2020

For the students admitted from 2020-21 onwards

SEMESTER I

S.No	CODE	Courses	CAT	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	20MA1102	Advanced Mathematics for Electrical and Electronics Engineering	PCC	3	0	0	3	40	60	100
2	20CM1201	Digital Modulation and coding Techniques	PCC	3	0	0	3	40	60	100
3	20CM1202	Advanced Digital Signal Processing	PCC	3	0	0	3	40	60	100
4	20CM1203	Optical Communication Networks	PCC	3	0	0	3	40	60	100
5	20CM1204	RF System Design	PCC	3	0	0	3	40	60	100
6	20CM1205	Research Methodology and IPR	RMC	3	0	0	3	40	60	100
7	20AC10XX	Audit Course I	AC	2	0	0	0	100	0	100
PRACTICAL COURSES										
8	20CM1001	Signal Processing and Communication Laboratory	PCC	0	0	4	2	50	50	100
Total Credits				**20**	**0**	**4**	**20**	**390**	**410**	**800**

SEMESTER II

S.No	CODE	Courses	CAT	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	20CM2201	Advanced Wireless Communication and Networks	PCC	3	0	0	3	40	60	100
2	20CM2202	Microwave Integrated Circuits	PCC	3	1	0	4	40	60	100
3	20CM23XX	Professional Elective I	PE	3	0	0	3	40	60	100
4	20CM23XX	Professional Elective II	PE	3	0	0	3	40	60	100
5	20CM23XX	Professional Elective III	PE	3	0	0	3	40	60	100
6	20AC20XX	Audit Course II	AC	2	0	0	0	100	0	100
PRACTICAL COURSES										
7	20CM2001	Communication Networks Laboratory	PCC	0	0	4	2	50	50	100
8	20CM2002	Mini Project / Internship	EEC	0	1	2	2	50	50	100
Total Credits				**17**	**2**	**6**	**20**	**400**	**400**	**800**

LIST OF PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVES

S. No.	Course Code	Course Title	CAT	L	T	P	C	CIA	ESE	TOTAL
1.	20CMX301	Information Theory and Coding Techniques	PE	3	0	0	3	40	60	100
2.	20CMX302	*Signal Estimation for wireless communication	PE	3	0	0	3	40	60	100
3.	20CMX303	Vehicular systems and Networks	PE	3	0	0	3	40	60	100
4.	20CMX304	Advanced Radiation Systems	PE	3	0	0	3	40	60	100
5.	20CMX305	Embedded and IOT	PE	3	0	0	3	40	60	100
6.	20CMX306	Wireless Senor Networks	PE	3	0	0	3	40	60	100
7.	20CMX307	Cognitive Radio Network	PE	3	0	0	3	40	60	100

8.	20CMX308	Micro-Electro Mechanical Systems	PE	3	0	0	3	40	60	100
9.	20CMX309	High Speed Switching and Network	PE	3	0	0	3	40	60	100
10.	20CMX310	Satellite Communication and Navigation Systems	PE	3	0	0	3	40	60	100
11.	20CMX311	Massive MIMO and mmWave Systems	PE	3	0	0	3	40	60	100
12.	20CMX312	Machine Learning	PE	3	0	0	3	40	60	100
13.	20CMX313	Communication Protocol for IOT	PE	3	0	0	3	40	60	100
14.	20CMX314	Speech Signal Processing	PE	3	0	0	3	40	60	100
15.	20CMX315	Multimedia Compression	PE	3	0	0	3	40	60	100
16.	20CMX316	Wavelets and Subband coding	PE	3	0	0	3	40	60	100
17.	20CMX317	Deep Learning	PE	3	0	0	3	40	60	100
18.	20CMX318	Spread Spectrum communication	PE	3	0	0	3	40	60	100
19.	20CMX319	Block chain and its applications	PE	3	0	0	3	40	60	100
20.	20CMX320	5G Technology	PE	3	0	0	3	40	60	100

LIST OF OPEN ELECTIVES

S. No.	Course Code	Course Title	CAT	L	T	P	C	CIA	ESE	TOTAL
1.	20CM34XX	Green Communication	OE	3	0	0	3	40	60	100
2.	20CM34XX	**Industrial IOT	OE	3	0	0	3	40	60	100

*Principles of Signal Estimation for MIMO/OFDM wireless communication (NPTEL course)

** Introduction to Industry 4.0 and Industrial Internet of Things (NPTEL course)

AUDIT COURSES SEMESTER - I

S.No	Course Code	Course Name	L	T	P	C
1	20AC1091	English for Research Paper writing	2	0	0	0
2	20AC1092	Disaster Management	2	0	0	0
3	20AC1093	Sanskrit for Technical knowledge	2	0	0	0
4	20AC1094	Value Education	2	0	0	0
5	20AC1095	Constitution of India	2	0	0	0

AUDIT COURSES SEMESTER - II

S.No	Course Code	Course Name	L	T	P	C
1	20AC2091	Pedagogy Studies	2	0	0	0
2	20AC2092	Stress Management by Yoga	2	0	0	0
3	20AC2093	Personality Development Through Life Enlightenment Skills	2	0	0	0
4	20AC2094	Unnat Bharat Abhiyan	2	0	0	0

REGULATION 2016

For the students admitted from 2019-20 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

R2016

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

R2020

Semester	I	II	III	IV	Total
Credits	20	20	18	12	70

Chairman, Board of Studies

Dean – Academics

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COIMBATORE - 641 032

SYLLABUS

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20MA1102	ADVANCED MATHEMATICS FOR ELECTRICAL AND ELECTRONICS ENGINEERING	3	0	0	3

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
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.	9
II	**LINEAR PROGRAMMING** Formulation - Graphical solution - Simplex method - Artificial variable Techniques - Transportation and Assignment Models	9
III	**SCHEDULING BY PERT AND CPM** Network Construction - Critical Path Method - Project Evaluation and Review technique - Resource Analysis in Network Scheduling.	9
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.	9
V	**FUZZY LOGIC AND FUZZY ALGEBRA** Basic principles of Fuzzy logic - Fuzzy sets of operations - Fuzzy membership Matrix.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

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

CO5: Apply the Fuzzy logic in power system problems.

REFERENCE BOOKS:

R1- Gupta S.C. and Kapoor V.K."Fundementals of Mathematical Statistics", Sultan an Sons,2001

R2- Prem Kumar Gupta,D.S.Hira,"Operations Research," S.Chand &Company Ltd, New Delhi,3rd edition,2008.

R3- Panner Selvam,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.	20CM1201	DIGITAL MODULATION AND CODING TECHNIQUES	3	0	0	3

Course Objective

1. To gain knowledge on various digital modulation schemes.
2. To gain thorough understanding of optimum detection.
3. To learn about the different coding schemes.
4. To understand the concepts of spread spectrum communication.
5. To learn about the communication through band limited channel.

Unit	Description	Instructional Hours
I	**DIGITAL MODULATION TECHNIQUES** Representation of Digitally Modulated signals, Memory less Modulation Methods, Signaling Schemes with Memory –CPFSK, CPM, Power Spectrum of Digitally Modulated Signals-PSD of a digitally modulated signal with memory, PSD of a linear modulated signal, PSD of a digitally modulated signal with Finite memory, PSD of a digitally modulation scheme with a Markov Structure.	9
II	**OPTIMUM RECEIVERS FOR AWGN CHANNEL** Waveform and vector channel Models, Waveform and vector AWGN channel, Optimal Detection and Error Probability for band limited Signaling, Optimal Detection and Error Probability for power limited signaling. Non-coherent detection of carrier modulated signals, Optimal Noncoherent detection of FSK modulated signals, Error probability of Orthogonal signaling with Noncoherent detection, Differential PSK (DPSK).	9
III	**CHANNEL CODING** BCH codes, Reed – Solomon Codes, Low Density Parity Check codes, Coding for channels with burst errors Interleavers, Combining Codes. Convolutional codes- Decoding of Convolutional codes- Distance properties of Convolutional codes, Turbo codes and iterative decoding, Trellis Coded Modulation.	9
IV	**SPREAD SPECTRUM COMMUNICATION** Model of Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Signals, Frequency-Hopped Spread Spectrum Signals, CDMA- Multi user detection in CDMA- Synchronization of SS systems.	9
V	**COMMUNICATION THROUGH BAND LIMITED CHANNELS** Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Optimum receiver for channels with ISI and AWGN. Equalization algorithms – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms. Reduced complexity ML detectors, Iterative equalization and decodingTurbo equalization.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Formulate a mathematical model for digital modulation schemes.

CO2: Design optimum coherent and non coherent receiver for digital modulation schemes

CO3: Apply mathematical modeling for BER analysis and Band width calculation of digital modulation schemes

CO4: Compare the performance of linear block codes

CO5: Design channel encoder and decoder based on the given specification using the channel coding algorithms.

REFERENCE BOOKS:

R1- John G. Proakis., and Masoud Salehi. "Digital Communication" , McGraw- Hill, International Edition 2008

R2-M.K.Simon, S.M.Hinedi and W.C.Lindsey, "Digital communication techniques; Signaling and detection", prentice Hall India, New Delhi.1995

R3- Simon Haykin, "Digital communications", John Wiley and sons, 2006

R4-B.P.Lathi "Modern digital and analog communication systems", 3rd Edition, Oxford University press 1998.

R5-Andrew J. Viterbi, "CDMA: Principles of Spread Spectrum Communications,"Prentice Hall, USA, 1995.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CM1202	ADVANCED DIGITAL SIGNAL PROCESSING	3	0	0	3

Course Objective

1.To study the basic operation of various signals and system
2.To learn the fundamentals of filters
3.To know the concepts of signal processing
4.To understand the concepts of various filter banks and spectrum analysis
5.To study the concepts and fundamentals of adaptive filter

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Classification of signals and systems – Properties of Systems – LTI Systems – Need for frequency domain analysis - Fourier transform for continuous and discrete time signals – Z-Transform - relationships between system representations - DFT – FFT - recursive and non-recursive filters – Linear phase FIR filters – Realization of FIR filters – finite word length effects in DSP system design	9
II	**MULTIRATE SIGNAL PROCESSING** Representation of discrete time signals – down sampling – up sampling - Noble identities – cascading sampling rate convertors - Decimation with transversal filters – interpolation with transversal filters – decimation with polyphase filters – interpolation with polyphase filters – decimation and interpolation with rational sampling factors - multistage implementation of sampling rate convertors.	9
III	**FILTER BANKS** Two channel filter banks - QMF filter banks - Perfect Reconstruction Filter banks - Filter banks with tree structure and parallel structure - Applications – speech and audio coding – image and video coding	9
IV	**POWER SPECTRUM ESTIMATION** Introduction – Non parametric methods - Periodogram – Modified Periodogram - Bartlett, Welch & Blackman Tukey methods - Performance comparison - Parametric methods - Auto Regressive (AR) spectrum estimation - Relationship between autocorrelation and model parameters – Moving Average and Auto Regressive Moving Average spectrum estimation.	9
V	**ADAPTIVE FILTERS:** Introduction – Applications – System identification – Inverse modeling – Prediction - Interference Cancellation- Adaptive linear combiner – Performance function – Gradient and Minimum Mean Square error – Gradient search by the method of steepest descent – LMS algorithm – convergence of LMS algorithm – Learning curve – Misadjustment – RLS algorithm	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to
CO1: Interpret functions of various systems and signals.
CO2: Analyze working and operation of different filter
CO3: Understand the concept of various signal processing.
CO4:Analyze and understand the power spectrum of different filters
CO5: Analyszeand understand the concepts of adaptive filter.

