

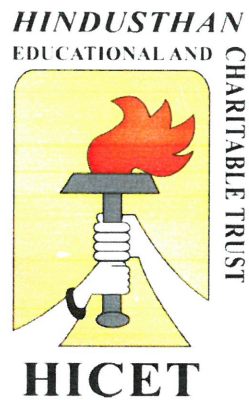
HINDUSTHAN COLLEGE OF ENGINEERING AND TECHNOLOGY

(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

2021-2022

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.

P. Haykal
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ECE - HiCET**



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VISION AND MISSION OF THE DEPARTMENT

VISION

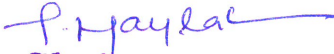
To nurture Electronics and Communication Professionals with exemplary technical skills adorned with ethical values.

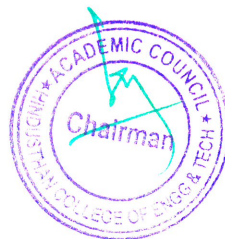
MISSION

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

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

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


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PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

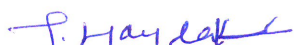
- PO 1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO 2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO 3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- PO 4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- PO 5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

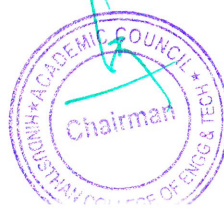

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- PO 6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- PO 7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PO 8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO 9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- PO10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design 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.

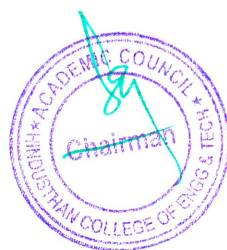
PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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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Coimbatore, Tamil Nadu.



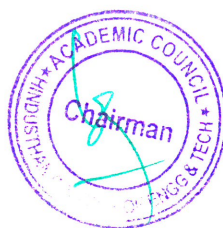
**DETAILS OF CHANGES CARRIED OUT IN CURRICULUM & SYLLABUS
CBCS PATTERN
POST GRADUATE PROGRAMMES
M.E. COMMUNICATION SYSTEMS**

REGULATION-2020

For the students admitted from 2020-21 and 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

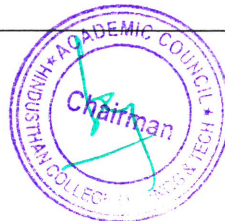
S.No	CODE	Courses	CAT	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	20CM2201	Advanced Wireless Communication and Networks	PCC	3	0	0	3	40	60	100
2	20CM2202	Microwave Integrated Circuits	PCC	3	1	0	4	40	60	100
3	20CM23XX	Professional Elective I	PE	3	0	0	3	40	60	100
4	20CM23XX	Professional Elective II	PE	3	0	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

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	2	0	0	0



		Skills								
4	20AC2094	Unnat Bharat Abhiyan	2	0	0	0				

For the students admitted from 2020-21 and onwards

SEMESTER III

S.No	CODE	Courses	CAT	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	20CM33XX	Professional Elective IV	PE	3	0	0	3	40	60	100
2	20CM33XX	Professional Elective V	PE	3	0	0	3	40	60	100
3	20CM33XX	Professional Elective VI	PE	3	0	0	3	40	60	100
4	20XX34XX	Open Elective	OE	3	0	0	3	40	60	100
PRACTICAL COURSES										
5	20CM3901	Project Phase I	EEC	0	0	12	6	50	50	100
Total Credits				12	0	12	18	210	290	500

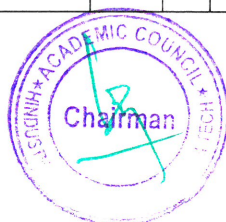
SEMESTER IV

S.No	CODE	Courses	CAT	L	T	P	C	CIA	ESE	TOTAL
Practical Courses										
1	20CM4901	Project Phase II	EEC	0	0	24	12	50	50	100
Total Credits				0	0	24	12	50	50	100

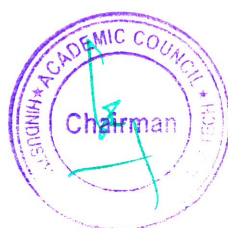
LIST OF PROFESSIONAL ELECTIVES

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	PE	3	0	0	3	40	60	100



		wireless communication								
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 Sensor 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)

CREDIT DISTRIBUTION

R2020

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

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Principal

PRINCIPAL
Hindusthan College of Engineering & Technology,
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.