REFERENCE BOOKS:

R1-Fliege N J, "Multirate Digital Signal Processing", John Wiley and sons, 2010

R2-Vaidyanathan P P, "Multirate Systems and Filter banks", Prentice Hall, 2008.

R3-Ifeachor E C and Jervis B W, "Digital Signal Processing: A Practical Approach", Prentice Hall,2009

R4-Hayes M H, "Statistical Digital Signal Processing and Modeling ", Wiley, New York,2008

R5-Simon Haykin "Adaptive Filter Theory", Pearson education,2010

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CM1203	OPTICAL COMMUNICATION 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.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Interpret functions of various optical network components.
CO2: Analyze broadcast-and-select and wavelength routing networks
CO3: Understand the working of various power devices and display devices.
CO4: Explain photonic packet switching concepts and access networks
CO5: Analyze different network management functions.

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.	20CM1204	RF SYSTEM DESIGN	3	0	0	3

Course Objective

The student should be able to
1. Study the general behavior of RF design
2. Gain knowledge on RF filters.
3. Give thorough understanding on various RF components.
4. Provide knowledge on basic characteristics of RF amplifier
5. Impart knowledge on Oscillators and mixers.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO RF DESIGN** Importance of RF design, Electromagnetic Spectrum, RF behavior of passive Components, Chip components and Circuit Board considerations, Scattering Parameters, Smith Chart and applications.	9
II	**RF FILTER DESIGN** Overview , Basic resonator and filter configuration, Special filter realizations, Filter implementations, Coupled filter.	9
III	**ACTIVE RF COMPONENTS & APPLICATIONS** RF diodes, BJT, RF FETs, High electron mobility transistors; Matching and Biasing Networks – Impedance matching using discrete components, Microstripline matching networks, Amplifier classes of operation and biasing networks	9
IV	**RF AMPLIFIER DESIGNS** Characteristics, Amplifier power relations, Stability considerations, Constant gain circles, Constant VSWR circles, Broadband , high power and multistage amplifiers	9
V	**OSCILLATORS, MIXERS & APPLICATIONS** Basic Oscillator model, High frequency oscillator configuration, Basic characteristics of Mixers, Phase Locked Loops , RF couplers Wilkinson divider and Lange coupler , Detector and demodulator circuits.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1:Describe the various active and passive components of RF circuits
CO2;Analyze the microstrip line filters
CO3: Analyze the biasing methods for RF amplifiers
CO4: Design matching networks using smith chart.
CO5:Compare various Oscillators for their performance.

REFERENCE BOOKS:

R1 - Reinhold Ludwig and Powel Bretchko, "RF Circuit Design – Theory and Applications", Pearson Education Asia, First Edition, 2001

R2 - Joseph . J. Carr, "Secrets of RF Circuit Design" , McGraw Hill Publishers, Third Edition, 2000.

R3 - Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education Asia, Second Edition, 2002.

R4 - Ulrich L. Rohde and David P. NewKirk, "RF & Microwave Circuit Design", John Wiley & Sons USA 2000.

R5 - Roland E. Best, "Phase - Locked Loops : Design, simulation and applications", McGraw Hill Publishers 5th edition 2003

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CM1205	RESEARCH METHODOLOGY AND IPR	3	0	0	3

Course Objective

1.To impart knowledge and skills required for research and IPR:
2.Problem formulation, analysis and solutions.
3.Technical paper writing / presentation without violating professional ethics
4.Patent drafting and filing patents.

Unit	Description	Instructional Hours
I	**RESEARCH PROBLEM FORMULATION** -Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations	9
II	**LITERATURE REVIEW** Effective literature studies approaches, analysis, plagiarism, and research ethics	9
III	**TECHNICAL WRITING /PRESENTATION** Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.	9
IV	**INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)** Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	9
V	**INTELLECTUAL PROPERTY RIGHTS (IPR)** Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to
CO1:Ability to formulate research problem
CO2:Ability to carry out research analysis
CO3:Ability to follow research ethics
CO4:Ability to understand that today's world is controlled by Computer, Information Technology, but
CO5:tomorrow world will be ruled by ideas, concept, and creativity
CO6:Ability to understand about IPR and filing patents in R & D.

REFERENCE BOOKS:

R1- Asimov, "Introduction to Design", Prentice Hall, 1962

R2- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

R3- Mayall, "Industrial Design", McGraw Hill, 1992
R4- Niebel, "Product Design", McGraw Hill, 1974.

R5- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

Chairman - BoS
ECE - HiCET

Dean (Academics)
HiCET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CM1001	SIGNAL PROCESSING AND COMMUNICATION LABORATORY	0	0	4	2

Course Objective

1. To design IIR filters
2. To effectively remove the noise during transmission
3. To analyze the signals in the frequency domain using subbands.
4. To estimate the noise signals.
5. To implement digital modulation techniques.

S.NO	LIST OF EXPERIMENTS
	Simulation using MATLAB / EQUIVALENT SOFTWARE PACKAGE
1.	IIR Filter Design
2.	Noise Cancellation
3.	Echo Cancellation
4.	Multirate signal processing
5.	Subband Coding of Speech Signals
6.	Estimate the PSD of a noisy signal using periodogram and modified periodogram
7.	Generation & detection of binary digital modulation techniques
8.	Performance evaluation of simulated CDMA system
9.	Spread Spectrum communication system - Pseudo random binary sequence generation
10.	Channel equalizer design

TOTAL HOURS 45

Course Outcome

After completion of the course the learner will be able to

CO1: Design filter for processing specific frequency bands
CO2: Implement the adaptive filtering algorithms
CO3: Estimate and predict the noise for effective communication
CO4: generate and detect digital communication signals of various modulation techniques
CO5: Evaluate cellular mobile communication technology and propagation model

Chairman - BoS
ECE - TRICET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CM2201	ADVANCED WIRELESS COMMUNICATION 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 management.

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 Networksee (PANs)- The Internet- Virtual Private Networks (VPNs) - Network Topologies- Choosing the Right Topology- Network Hardware 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.	9
	Total Instructional Hours	**45**

Chairman - BoS
ECE - HICET

Dean (Academics)
HICET

Course Outcome	**After completion of the course the learner will be able to** 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.

Chairman - BoS
ECE - BHCET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CM2202	MICROWAVE INTEGRATED CIRCUITS	3	1	0	4

Course Objective

1. To study and understand the purpose of planar transmission lines and components at microwave frequencies
2. To understand and design various impedance matching networks using lumped and distributed elements
3. To enable the student to understand and design different microwave amplifiers and oscillators
4. To study and understand the mixer and control circuits used at microwave frequencies
5. To understand the various techniques used in Microwave IC Design and Measurements

Unit	Description	Instructional Hours
I	**PLANAR TRANSMISSION LINES AND COMPONENTS** Review of Transmission line theory – S parameters-Transmission line equations – reflection coefficient – VSWR – Microstrip lines: Structure, waves in microstrip, Quasi-TEM approximation, Coupled lines: Even mode and odd mode analysis – Microstrip discontinuities and components – Strip line – Slot line – Coplanar waveguide – Filters – Power dividers and Couplers	12
II	**IMPEDANCE MATCHING NETWORKS** Circuit Representation of two port RF/Microwave Networks: Low Frequency Parameters, High Frequency Parameters, Transmission Matrix, ZY Smith Chart, Design of Matching Circuits using Lumped Elements, Matching Network Design using Distributed Elements	12
III	**MICROWAVE AMPLIFIER AND OSCILLATOR DESIGN** Characteristics of microwave transistors – Stability considerations in active networks – Gain Consideration in Amplifiers – Noise Consideration in active networks – Broadband Amplifier design – Oscillators: Oscillator versus Amplifier Design – Oscillation conditions – Design and stability considerations of Microwave Transistor Oscillators.	12
IV	**MIXERS AND CONTROL CIRCUITS** Mixer Types – Conversion Loss – SSB and DSB Mixers – Design of Mixers: Single Ended Mixers – Single Balanced Mixers – Sub Harmonic Diode Mixers, Microwave Diodes, Phase Shifters – PIN Diode Attenuators	12
V	**MICROWAVE IC DESIGN AND MEASUREMENT TECHNIQUES** Microwave Integrated Circuits – MIC Materials- Hybrid versus Monolithic MICs – Multichip Module Technology – Fabrication Techniques, Miniaturization Techniques, Introduction to SOC, SOP, Test Fixture Measurements, Probe Station Measurements, Thermal and Cryogenic Measurements, Experimental Field Probing Techniques.	12
	Total Instructional Hours	**60**

Course Outcome

After completion of the course the learner will be able to

CO1: Understand the theory of transmission lines used at microwave frequencies
CO2: Design and analyze various impedance matching networks using microwave components.
CO3: Perform stability analysis and be able to design amplifiers and oscillators at microwave frequencies.
CO4: Understand and analyze various the mixer and control circuits used at microwave frequencies
CO5: Perform stability analysis in the design of microwave amplifiers and oscillators

REFERENCE BOOKS:

R1- Jia Sheng Hong, M. J. Lancaster, "Microstrip Filters for RF/Microwave Applications", John Wiley & Sons, 2001
R2- David M. Pozar, "Microwave Engineering", II Edition, John Wiley & Sons, 1998
R3- Guillermo Gonzalez, "Microwave Transistor Amplifiers – Analysis and Design", II Edition, Prentice Hall, New Jersy
R4- Thomas H.Lee, "Planar Microwave Engineering", Cambridge University Press, 2004
R5- Matthew M. Radmanesh, "Radio Frequency and Microwave Electronics", Pearson Education, II Edition 2002
R6- Ravender Goyal, "Monolithic MIC; Technology & Design", Artech House, 1989.
R7- Gupta K.C. and Amarjit Singh, "Microwave Integrated Circuits", John Wiley, New York, 1975
R8- Hoffman R.K. "Handbook of Microwave Integrated Circuits", Artech House, Boston, 1987

Chairman - BoS
ECE - RICET

Dean (Academics)
RICET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CM2001	COMMUNICATION NETWORKS LABORATORY	0	0	4	2

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 understand MIMO system and match with the theoretical concepts.
4. To interpret MC-CDMA system Bit Error Rate
5. To understand the functioning of IP network and TCP protocols in Wireless Environment.

Exp.No.	Description of the Experiments
1.	Path loss Measurement and Characterization of Wireless Channels
2.	Wireless Channel equalizer design (ZF / LMS / RLS) using Simulation Packages.
3.	OFDM transceiver design using Simulation Packages.
4.	Simulation of MIMO systems using Simulation Packages.
5.	Analysis of Bit Error Rate of MC-CDMA System
6.	Cellular network modelling and performance analysis in terms of Blocking Probability and Spectral Efficiency.
7.	Implement wireless to wireless communication using wireless protocol.
8.	Algorithms to implement packet forwarding/ packet classification/packet switching in IP Routers
9.	Implement applications using TCP & UDP sockets like (i) DNS (ii)SNMP (iii) File Transfer
10.	Simulating a Mobile Adhoc Network using Wifi Network
	Total Practical Hours **45**

Course Outcome

After completion of the course the learner will be able to

CO1: Design and analyse the multipath fading channels and diversity.

CO2: Design and implement BER performance of OFDM scheme

CO3: Analyze the performance of MIMO for multi carrier system.

CO4. Analyze the performance of MC-CDMA system.

CO5: Design and implement communication protocol for different functionalities

Chairman - BoS
ECE - RICET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX301	INFORMATION THEORY AND CODING TECHNIQUES	3	0	0	3

Course Objective

1. To review the fundamentals of various coding techniques
2. To acquire knowledge on iteratively decoded codes
3. To impart knowledge on various low density parity check codes
4. To understand the design of LDPC decoders
5. To learn the design principles of space-time coding techniques

Unit	Description	Instructional Hours
I	**BCH AND REED-SOLOMON CODES** BCH codes - Reed-Solomon codes - Decoding BCH and RS codes - finding the Error Locator Polynomial - Non-binary BCH and RS Decoding - Erasure decoding for Non-binary BCH and RS codes - Galois field Fourier Transform method - variations and extensions of Reed-Solomon codes.	9
II	**ITERATIVELY DECODED CODES** Construction and Notation - Tanner Graphs - Transmission through Gaussian Channel - Decoding LDPC codes - The iterative decoder on General Block Codes - Density Evolution - EXIT charts for LDPC codes - Irregular LDPC codes- LDPC code construction - Encoding LDPC codes - Low-Density Generator Matrix codes - Serial Concatenated codes- Repeat - Accumulate codes - Irregular RA codes.	9
III	**LOW DENSITY PARITY CHECK CODES** EG-LDPC codes - PG-LDPC codes - Shortened finite geometry LDPC codes - Gallager LDPC codes - Masked EG-Gallager LDPC codes - Quasi-cyclic codes by circulant decomposition - Random LDPC codes - Graph - Theoretic LDPC codes - Construction of LDPC codes based on Balanced incomplete block designs - Concatenations with LDPC and Turbo codes.	9
IV	**DESIGN OF LDPC DECODERS** An Overview of Trellis - coded Modulation - Capacity of Two-dimensional Signal Sets-Bit-interleaved Trellis Coded Modulation Based on Turbo and -LDPC Codes - Design of Flexible Inter-leavers and Parity - check Matrices - Puncturing Strategies - Parallel Architectures for High-speed Decoders and Their Implementation.	9
V	**SPACE-TIME CODING** Introduction - Fading Channels - Diversity Transmission and Reception: the MIMO channel - Space-time block codes - complex orthogonal Designs - Space-time trellis codes.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Analyze various source coding and decoding techniques
CO2: Analyze various iteratively decoded codes and their techniques
CO3: Understand and analyze various low density parity check codes.
CO4: Understand the design of LDPC decoders.
CO5: Understand the design principles and solve problems using space-time coding techniques

REFERENCE BOOKS:

R1-Todd K Moon, "Error Correction Coding: Mathematical Methods and Algorithms", Wliey, 2005
R2-Richard B Wells, "Applied Coding and Information Theory for Engineers", Prentice Hall, 1999.
R3-Peter Sweeney, "Error Control Coding: From Theory to Practice", Wiley,2002.
R4-Shu Lin, Daniel J. Costello, "Error control coding", 2nd Edition, Pearson,2005

Chairman - BoS
UCE - BSCBT

Dean (Academic Affairs)
BSCBT

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX303	VEHICULAR SYSTEMS AND NETWORK	3	0	0	3

Course Objective

The student should be able to

1. To understand the basic concepts of vehicular networks and the applications.
2. To describe MAC protocols and heterogeneous wireless communication used in vehicular networks.
3. To explain the various routing protocols and IP address configuration.
4. To analyze message scheduling.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO VEHICULAR NETWORK** Vehicular network definition, special characteristics, technical challenges, Evolution and progress, Vehicular network application and services, public safety application, vehicular traffic coordination, road traffic management.	9
II	**MAC PROTOCOLS & HETEROGENEOUS WIRELESS COMMUNICATION** DSRC spectrum and applications for vehicular networks, IEEE standards for MAC protocols - A cluster based, A distributed MAC protocol, Priority based secure MAC protocol, Introduction to heterogeneous wireless communications, enabling technologies for vehicular communication networks, platform for design and simulation.	9
III	**ROUTING IN VEHICULAR NETWORKS** Challenges and requirements for routing protocols, classification, basic solutions, Map based solutions, based on trajectories, based on traffic information. Adhoc IP address auto configuration problem, IP address auto configuration solution requirements, Analysis of solution space, IP address auto configuration in vehicular networks	9
IV	**MESSAGE SCHEDULING** Context and motivations, congestion control approaches, dynamic message scheduling, Analysis and validation	9
V	**NETWORK MOBILITY** The network mobility problem, NEMO basic support protocol, NEMO route optimization, NEMO in vehicular scenario, Mobile ADhoc NEMO.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1 : Understand the basic concepts of vehicular networks and the applications.

CO2 : Understand MAC protocols and heterogeneous wireless communication used in vehicular networks.

CO3 : Evaluate the routing protocols and IP address configuration.

CO4 : Analyze message scheduling and network mobility problem in vehicular networks

REFERENCE BOOKS:

R1-HassnaaMoustafa and Yan Zhang, — Vehicular networks – Techniques, Standards and applications‖ CRC Press, New York, 2009

R2-StephenOlariu and Michele C Weigle, — Vehicular networks – From theory to Practice‖, CRC Press, New York, 2009.

R3 - H. Hartensteinand K. P. Laberteaux, —VANET: Vehicular Applications and InterNetworking Technologies, Wiley, 2010

R4-C. Sommer, F. Dressler, —Vehicular Networking‖,Cambridge University Press, 2015

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX304	ADVANCED RADIATION SYSTEMS	3	0	0	3

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	**MEASUREMENT TECHNIQUES AND APPLICATIONS** Antenna Impedance and Radiation Measurements-Antennas for biomedical applications - smart antennas for mobile communications – antenna for infrared detectors - marine applications - plasma antennas.	12
	Total Instructional Hours	**60**

Course Outcome

After completion of the course the learner will be able to

CO1:Understand the fundamentals behind the 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:Identify the antennas specific to the applications

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.

Chairman - BoS
ECE - RICET

ACADEMIC COUNCIL Chairman

Dean (Academic)
RICET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX305	EMBEDDED AND IOT	3	0	0	3

Course Objective

The student should be able to

1. Understand and acquire knowledge on the architecture of embedded systems.
2. Understand the different peripheral devices, Communication buses and Protocols.
3. Understand the evolution of Internet of Things (IoT).
4. Understand different cloud servers and APP development tools.
5. Apply the concept of Internet of Things in real world scenario.

Unit	Description	Instructional Hours
I	**COMPONENTS OF EMBEDDED SYSTEMS** Introduction to Embedded Systems Embedded Design Life Cycle. Overview of ARM Processors. Functional block diagram of ARM Cortex-A, Cortex-R and Cortex-M series controllers and its features.	9
II	**PERIPHERAL INTERFACING TECHNIQUES** Memory Management - Program Memory, Data Memory. AHB and APB Bus Structure. GPIOs, Timer/Counters, Capture/Compare Modules, PWM, QEI, RTC, WDT, DMA, EEPROM and PLL. Serial Peripherals: UART, I2C, SPI, CAN and USB. Hardware and Software Interrupts, Analog Peripherals: ADC, DAC and Analog Comparators.	9
III	**INTERNET OF THINGS** Introduction, IoT protocols: MQTT and AMQP, IoT Security: AES and TLS1.2, FOTA, Consumer Electronics IoT, Automotive IoT, Health Care IoT and Industrial IoT.	9
IV	**CLOUD AND APP FACILITIES FOR IoT** Amazon Web Services Cloud (AWS), MS Azure, IBM Bluemix, Carriots and Thing Speak, GE predix. MIT App Inventor and Android App Development tools.	9
V	**CASE STUDY** Simple problems simulation using IDE, Smart Sensors Interfacing, Experimenting Serial Communication Protocols, Remote Monitoring and Control through Web Browser using WiFi, Cloud based Data Analysis.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Describe the architecture of embedded system and compare various embedded processors.
CO2: Understand and compare various communication protocols.
CO3: Describe the concepts of IoT.
CO4: Describe cloud servers and APP development.
CO5: Analyze applications of IoT in real time scenario.

REFERENCE BOOKS:

R1 - Arshdeep Bahga and Vijai Madisetti "Internet of Things: A Hands-on Approach", Bahga & Madisetti, 2014

R2 - Jonathan W. Valvano, "Embedded Systems: Real-Time Interfacing to Arm(r) Cortex -M Microcontrollers: Volume 2", Create Space Independent Publishing Platform, 2012.

R3 - Jonathan W. Valvano, "Embedded Systems: Real-Time Interfacing to Arm(r) Cortex -M Microcontrollers: Volume 1", Create Space Independent Publishing Platform, 2011.