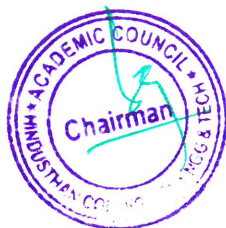
Unit	Description	Instructional Hours
TESTING OF HYPOTHESES		
I	Sampling distributions -Type I and Type II errors - Tests based on Normal, t, Chi-Square and F distributions for testing of mean, variance and proportions -Tests for Independence of attributes and Goodness of fit.	9
LINEAR PROGRAMMING		
II	Formulation - Graphical solution - Simplex method - Artificial variable Techniques - Transportation and Assignment Models	9
SCHEDULING BY PERT AND CPM		
III	Network Construction - Critical Path Method - Project Evaluation and Review technique - Resource Analysis in Network Scheduling.	9
LINEAR ALGEBRA		
IV	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
FUZZY LOGIC AND FUZZY ALGEBRA		
V	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."Fundamentals 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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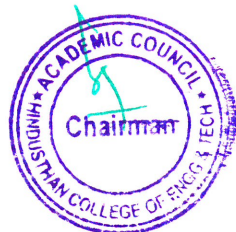
Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CM1201	DIGITAL MODULATION AND CODING TECHNIQUES	3	0	0	3

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
	DIGITAL MODULATION TECHNIQUES	
I	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
	OPTIMUM RECEIVERS FOR AWGN CHANNEL	
II	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
	CHANNEL CODING	
III	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
	SPREAD SPECTRUM COMMUNICATION	
IV	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
	COMMUNICATION THROUGH BAND LIMITED CHANNELS	
V	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 decoding Turbo equalization.	9
Total Instructional Hours		45

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After completion of the course the learner will be able to

**Course
Outcome**

- 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

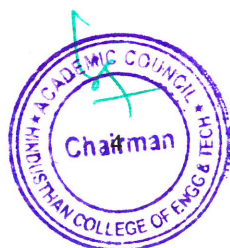
After completion of the course the learner will be able to

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: Analyze and 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, Metropolitan-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

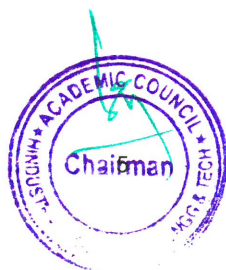
After completion of the course the learner will be able to

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, 1st 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

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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

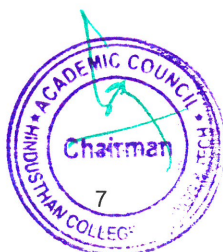
After completion of the course the learner will be able to

- 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


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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	
	<ol style="list-style-type: none"> 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

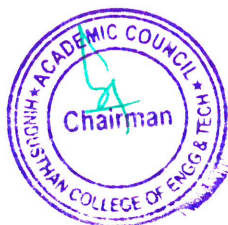
Simulation using MATLAB / EQUIVALENT SOFTWARE PACKAGE

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

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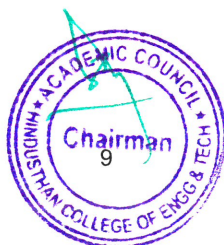
Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CM2201	ADVANCED WIRELESS COMMUNICATION AND NETWORKS	3	0	0	3

- 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	<p>MULTIPATH FADING CHANNELS AND DIVERSITY</p> <p>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.</p>	9
II	<p>OFDM AND OFDMA SYSTEMS</p> <p>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.)</p>	9
III	<p>MC-CDMA, MIMO AND LTE</p> <p>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.</p>	9
IV	<p>COGNITIVE RADIO AND ITS APPLICATIONS</p> <p>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.</p>	9
V	<p>WIRELESS NETWORKS</p> <p>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.</p>	9

Total Instructional Hours 45

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Course Outcome	<p>After completion of the course the learner will be able to</p> <p>CO1:Analyze the basics of multipath propagation and its characteristics</p> <p>CO2:Compare and contrast the performance of OFDM and OFDMA systems</p> <p>CO3:Describe the operation of transmitter and receiver of MC-CDMA, MIMO and LTE systems</p> <p>CO4:Demonstrate the impact of cognitive radio and its applications</p> <p>CO5:Analyze the various wireless networks and its characteristics</p>
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REFERENCE BOOKS:

- R1- Andreas F. Molisch, Wireless Communications, 2nd Edition, John Wiley & Sons Ltd, 2011.
- R2- Yong Soo Cho, Jackwon 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 Ghayeb, "Coding for MIMO Communication Systems", John Wiley & Sons Ltd, 2007.