R4 - Steve Furber," ARM System-on-Chip Architecture", Prentice Hall of India, New Delhi, 2009

R5 - Arnold S. Berger, "Embedded Systems Design: An Introduction to Processes, Tools, and Techniques" CMP Books, 2002.

R6 - Tiva TM4C123GH6PM Microcontroller Datasheet.

Chairman - BoS
RICET

Dean (Academics)
RICET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX306	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 learn tools 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 between mobile ad-hoc and sensor networks, Applications of sensor networks-Enabling Technologies for Wireless Sensor Networks.	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

After completion of the course the learner will be able to

CO1: Able 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.

Chairman - BoS
ECE - HiCET

Dean (Academics)
HiCET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX307	COGNITIVE RADIO NETWORK	3	0	0	3

Course Objective

1. To understand the fundamentals of Software Defined radio and compare various SDR platforms.
2. To enable the student to understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation.
3. To enable the student to understand the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication.
4. To analyze the various methods of implementing the Cognitive Radio functions
5. To exemplify the research challenges in designing a Cognitive Radio Network and the applications

Unit	Description	Instructional Hours
I	**SOFTWARE DEFINED RADIO AND ITS ARCHITECTURE** Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications. Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.	9
II	**COGNITIVE RADIOS AND ITS ARCHITECTURE** Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques, Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architechture.	9
III	**SPECTRUM SENSING AND IDENTIFICATION** Overview-Classification-Matched Filter , waveform based sensing - cyclo stationary based sensing -Energy detector based sensing - Radio Identifier - Cooperative Sensing -Spectrum Opportunity Detection , Fundamental Trade-offs: Performance versus Constraint , MAC Layer Performance Measures, Global Interference Model, Local Interference Model, Fundamental Trade-offs: Sensing Accuracy versus Sensing Overhead.	9
IV	**USER COOPERATIVE COMMUNICATIONS** User Cooperation and Cognitive Systems , Relay Channels: General Three-Node Relay Channel, Wireless Relay Channel , User Cooperation in Wireless Networks: Two-User Cooperative Network, Cooperative Wireless Network , Multihop Relay Channel	9
V	**INFORMATION THEORETICAL LIMITS ON CR NETWORKS** Types of Cognitive Behavior, Interference-Avoiding Behavior: Spectrum Interweave, Interference-Controlled Behavior: Spectrum Underlay, Underlay in Small Networks: Achievable Rates, Underlay in Large Networks: Scaling Laws, Interference-Mitigating Behavior: Spectrum Overlay, Opportunistic Interference Cancellation, Asymmetrically Cooperating Cognitive Radio Channels.	9
	Total Instructional Hours	**45**

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Course Outcome

After completion of the course the learner will be able to

CO1: Appreciate the motivation and the necessity for cognitive radio communication strategies.

CO2: Demonstrate understanding of the enabling technologies for its implementation

CO3: Demonstrate understanding of the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication.

CO4: Evolve new techniques and demonstrate their feasibility using mathematical validations and simulation tools.

CO5: Interpret the impact of the evolved solutions in future wireless network design.

REFERENCE BOOKS:

R1- . Alexander M. Wyglinski, Maziar Nekovee, And Y. Thomas Hou, "Cognitive Radio Communications and Networks - Principles And Practice", Elsevier Inc. , 2010.

R2 - Kwang-Cheng Chen and Ramjee Prasad, "Cognitive Radio Networks", John Wiley & Sons, Ltd, 2009.

R3 -. Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, "Cognitive Radio Networks - From Theory to Practice", Springer Series, Analog Circuits and Signal Processing, 2009.

R4- J. Mitola, "Cognitive Radio: An Integrated Agent Architecture for software defined radio", Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.

R5- Simon Haykin, "Cognitive Radio: Brain –empowered wireless communications", IEEE Journal on selected areas in communications, Feb 2005.

R6- Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, "Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey Elsevier Computer Networks", May 2006.

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ECE - HICET

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ACADEMIC COUNCIL

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HICET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX308	MICRO-ELECTRO MECHANICAL SYSTEMS	3	0	0	3

Course Objective

1. To introduce students with concepts of MEMS products, sensors and fabrication.
2. To study about mechanics for MEMS design.
3. To Study about the electro static design and system issues for MEMS.
4. To understand the MEMS applications.
5. To understand the concepts of RF MEMS and optical MEMS.

Unit	Description	Instructional Hours
I	**UNIT I INTRODUCTION TO MEMS** MEMS and Microsystems, Miniaturization, Typical products, Micro sensors, Micro actuation, MEMS with micro actuators, Micro-accelerometers and Micro fluidics, MEMS materials, Micro fabrication	9
II	**UNIT II MECHANICS FOR MEMS DESIGN** Elasticity, Stress, strain and material properties, Bending of thin plates, Spring configurations, torsional deflection, Mechanical vibration, Resonance, Thermo mechanics – actuators, force and response time, Fracture and thin film mechanics	9
III	**UNIT III ELECTRO STATIC DESIGN AND SYSTEM ISSUES** Electrostatics: basic theory, electro static instability. Surface tension, gap and finger pull up, Electro static actuators, Comb generators, gap closers, rotary motors, inch worms, Electromagnetic actuators. Bi-stable actuators. Electronic Interfaces, Feedback systems, Noise , Circuit and system issues	9
IV	**UNIT IV MEMS APPLICATION** Case studies – Capacitive accelerometer, Peizo electric pressure sensor, Micro-fluidics application, Modeling of MEMS systems, CAD for MEMS.	9
V	**UNIT V INTRODUCTION TO OPTICAL AND RF MEMS** Optical MEMS, - System design basics – Gaussian optics, matrix operations, resolution. Case studies, MEMS scanners and retinal scanning display, Digital Micro mirror devices. RF Memes – design basics, case study – Capacitive RF MEMS switch, performance issues	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Able to demonstrate an understanding of the different aspects of micro-system design.
CO2: Familiar with Mechanical and the Electrostatic design aspects
CO3: Familiar with the different applications and their design basics
CO4: In a position to identify a suitable MEMS structure, material and fabrication procedure based on the application and functionality.
CO5: Capable of applying his knowledge and design tools and will be well practiced in design skills.

REFERENCE BOOKS:

R1 - Stephen Santeria, "Microsystems Design", Kluwer publishers, 2000.
R2 - N.P.Mahalik, "MEMS",Tata McGraw hill, 2007
R3 - Nadim Maluf, "An introduction to Micro electro mechanical system design", Artech House, 2000
R4 - Mohamed Gad-el-Hak, "The MEMS Handbook", CRC press Baco Raton,2000.
R5 - Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture", Tata McGraw Hill, New Delhi, 2002.

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ECE - HiCET

Dean (Academics)
HiCET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX309	HIGH SPEED SWITCHING AND NETWORK	3	0	0	3

Course Objective

1. To understand the basics of switching technologies and their implementation LANs, ATM networks and IP networks
2. To understand the different queuing strategies and their impact on the blocking performances.
3. To understand the concepts of various packet switching architectures
4. To learn the fundamentals of Optical Switching Architectures
5. To exploit and integrate the best features of different architectures for high speed switching.

Unit	Description	Instructional
I	**UNIT I LAN SWITCHING TECHNOLOGY** Switching Concepts, LAN Switching, switch forwarding techniques - cut through and store and forward, Layer 3 switching, Loop Resolution, Switch Flow control, virtual LANs. .	9
II	**UNIT II QUEUES IN HIGH SPEED SWITCHES** Internal Queueing -Input, output and shared queueing, multiple queueing networks – combined Input, output and shared queueing - performance analysis of Queued switches	9
III	**UNIT III PACKET SWITCHING ARCHITECTURES** Architectures of Internet Switches and Routers- Bufferless and buffered Crossbar switches, Multi-stage switching, Optical Packet switching; Switching fabric on a chip; Internally buffered Crossbars	9
IV	**UNIT IV. OPTICAL SWITCHING ARCHITECTURES** Need for Multilayered Architecture-, Layers and Sub-layers, Spectrum partitioning, Optical Network Nodes, Network Access Stations, Overlay Processor, Logical network overlays, Connection Management and Control	9
V	**UNIT 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

After completion of the course the learner will be able to

CO1: Familiar with the basics of switching technologies and their implementation in LANs, ATM , IP and Optical networks.
CO2: Familiar with the different switching architectures and queuing strategies
CO3: Able to analyze switching networks based on their blocking performances and implementation complexities.
CO4: Able to identify suitable switch architectures for a specified networking scenario
CO5: To apply switching technologies, architectures and buffering strategies for designing high speed communication networks and analyse their performance

REFERENCES BOOKS

R1-AchillePattavina, "Switching Theory: Architectures and performance in Broadband ATM networks ",John Wiley & Sons Ltd, New York. 1998

R2-Thomas E. Stern, Georgios Ellinas, Krishna Bala, "Multiwavelength Optical Networks – Architecture, Design and control" , Cambridge University Press, 2nd Edition, 2009.

R3- Rich Siefert, Jim Edwards, "The All New Switch Book – The Complete Guide to LAN Switching Technology", Wiley Publishing, Inc., 2nd Edition, 2008.

R4-Elhanany M. Hamdi, "High Performance Packet Switching architectures", Springer Publications, 2007.

R5-Christopher Y Metz, "Switching protocols & Architectures", McGraw - Hill Professional Publishing, New York, 1998.

R6-Rainer Handel, Manfred N Huber, Stefan Schroder, "ATM Networks - Concepts Protocols, Applications", Addison Wesley, New York, 3rd Edition, 1999

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MCB - HICET

Dean (Academics)
HICET

Programme	Course Code	Name of the Course	L	T	P	C
ME	20CMX310	SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS	3	0	0	3

Course Objective

The student should be able to
Understand the necessity for satellite based communication, the essential elements involved and the transmission methodologies.
Understand the different interferences and attenuation mechanisms affecting the satellite link design.
Expose the advances in satellite based navigation, GPS and the different application scenarios.

Unit	Description	Instructional Hours
I	**ELEMENTS OF SATELLITE COMMUNICATION** Satellite Systems, Orbital description and Orbital mechanics of LEO, MEO and GSO, Placement of a Satellite in a GSO, Antennas and earth coverage, Altitude and eclipses, Satellite drift and station keeping, Satellite – description of different Communication subsystems, Bandwidth allocation.	9
II	**SATELLITE SPACE SEGMENT AND ACCESS** Introduction; attitude and orbit control system; telemetry, tracking and command; power systems, communication subsystems, antenna subsystem, equipment reliability and space qualification, Multiple Access: Demand assigned FDMA - spade system - TDMA - satellite switched TDMA –CDMA.	9
III	**SATELLITE LINK DESIGN** Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design: System noise temperature and G/T ratio, Downlink and uplink design, C/N, Link Design with and without frequency reuse, link margins, Error control for digital satellite link.	9
IV	**SATELLITE BASED BROADBAND COMMUNICATION** VSAT Network for Voice and Data – TDM/TDMA, SCPC/DAMA, Elements of VSAT Network, Mobile and Personal Communication Services, Satellite based Internet Systems, Multimedia Broadband Satellite Systems, UAVs.	9
V	**SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM** Radio and Satellite Navigation, GPS Position Location Principles of GPS Receivers and Codes, Satellite Signal Acquisition, GPS Receiver Operation and Differential GPS, INS, Indian Remote Sensing and ISRO GPS Systems.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Demonstrate an understanding of the basic principles of satellite based communication the essential elements involved and the transmission methodologies.
CO2: Familiarize with satellite orbits, placement and control, satellite link design and the communication system components.
CO3: Demonstrate an understanding of the different interferences and attenuation mechanisms affecting the satellite link design.
CO4: Demonstrate an understanding of the different communication, sensing and navigational applications of satellite.
CO5: Familiarize with the implementation aspects of existing satellite based systems

REFERENCE BOOKS:

R1 - Wilbur L. Pritchard, Hendri G. Suyderhoud and Robert A. Nelson, "Satellite Communication Systems Engineering", Prentice Hall/ Pearson, 2007.

R2 - Timothy Pratt and Charles W.Bostain, "Satellite Communications", John Wiley and Sons, 2nd Edition, 2012.

R3 - D.Roddy, "Satellite Communication", McGraw Hill, 4th Edition (Reprint), 2009.

R4 - Tri T Ha, "Digital Satellite Communication", McGraw Hill, 2nd Edition, 1990.

R5 - B.N.Agarwal, "Design of Geosynchronous Spacecraft", Prentice Hall, 1993.

R6 - Brian Ackroyd, "World Satellite Communication and Earth Station Design", BSP Professional Books, 1990.

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ECE - KCET

Dean (Academics)
KCET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX311	MASSIVE MIMO AND mmWAVE SYSTEMS	3	0	0	3

Course Objective

- To understand the principles and challenges involved in the design of Massive MIMO systems
- To understand the propagation aspects of Millimeter wave signals and the fundamentals of Millimeter wave devices and circuits.
- To understand the various components of Millimeter wave MIMO systems.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Massive MIMO: principles, characteristics and transmission/detection techniques; Channel hardening in large dimensions,- Channel Models – Effect of spatial correlation – Channel Estimation – Pilot contamination in massive MIMO – Implementation challenges and Standardization.	9
II	**PRECODING IN LARGE MIMO SYSTEMS** SVD precoding, Precoding in a multiuser MIMO downlink –Linear precoding- Linear precoding, Non-linear precoding, Precoding in large multiuser MISO systems, Multicell precoding.	9
III	**mmWAVE PROPAGATION** Millimeter wave characteristics- millimeter wave wireless, implementation challenges, Radio wave propagation for mm wave: Large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Emerging applications of millimeter wave communications.	9
IV	**mmWAVE COMMUNICATION SYSTEMS** Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM, Millimeter wave link budget, Transceiver architecture, Transceiver without mixer, Receiver without Oscillator, millimeter wave calibration, production and manufacture, Millimeter wave design considerations.	9
V	**mmWAVE MIMO SYSTEMS** Massive MIMO Communications, Spatial diversity of Antenna Arrays, Multiple Antennas, Multiple Transceivers, Noise coupling in MIMO system, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation, Beamforming for MmWave communications: Analog beamforming, digital beamforming and hybrid Beamforming.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Ability to appreciate Massive MIMO: characteristics and implementation challenges
CO2: Understand the need and impact of different precoding approaches
CO3: Ability to characterize propagation issues at Millimeter wave frequencies
CO4: Ability to estimate link budget and identity Millimeter wave devices and circuits specifications
CO5: Understand and appreciate the various implementation aspects of mmWave MIMO systems.

REFERENCE BOOKS:

R1- Chockalingam and B. Sundar Rajan, " Large MIMO Systems ", Cambridge University Press, 2014.

R2- Ezio Biglieri, Robert Calderbank, Anthony Constantinides, Andrea Goldsmith, Arogyaswami Paulraj, Vincent Poor, "MIMO Wireless Communications", Cambridge University Press, 2006.

R3- I. Robertson, N. Somjit and M. Chongcheawchamnan, "Microwave and Millimetre-Wave Design for Wireless Communications", 2016.

R4- T.S. Rappaport, R.W. Heath Jr., R.C. Daniels and J.N. Murdock, "Millimeter Wave Wireless Communications: Systems and Circuits", 2015.

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HiCET

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HiCET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX312	MACHINE LEARNING	3	0	0	3

Course Objective

1. To study the Mathematical background of machine learning.
2. To enable the student to understand the concept of machine learning.
3. To learn the fundamentals of different Neural network architectures.
4. To know the machine learning application in wireless communication and bio-medical.
5. To expose the student to be familiar with a set of well-known supervised, semi-supervised and unsupervised learning algorithms

Unit	Description	Instructional Hours
I	**MATHEMATICAL BACKGROUND** Linear Algebra – Arithmetic of matrices, Norms, Eigen decomposition, Singular value decomposition, Pseudo inverse, Component analysis. Probability theory – probability distribution, conditional probability, Chain rule, Bayes rule, Information theory, Structured Probabilistic models.	9
II	**MACHINE LEARNING BASICS** Supervised and Unsupervised learning, Capacity, Overfitting and Underfitting, Cross Validation, Linear regression, Logistic Regression, Regularization, Naive Bayes, Support Vector Machines (SVM), Decision tree, Random forest, K-Means Clustering, k nearest neighbor.	9
III	**NEURAL NETWORKS** Feedforward Networks , Back propagation, Convolutional Neural Networks-LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Back propagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks. Recurrent Neural Network(RNN) – Back propagation through time (BPTT), Vanishing and Exploding Gradients.	9
IV	**ML IN WIRELESS AND SECURITY** Water-filling power allocation, Optimization for MIMO Systems, OFDM Systems and MIMO-OFDM systems. Optimization in beamformer design – Robust receive beamforming, Transmit downlink beamforming. Application: Radar for target detection, Array Processing, MUSIC, ML in Side channel analysis.	9
V	**ML IN BIO-MEDICAL** Machine Learning in Medical Imaging. Deep Learning for Health Informatics. Deep Learning Automated ECG Noise Detection and Classification System for Unsupervised Healthcare Monitoring. Techniques for Electronic Health Record (EHR) Analysis.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Demonstrate understanding of the mathematical principles underlying machine learning.
CO2: Familiar with the different machine learning techniques and their use cases.
CO3: In a position to formulate machine learning problems corresponding to different applications.
CO4: Able to recognize the characteristics of machine learning techniques that are useful to solve real-world problems.
CO5: In a position to read current research papers, understand the issues and the machine learning based solution approaches.

REFERENCE BOOKS:

R1-Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep learning",Cambridge,MA, MIT Press, 2017.

R2-Tom M. Mitchell, "Machine Learning", McGraw Hill, 1997.

R3-Ethem Alpaydın, "Introduction to machine learning", MIT Press, 3rd Edition, 2014.

R4-M. N. Wernick, Y. Yang, J. G. Brankov, G. Yourganov and S. C. Strother, "Machine Learning in Medical Imaging", IEEE Signal Processing Magazine, vol. 27, no. 4, pp. 25-38, July 2010.

R5-Ravi et al., "Deep Learning for Health Informatics," IEEE Journal of Biomedical and Health Informatics, vol. 21, no. 1,

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HiCET

pp. 4-21, Jan. 2017.

R6-U. Satija, B. Ramkumar and M. S. Manikandan, "Automated ECG Noise Detection and Classification", IEEE Journal of Biomedical and Health Informatics PP(99), March 2017.

R7-"System for Unsupervised Healthcare Monitoring," IEEE Journal of Biomedical and Health Informatics, vol. 22, no. 3, pp. 722-732, May 2018.

R8-B. Shickel, P. J. Tighe, A. Bihorac and P. Rashidi, "Deep EHR: A Survey of Recent Advances in Deep Learning Techniques for Electronic Health Record (EHR) Analysis," IEEE Journal of Biomedical and Health Informatics, vol. 22, no. 5, pp. 1589-1604, Sept. 2018.

R9-A. Heuser, S. Picek, S. Guilley and N. Mentens, "Lightweight Ciphers and their Side-channel Resilience," IEEE Transactions on Computers.

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ECE - SVCET

Dean (Academics)
SVCET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX313	COMMUNICATION PROTOCOL FOR IOT	3	0	0	3

Course Objective

1. To learn the fundamentals IoT
2. To understand the design principles of IoT
3. To compare and analyze different standards for IoT
4. To give exposure to M2M Architecture and Light weight protocols
5. To design and Implement IoT applications

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Internet of things overview, Design principles for connected devices, Web thinking for connected devices, Internet Principles.	9
II	**6LOWPAN AND RPL**: 6LoWPAN and RPL Standardization Adaptation Layer RPL Downward Routes, Multicast Membership, Packet Routing	9
III	**ZIGBEE SMART ENERGY 2.0**: REST Overview, ZigBee SEP 2.0 Overview, Function Sets and Device Types, ZigBee SE 2.0 Security	9
IV	**ETSI M2M ARCHITECTURE:** Introduction to ETSI TC M2M, System Architecture, ETSI M2M Interactions Overview, Security in the ETSI M2M Framework, Interworking with Machine Area Networks	9
V	**COAP AND MQTT**: Constrained application protocol overview, RFC 7252, MQTT basics, Developing Projects , connecting to server ,Controlling Output Devices.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Study the introduction of IoT.
CO2: Ability to understand the concepts of 6LOWPAN and RPL
CO3: Understand the working of various Zigbee function and security.
CO4: Explain different architecture of M2M
CO5: Analysze different output devices

REFERENCE BOOKS:

R1 - Adrian McEwen,Hakim Cassimally ‖Designing the Internet of Things‖ John Wiley and Sons, Ltd , 2014.

R2 - Olivier Hersent, David Boswarthick, Omar Elloumi —The Internet of Things: Key Applications and Protocols‖, 2nd Edition John Wiley & Sons Ltd 2012
R3 - Peter Waher —Learning Internet of Things‖ 2015 Packt Publishing.

R4 - Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle —From Machine-to-Machine to the Internet of Things‖ Introduction to a New Age of Intelligence , Academic Press 2014

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BOS - HICET

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HICET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX314	SPEECH SIGNAL PROCESSING	3	0	0	3

Course Objective

The student should be able to

CO1: Study the mechanism and model of speech production
CO2: Apply auditory transforms Techniques
CO3: Estimate LPC parameters and Feature extraction of of speech signal
CO4: Illustrate Speech synthesis
CO5: Apply various algorithms for speech and audio signal processing

Unit	Description	Instructional Hours
I	**MECHANISM OF SPEECH** Introduction : Speech processing and application - Voice production Mechanism - Physiological and Mathematical Model – Nature of Speech signal - Acoustic Phonetics – Acoustics of speech production – Discrete time modeling of Speech production – Representation of Speech signals – Categorization of Speech Sounds based on the source-system and the articulatory model - Articulatory features.	9
II	**SPEECH SIGNAL PROCESSING CONCEPTS** Discrete time speech signals, Fast Fourier transform and Z-transform for speech recognition, Convolution - Linear and Non linear filter banks. Spectral estimation of speech using the Discrete Fourier transform. Pole-zero modeling of speech and linear prediction (LP) analysis of speech. Homomorphic speech signal de convolution, real and complex cepstrum, application of cepstral analysis to speech signals..	9
III	**LINEAR PREDICTIVE ANALYSIS AND FEATURE EXTRACTION 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 – pattern recognition methods for Pitch detection – Vocoders : CELP - VELP – Feature Extraction - MFCC, LPCC - Speech distortion measures :mathematical and perceptual – Log–Spectral Distance, Cepstral Distances,	9
IV	**UNIT V SPEECH SYNTHESIS** Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, hidden Markov model-based TTS, context dependent sub-word units for TTS, intelligibility and naturalness – role of prosody, Applications and current status.	9
V	**APPLICATION OF SPEECH & AUDIO SIGNAL PROCESSING** Spectral Estimation – Spectral enhancement algorithm, dynamic time warping – Music analysis – Pitch Detection –Feature Extraction for ASR - Auditory models – Speaker identification and verification – Voice response system – voice over IP.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Describe the fundamentals of speech and Model speech production.
CO2: Estimate the different parameters and analysis in speech signal.
CO3: Implement linear predictive analysis and extract features of speech signal.
CO4: Build speech synthesis systems.
CO5: Choose an appropriate algorithm in speech model for a given application.

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Dean (Academics)

REFERENCE BOOKS:

R1 - Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.

R2 - Thomas F Quatieri, "Discrete-Time Speech Signal Processing – Principles and Practice", Pearson 2012

R3 - B. Gold and N. Morgan, "Speech and Audio Signal Processing: Processing and perception of speech and music", Wiley, Second edition,2011

R4 - L. R. Rabiner and Schaffer, "Digital Processing of Speech signals Pearson Education", 2004

R5 - Heiga Zen, Keiichi Tokuda, Alan W. Black, "Statistical Parametric Speech Synthesis", Speech Communication, Vol. 51, Issue 11, Nov. 2009, pp. 1039 - 1064.

R6 - J.L.Flanagan, "Speech analysis: Synthesis and Perception", 2nd edition, Berlin, 1972.

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ECE - HICET

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Dean (Academics)
HICET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX315	MULTIMEDIA COMPRESSION	3	0	0	3

Course Objective

The student should be conversant with

1. To introduce the significance of data compression and the idea of various Huffman codes.
2. To develop the knowledge of generating tags, deciphering the tag in Arithmetic coding approaches,and the application of static and dynamic dictionary approaches.
3. To introduce the concept of Audio compression and various audio compression standards and its applications.
4. To understand the need, concept of 2D and 3D compression and to develop the knowledge of various recent compression standards and techniques.
5. To introduce the concept of Video compression and various Video compression standards and its applications.

Unit	Description	Instructional Hours
I	**UNIT I INTRODUCTION** Compression Techniques - Overview of information theory - lossless and lossy coding– Modeling and Coding - Taxonomy of compression techniques – Rate distortion theory - Huffman coding – Non-Binary Huffman codes – adaptive Huffman coding – Application of Huffman coding.	9
II	**UNIT II ARITHMETIC CODING AND DICTIONARY TECHNIQUES** Introduction- coding a sequence – generating deciphering the tag – Generating a binary code – Uniqueness of arithmetic code – Algorithm, integer implementation – comparison of Huffman and arithmetic coding – Applications -Static and Adaptive dictionary – LZ77, LZ78, LZW approach – Applications - Facsimile encoding – run length coding – comparison of MH, MR, MMR and JBIG. Scalar and Vector Quantization	9
III	**UNIT III AUDIO COMPRESSION** Audio compression techniques - frequency domain and filtering - basic sub-band coding - application to speech coding - G.722 - application to audio coding - MPEG audio - silence suppression - speech compression techniques –Vocoders.	9
IV	**UNIT IV IMAGE COMPRESION** Predictive techniques - DPCM, DM - KL transform – discrete cosine, Walsh- Hadamard transform - JPEG, Wavelet based compression: quad-trees, EZW, SPIHT, JPEG-2000	9
V	**UNIT V VIDEO COMPRESSION** Video signal representation – Motion compensation – MPEG standards - Motion estimation techniques - H.261 family of standards - Motion video compression.	9
	Total Instructional Hours	**45**

Course Outcome

After the completion of the course, the learner will be able to

CO1: Able to differentiate different coding techniques.
CO2: Able to understand different arithmetic coding techniques.
CO3: Able to illustrate different audio compression standards
CO4: Able to illustrate different Image compression standards
CO5: Able to differentiate different video compression standards

REFERENCE BOOKS:

R1.-Salomon D, —Data Compression The Complete Reference‖, Springer, 2007.

R2- Salomon D, —A Guide to Data Compression Methods‖, Springer, 2002.

R3-Jan Vozer, —Video Compression for Multimedia‖, AP Press, New York, 1995.

R4-Alistar Moffat, —Compression and Coding Algorithms‖, Kluwer Academic Publishers, 2002.

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ECE - KSRCET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX316	WAVELETS AND SUBBAND CODING	3	0	0	3

Course Objective

1. To study the analysis of various transform
2. To learn the fundamentals of Continuous Wavelet Transforms
3. To learn the fundamentals of Discrete Wavelet Transforms
4. To understand the concepts of various advanced wavelet techniques
5. To design applications based on wavelets

Unit	Description	Instructional Hours
I	**INTRODUCTION** Signal spaces - concept of Convergence - Hilbert spaces for energy signals. Fourier basis & Fourier Transform – Limitations of standard Fourier analysis – Need for Time-Frequency Analysis, Spectrogram plot – Windowed Fourier transform Tiling of the Time-Frequency Plane for STFT – Heisenberg"s Uncertainty principle – Short time Fourier transform (STFT) Analysis- short comings of STFT- Need for Wavelets.	9
II	**CONTINUOUS WAVELET TRANSFORMS (CWT)** Introduction, Continuous Time wavelets, Definition of CWT, The CWT as a correlation, Constant Q-Factor Filtering Interpolation and time frequency resolution, the CWT as an operator, inverse CWT.	9
III	**DISCRETE WAVELET TRANSFORM (DWT) AND MRA** Introduction,Approximation of vectors in nested linear vector spaces, example of an MRA-Bases for the approximations subspaces and Haar scaling function, Bases for detail subspaces and Haar wavelet, Formal definition of an MRA, Construction of a general orthonormal MRA, A wavelet basis for MRA, Interpreting orthonormal MRAs for Discrete time signals, Daubechies Wavelets, Relationship between Filter banks and wavelet basis, Important wavelets: Haar, Mexican hat, Meyer, Shannon, Daubechies	9
IV	**ADVANCED TOPICS** Wavelet packets, Non - separable multidimensional wavelets, Bi-orthogonal basis-B-Splines, Lifting scheme of wavelet generation, Multiwavelets, Ridgelets, Curvelets.	9
V	**APPLICATIONS OF WAVELETS** Signal Denoising - Sub-band coding of Speech and music– Image Compression using 2-D DWT- JPEG 2000 standard - Fractal Signal Analysis.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Interpret analysis on various transform.
CO2: Understand fundamentals of Continuous Wavelet Transforms
CO3: Understand the fundamentals of Discrete Wavelet Transforms
CO4: Explain concepts of various advanced wavelet techniques
CO5: design applications based on wavelets

REFERENCE BOOKS:

R1 - Soman K P and Ramachandran K I, "Insight into Wavelets from Theory to Practice", Prentice Hall India, 2010

R2 - Jaideva C Goswami and Andrew K Chan, "Fundamentals of Wavelets – Theory, Algorithms and Applications", John Wiley and Sons, Inc., Singapore, 1999.

R3 - Fliege. N J, "Multirate Digital Signal Processing", John Wiley and Sons, Newyork,1994.

R4 - Wornell G W, "Signal Processing with Fractals: A Wavelet based Approach", Prentice Hall, 1995.

R5 - Vetterli M and Kovacevic J, "Wavelets and Subband Coding," Prentice Hall, 1995.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX317	DEEP LEARNING	3	0	0	3

Course Objective

1. Introduce to the basic concepts of neural networks.
2. Identify and analyze the various types of neural networks and models of neuron and apply accordingly.
3. Introduce the concept of deep learning and its types.
4. Explore the concepts of applications of deep learning.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO NEURAL NETWORKS** Characteristics of Neural Networks, Historical Development of Neural Networks Principles, Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, Pattern Recognition Tasks by the Functional Units. Introduction, Analysis of pattern Association Networks, Analysis of Pattern Classification Networks, Analysis of pattern storage Networks. Analysis of Pattern Mapping Networks.	9
II	**FEEDBACK NEURAL NETWORKS** Introduction, Analysis of Linear Auto associative FF Networks, Analysis of Pattern Storage Networks. Competitive Learning Neural Networks & Complex pattern Recognition Introduction, Analysis of Pattern Clustering Networks, Analysis of Feature Mapping Networks, Associative Memory.	9
III	**FUNDAMENTALS OF DEEP LEARNING** Defining Deep Learning, Common architectural principles of Deep Networks, Building Blocks of Deep Networks, and Major architectures of Deep Networks: Unsupervised Pretrained Networks, Convolution Neural Networks (CNNs), Recurrent Neural Networks.	9
IV	**CONVOLUTION NEURAL NETWORKS** The convolution operation, motivation, pooling, Convolution and Pooling as an Infinitely Strong Prior, Applications of deep learning: Large scale deep learning, Computer vision, Speech Recognition, Natural Processing, other applications.	9
V	**SEQUENTIAL MODELLING** Recurrent neural networks: Recursive neural networks, The long short –term Memory, explicit memory, Auto encoders: Under complete, regularised, Stochastic Encoders and Decoders, Denoising Auto encoders	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1:Analyze and apply the basic the concepts of neural networks
CO2:Analyze various types of neural networks and use various activation functions to solve complex problems.
CO3:Relate the concept of deep learning and its architecture.
CO4:Design and carry out empirical analysis for various types of applications of deep learning systems.

REFERENCE BOOKS:

R1 - Neural Networks by Simon Haykin PHI
R2 - Deep learning (Adaptive computation &Machine learning) by Ian Good Fellow, YoshuaBengio, AranCourville.
R3 - Fundamentals of Neural Networks: Architectures, Algorithms and Applications, by Fausett..

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX318	SPREAD SPECTRUM COMMUNICATION	3	0	0	3

Course Objective

1. Understand the concept of Spread Spectrum and study various types of Spread spectrum sequences and their generation.
2. Understand the principles of Code Division Multiple Access (CDMA) and use of Spread spectrum concept in CDMA
3. Understand various Code tracing loops for optimum tracking of wideband signals viz spread spectrum signals
4. Understand the procedure for synchronization of receiver for receiving the Spread spectrum signal.
5. Study the performance of spread spectrum systems in Jamming environment, systems with Forward Error Correction and Multiuser detection in CDMA cellular radio.

Unit	Description	Instructional Hours
I	Introduction to Spread Spectrum Systems: Fundamental Concepts of Spread Spectrum Systems, Pseudo Noise Sequences, Direct Sequence Spread Spectrum, Frequency Hop Spread Spectrum, Hybrid Direct Sequence Frequency Hop Spread Spectrum, Code Division Multiple Access. Binary Shift Register Sequences for Spread Spectrum Systems Introduction, Definitions, Mathematical Background and Sequence Generator Fundamentals, Maximal Length Sequences, Gold Codes.	9
II	Code Tracking Loops: Introduction, Optimum Tracking of Wideband Signals, Base Band Delay-Lock Tracking Loop, Tau-Dither Non- Coherent Tracking Loop, Double Dither Non-Coherent Tracking Loop.	9
III	Initial Synchronization of the Receiver Spreading Code: Introduction, Problem Definition and the Optimum Synchronizer, Serial Search Synchronization Techniques, Synchronization using a Matched Filter, Synchronization by Estimated the Received Spreading Code.	9
IV	Cellular Code Division Multiple Access (CDMA) Principles: Introduction, Wide Band Mobile Channel, The Cellular CDMA System, Single User Receiver in a Multi User Channel, CDMA System Capacity, Multi-User Detection in CDMA Cellular Radio, Optimal Multi-User Detection, Linear Suboptimal Detectors, Interference Combat Detection Schemes, Interference Cancellation Techniques.	9
V	Performance of Spread Spectrum Systems in Jamming Environments Spread Spectrum, Communication System Model, Performance of Spread Spectrum Systems without Coding. Performance of Spread Spectrum Systems with Forward Error Correction Elementary Block Coding Concepts, Optimum Decoding Rule, Calculation of Error Probability, Elementary Convolution Coding Concepts, Viterbi Algorithm, Decoding and Bit-Error Rate.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1:Ability to understand the concept of Spread Spectrum and study various types of Spread spectrum sequences and their generation.

CO2: Ability to understand the principles of Code Division Multiple Access (CDMA) and use of Spread spectrum concept in CDMA

CO3:Ability to understand various Code tracing loops for optimum tracking of wideband signals viz spread spectrum signals

CO4: Ability to understand the procedure for synchronization of receiver for receiving the Spread spectrum signal.

CO5:Study the performance of spread spectrum systems in Jamming environment, systems with Forward Error Correction and Multiuser detection in CDMA cellular radio.

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REFERENCE BOOKS:

R1-Rodger E Ziemer, Roger L. Peterson and David E Borth - "Introduction to Spread Spectrum Communication-Pearson, 1st Edition, 1995.

R2-Mosa Ali Abu-Rgheff – "Introduction to CDMA Wireless Communications." Elsevier Publications, 2008

R3-George R. Cooper, Clare D. Mc Gillem - "Modern Communication and Spread Spectrum," McGraw Hill, 1986.

R4-Andrew j. Viterbi - "CDMA: Principles of spread spectrum communication," Pearson Education, 1st Edition, 1995.

R5-Kamilo Feher - "Wireless Digital Communications," PHI, 2009. 4. Andrew Richardson - "WCDMA Design Handbook," Cambridge University Press, 2005. 5. Steve Lee - Spread Spectrum CDMA, McGraw Hill, 2002.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX319	BLOCK CHAIN AND ITS APPLICATIONS	3	0	0	3

Course Objective

1.To understand the need for Blockchain
2.To Explore the major components of Blockchain
3. To Learn about Hyperledger Fabric model and its Architecture
4. To Identify the use cases for a Blockchain application

Unit	Description	Instructional Hours
I	Introduction to Blockchain: Digital Money to Distributed Ledgers , Design Primitives: Protocols, Security, Consensus, Permissions, Privacy. Blockchain Architecture and Design: Basic crypto primitives: Hash, Signature,) Hashchain to Blockchain, Basic consensus mechanisms	9
II	Consensus: Requirements for the consensus protocols, Proof of Work (PoW), Scalability aspects of Blockchain consensus protocols Permissioned Blockchains:Design goals, Consensus protocols for Permissioned Blockchains	9
III	Hyperledger Fabric (A): Decomposing the consensus process , Hyperledger fabric components, Chaincode Design and Implementation Hyperledger Fabric (B): Beyond Chaincode: fabric SDK and Front End (b) Hyperledger composer tool	9
IV	Use case 1 : Blockchain in Financial Software and Systems (FSS): (i) Settlements, (ii) KYC, (iii) Capital markets, (iv) Insurance Use case 2: Blockchain in trade/supply chain: (i) Provenance of goods, visibility, trade/supply chain finance, invoice management discounting, etc	9
V	Use case 3: Blockchain for Government: (i) Digital identity, land records and other kinds of record keeping between government entities, (ii) public distribution system social welfare systems Blockchain Cryptography, Privacy and Security on Blockchain	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: Ability to understand the need for Blockchain
CO2: Ability to explore the major components of Blockchain
CO3: Ability to learn about Hyperledger Fabric model and its Architecture
CO4: Ability to identify the use cases for a Blockchain application

REFERENCE BOOKS:

R1- 1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos, ISBN: 978-1-449-37404-4,2014

R2- Blockchain by Melanie Swa, O'Reilly , Publisher(s): O'Reilly Media, ,2015,ISBN:9781491920480

R3-Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits.

https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX320	5G TECHNOLOGY	3	0	0	3

Course Objective

1. To introduce students with concepts, design issues in 5G networks.
2. To study about architectures and protocols and the state-of-the–art developments in next generation wireless network technologies.
3. To Study various Multiple Access techniques for wireless channels.
4. To understand the relevance of MIMO techniques.
5. To analyze different types of cooperative communications.

Unit	Description	Instructional Hours
I	**5G CHANNEL MODEL** Modeling requirements and scenarios, Channel model requirements and Measurements, Propagation scenarios, METIS channel models, Map-based model, stochastic model, Comparison of Models	9
II	**MULTI-CARRIER WAVEFORMS FOR 5G** Filter-bank based multi-carrier (FBMC)- Principles, Transceiver block diagram, Frame structure, Resource structure, allocation, mapping. Universal filtered multi carrier (UFMC)- Principles, Transceiver structure, Frame and Resource structure, allocation, mapping. Generalized frequency division multicarrier (GFDM) – Principles, Transceiver Block diagram, Frame structure, Resource structure, allocation, mapping, MIMO-GFDM.	9
III	**MULTIPLE ACCESS TECHNIQUES IN 5G** Challenges in OFDM- NOMA – Principle- Superposition Coding, Successive Interference Cancellation, Power Domain NOMA, Sparse Code NOMA- types, Power Domain Sparse Code NOMA, Cooperative NOMA- Benefits and Challenges.	9
IV	**MASSIVE MIMO** Introduction-pilot design and channel estimation- uplink data transmission and downlink data transmission for Single cell systems and multi cell systems – capacity analysis.	9
V	**COOPERATIVE COMMUNICATION** Machine Type Communication (MTC), Device to Device Communication (D2D), 5G Narrowband IoT, Cloud Computing architecture and Protocols, Relaying: Cooperative NOMA- Benefits and Challenges, Half duplex relaying, Full duplex relaying, Amplify and forward relaying, Decode and forward relaying, Decode and forward relaying with PLNC, BER Analysis, Capacity Analysis.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Able to analyze the performance of different channel models adopted in 5G wireless systems.
CO2: Able to design a transceiver for Multicarrier waveforms.
CO3: Able to analyze multiple access techniques in 5G networks
CO4: Able to design a pilot, estimate channels and analyze capacity for single cell and multicell Massive MIMO
CO5: Able to analyze different types of cooperative communications.

REFERENCE BOOKS:

R1-AfifOsseiran, Jose.F.Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.

R2-Robert W. Heath Jr., Nuria González-Prelcic, SundeepRangan, WonilRoh,and Akbar M. Sayeed, "An Overview of Signal Processing Techniques for Millimeter Wave MIMO Systems", IEEE Journal of Selected Topics in Signal Processing, Vol. 10, No. 3, April 2016

R3-MinChulJu and Il-Min Kim, "Error Performance Analysis of BPSK Modulation in Physical- Layer Network-Coded Bidirectional Relay Networks", IEEE Transactions on Communications, Vol. 58, No. 10, October 2010.

R4-Shengli Zhang, Soung-Chang Liew, Patrick P.Lam, "Physical Layer Network Coding", Mobicom _06, Proceeding of the 12th International Conference on Mobile Computing and Networking, pp.358-365, Los Angeles, CA, USA, Sep.23-29,2006

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Dean

OPEN ELECTIVE

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CM34XX	GREEN COMMUNICATION	3	0	0	3

Course Objective

1. To study about fundamentals of green radio networks.
2. To impart the importance of reducing energy consumption.
3. To learn about CO2 emissions and inculcate green concepts for energy efficient approaches.
4. To study about the power management technique.
5. To understand the concept of designing next generation wireless networks.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Fundamental Tradeoffs on the Design of Green Radio Networks: Insight from Shannon's capacity formula - impact of practical constraints - latest research and directions; Algorithms for Energy Harvesting Wireless Networks: Energy harvesting technologies - PHY and MAC layer optimization for energy harvesting wireless networks.	9
II	**GREEN MODULATION AND CODING** Modulation: Green modulation and coding schemes in energy constrained wireless networks - energy consumption of uncoded scheme - energy consumption analysis of LT coded modulation.	9
III	**CO-OPERATIVE TECHNIQUES** Co-operative Techniques for Energy Efficient Wireless Communications: Energy efficiency metrics for wireless networks – co-operative networks - optimizing the energy efficiency performance of co-operative networks - energy efficiency in co-operative base stations.	9
IV	**BASE STATION POWER MANAGEMENT TECHNIQUES** Base Station Power Management Techniques for Green Radio Networks: Opportunistic spectrum and load management for green radio networks - energy saving techniques in cellular wireless base stations - power management for base stations in a smart grid environment.	9
V	**WIRELESS ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS** Cross Layer Design: Adaptive packet scheduling for green radio networks - energy efficient relaying for cooperative cellular wireless networks - energy performance in TDD CDMA multihop cellular networks - resource allocation for green communication in relay based cellular networks.	9
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able to

CO1: To gain the knowledge about green radio networks
CO2: To work with green modulation and coding technique.
CO3: To apply the energy efficiency technique with wireless networks
CO4: To analyze the radio techniques to reduce the overall energy consumption.
CO5: To design new green radio architectures

REFERENCE BOOKS:

R1-Ekram Hossain, Vijay K. Bhargava and Gerhard P. Fettweis, "Green RadioCommunication Networks", Cambridge University Press, 2012.

R2-F. Richard Yu, Yu, Zhang and Victor C. M. Leung "Green Communications andNetworking", CRC press, 2012.

R3-Mohammad S. Obaidat, Alagan Anpalagan and Isaac Woungang, "Handbook of Green Information and Communication Systems", Academic Press, 2012.

R4-Jinsong Wu, Sundeep Rangan and Honggang Zhang, "Green Communications:Theoretical Fundamentals, Algorithms and Applications", CRC Press, 2012.

R5-Mazin Al Noor, "Green Radio Communication Networks Applying Radio-Over-FibreTechnology for Wireless Access", GRIN Verlag, 2012.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20AC1091	ENGLISH FOR RESEARCH PAPER WRITING	2	0	0	0

Course Objective

1. Teach how to improve writing skills and level of readability
2. Tell about what to write in each section
3. Summarize the skills needed when writing a Title 4. Infer the skills needed when writing the Conclusion 5. Ensure the quality of paper at very first-time submission

Unit	Description	Instructional Hours
I	**INTRODUCTION TO RESEARCH PAPER WRITING** Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	06
II	**PRESENTATION SKILLS** Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction	06
III	**TITLE WRITING SKILLS** Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check	06
IV	**RESULT WRITING SKILLS** Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	06
V	**VERIFICATION SKILLS** Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission	06
	Total Instructional Hours	**30**

Course Outcome

CO1: Understand that how to improve your writing skills and level of readability
CO2: Learn about what to write in each section
CO3: Understand the skills needed when writing a Title
CO4: Understand the skills needed when writing the Conclusion
CO5: Ensure the good quality of paper at very first-time submission

REFERENCE BOOKS:

R1: Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

R2: Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006

R3: Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006

R4: Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20AC1092	DISASTER MANAGEMENT	2	0	0	0

Course Objective

1. Summarize basics of disaster
2. Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
3. Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
4. Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflictsituations.
5. Develop the strengths and weaknesses of disaster management approaches

Unit	Description	Instructional Hours
I	**INTRODUCTION** Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.	06
II	**REPERCUSSIONS OF DISASTERS AND HAZARDS** Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	06
III	**DISASTER PRONE AREAS IN INDIA** Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post Disaster Diseases and Epidemics.	06
IV	**DISASTER PREPAREDNESS AND MANAGEMENT** Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard;Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.	06
V	**RISK ASSESSMENT** Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co- Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival	06
	Total Instructional Hours	**30**

Course Outcome

CO1:	Ability to summarize basics of disaster
CO2:	Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response
CO3:	Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4:	Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
CO5:	Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCE BOOKS:

R1: Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.

R2: NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.

R3: Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

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RICET

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20AC1093	SANSKRIT FOR TECHNICAL KNOWLEDGE	2	0	0	0

Course Objective

1. Illustrate the basic sanskrit language.
2. Recognize sanskrit, the scientific language in the world.
3. Appraise learning of sanskrit to improve brain functioning.
4. Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
5. Extract huge knowledge from ancient literature.

Unit	Description	Instructional Hours
I	**ALPHABETS** Alphabets in Sanskrit	06
II	**TENSES AND SENTENCES** Past/Present/Future Tense - Simple Sentences	06
III	**ORDER AND ROOTS** Order - Introduction of roots	06
IV	**SANSKRIT LITERATURE** Technical information about Sanskrit Literature	06
V	**TECHNICAL CONCEPTS OF ENGINEERING** Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	06
	Total Instructional Hours	**30**

Course Outcome

CO1: Understanding basic Sanskrit language
CO2: Write sentences.
CO3: Know the order and roots of Sanskrit.
CO4: Know about technical information about Sanskrit literature.
CO5: Understand the technical concepts of Engineering.

REFERENCE BOOKS:

R1: "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi

R2: "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

R3: "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20AC1094	VALUE EDUCATION	2	0	0	0

Course Objective

1. Understand value of education and self-development
2. Imbibe good values in students
3. Let the should know about the importance of character
4. To teach and inculcate the importance of value based living.
5. To give students a deeper understanding about the purpose of life.

Unit	Description	Instructional Hours
I	**VALUES AND SELF-DEVELOPMENT** Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements	7
II	**IMPORTANCE OF CULTIVATION OF VALUES** Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline	7
III	**PERSONALITY AND BEHAVIOR DEVELOPMENT** Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature	8
IV	**CHARACTER AND COMPETENCE** Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.	8
	Total Instructional Hours	**30**

Course Outcome

CO1: Students will understand the importance of value based living.
CO2: Students will gain deeper understanding about the purpose of their life.
CO3: Students will understand and start applying the essential steps to become good leaders.
CO4: Students will emerge as responsible citizens with clear conviction to practice values and ethics in life.
CO5: Students will become value based professionals and building a healthy nation.

REFERENCE BOOKS:

R1: Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20AC1095	CONSTITUTION OF INDIA	2	0	0	0

Course Objective

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
3. Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
4. To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the IndianConstitution
5. To understand the central and state relation, financial andadministrative.

Unit	Description	Instructional Hours
I	**HISTORY OF MAKING OF THE INDIAN CONSTITUTION & PHILOSOPHY OF THE INDIAN CONSTITUTION** History, Drafting Committee, (Composition & Working), Preamble, Salient Features	06
II	**CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES** Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.	06
III	**ORGANS OF GOVERNANCE** Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions	06
IV	**LOCAL ADMINISTRATION** District's Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level:Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy	06
V	**ELECTION COMMISSION** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.	06
	Total Instructional Hours	**30**

Course Outcome

- CO1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- CO2: Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- CO3: Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru
- CO4: The eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- CO5: Discuss the passage of the Hindu Code Bill of 1956.

REFERENCE BOOKS:

R1: The Constitution of India,1950(Bare Act),Government Publication.

R2: Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.

R3: M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.

R4: D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20AC2091	PEDAGOGY STUDIES	2	0	0	0

Course Objective

1. Review existing evidence on there view topic to inform programme design and policy
2. Making under taken by the DfID, other agencies and researchers.
3. Identify critical evidence gaps to guide the development.
4. Identify their Professional Development.
5. Improve the Research and Future Direction.

Unit	Description	Instructional Hours
I	**INTRODUCTION AND METHODOLOGY** Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.	06
II	**THEMATIC OVERVIEW** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.	06
III	**EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES** Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches -Teachers' attitudes and beliefs and Pedagogic strategies.	06
IV	**PROFESSIONAL DEVELOPMENT** Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes	06
V	**RESEARCH GAPS AND FUTURE DIRECTIONS** Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.	06
	Total Instructional Hours	**30**

Course Outcome

CO1:	What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
CO2:	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
CO3:	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
CO4:	How can teacher to develop their Professional development support effective pedagogy?
CO5:	How can improve the Research and Future Direction using effective pedagogy.

REFERENCE BOOKS:

R1: Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245- 261.

R2: Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.

R3: Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID

R4: Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.

R5: Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

R6: Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.

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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20AC2092	STRESS MANAGEMENT BY YOGA	2	0	0	0

Course Objective

1. To achieve overall health of body and mind
2. To overcome stress
3. To possess emotional stability.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO YOGA** Definitions of Eight parts of yoga.(Ashtanga)	10
II	**DO'S AND DON'T'S IN LIFE** Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.	10
III	**ASAN AND PRANAYAM** Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam	10
	Total Instructional Hours	**30**

Course Outcome

CO1: Develop healthy mind in a healthy body thus improving social health also
CO2: Improve efficiency
CO3: The student will apply forces and exert themselves using rarely used muscle groups

REFERENCE BOOKS:

R1: Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal
R2: "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20AC2093	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	2	0	0	0

COURSE OBJECTIVE

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Unit	Description	Instructional Hours
I	**NEETISATAKAM-HOLISTIC DEVELOPMENT** Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)	10
II	**DAY TO DAY WORK AND DUTIES** Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2- Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.	10
III	**STATEMENTS OF BASIC KNOWLEDGE** Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2- Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3- Verses 36,37,42 -Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63	10
	Total Instructional Hours	**30**

Course Outcome

CO1: Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life

CO2: The person who has studied Geeta will lead the nation and mankind to peace and prosperity

CO3: Study of Neet is hatakam will help in developing versatile personality of students.

REFERENCE BOOKS:

R1: Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010

R2: Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

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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.

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.

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.

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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	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.

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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 learn tools 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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MCD - NICHT

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NICHT

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

Chairman - BoS
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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

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.

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.

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.

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.

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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HiCET

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
II	**DATA LOGIC CELLS AND LIBRARY DESIGN** 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
III	**LOW-LEVEL DESIGN AND SCHEMATIC ENTRY, PROGRAMMABLE ASICs** 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
IV	**LOW LEVEL DESIGN LANGUAGE, LOGIC SYNTHESIS** 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
V	**CONSTRUCTION FLOOR PLANNING AND PLACEMENT AND ROUTING** 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.

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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.

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.

Chairman - BoS
ECE - HICET

Chairman

Dean (Academics)
HICET

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

Chairman

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HICET

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

Dean (Academics)