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

- Course Objective**
- To study and understand the purpose of planar transmission lines and components at microwave frequencies
 - To understand and design various impedance matching networks using lumped and distributed elements
 - To enable the student to understand and design different microwave amplifiers and oscillators
 - To study and understand the mixer and control circuits used at microwave frequencies
 - To understand the various techniques used in Microwave IC Design and Measurements

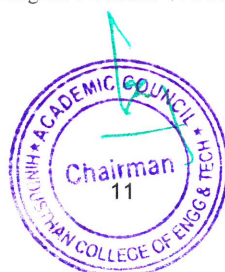
Unit	Description	Instructional Hours
I	PLANAR TRANSMISSION LINES AND COMPONENTS Review of Transmission line theory – S Parameters-Transmission line equations – reflection coefficient – VSWR – Microstrip lines: Structure, waves in microstrip, Quasi-TEM approximation, Coupled lines: Even mode and odd mode 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**
- Understand the theory of transmission lines used at microwave frequencies
 - Design and analyze various impedance matching networks using microwave components.
 - Perform stability analysis and be able to design amplifiers and oscillators at microwave frequencies.
 - Understand and analyze various the mixer and control circuits used at microwave frequencies
 - 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 Jersey
- 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

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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

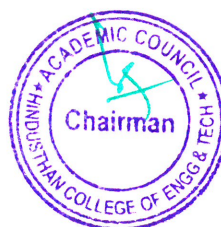
1. Path loss Measurement and Characterization of Wireless Channels
2. Wireless Channel equalizer design (ZF / LMS / RLS) using Simulation Packages.
3. OFDM transceiver design using Simulation Packages.
4. Simulation of MIMO systems using Simulation Packages.
5. Analysis of Bit Error Rate of MC-CDMA System
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

After completion of the course the learner will be able to

- Course Outcome**
- 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

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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	Description
	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

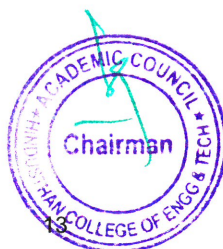
Unit	Description	Instructional Hours
	INTRODUCTION TO RESEARCH PAPER WRITING	
I	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness PRESENTATION SKILLS	06
II	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction TITLE WRITING SKILLS	06
III	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 RESULT WRITING SKILLS	06
IV	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 VERIFICATION SKILLS	06
V	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:	CO2:	CO3:	CO4:	CO5:
	Understand that how to improve your writing skills and level of readability	Learn about what to write in each section	Understand the skills needed when writing a Title	Understand the skills needed when writing the Conclusion	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 conflict situations.
 5. Develop the strengths and weaknesses of disaster management approaches

Unit	Description	Instructional Hours
	INTRODUCTION	
I	Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.	06
	REPERCUSSIONS OF DISASTERS AND HAZARDS	
II	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
	DISASTER PRONE AREAS IN INDIA	
III	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
	DISASTER PREPAREDNESS AND MANAGEMENT	
IV	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
	RISK ASSESSMENT	
V	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: Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company, 2007.
- R3: Sahni, Pardeep Et. Al. , " Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi, 2001.

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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.

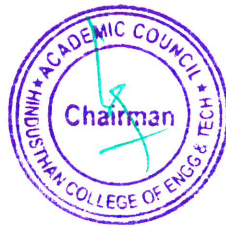
Unit	Description	Instructional Hours
I	ALPHABETS Alphabets in Sanskrit	06
II	TENSES AND SENTENCES Past/Present/Future Tense - Simple Sentences	06
III	ORDER AND ROOTS Order - Introduction of roots	06
IV	SANSKRIT LITERATURE Technical information about Sanskrit Literature	06
V	TECHNICAL CONCEPTS OF ENGINEERING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

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

REFERENCE BOOKS:

- R1: "Abhyastakam" – 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.

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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.

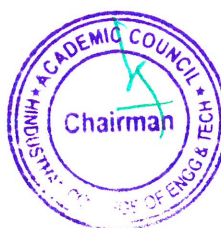
Unit	Description	Instructional Hours
	VALUES AND SELF-DEVELOPMENT	
I	Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements	7
	IMPORTANCE OF CULTIVATION OF VALUES	
II	Importance 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
	PERSONALITY AND BEHAVIOR DEVELOPMENT	
III	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
	CHARACTER AND COMPETENCE	
IV	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:	CO2:	CO3:	CO4:	CO5:
	Students will understand the importance of value based living.	Students will gain deeper understanding about the purpose of their life.	Students will understand and start applying the essential steps to become good leaders.	Students will emerge as responsible citizens with clear conviction to practice values and ethics in life.	Students will become value based professionals and building a healthy nation.

REFERENCE BOOKS:

RI: 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 Revolution in 1917 and its impact on the initial drafting of the Indian Constitution
 5. To understand the central and state relation, financial and administrative.

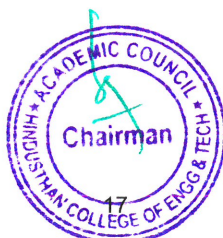
Unit	Description	Instructional Hours
I	HISTORY OF MAKING OF THE INDIAN CONSTITUTION & PHILOSOPHY OF THE INDIAN CONSTITUTION History, Drafting Committee. (Composition & Working), Preamble, Salient Features	06
II	CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES Fundamental Rights, Right to Equality, Right 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.

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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 andresearchers.
 3. . Identify critical evidence gaps to guide the development.
 4. Identify their Professional Development.
 5. Improve the Research and Future Direction.

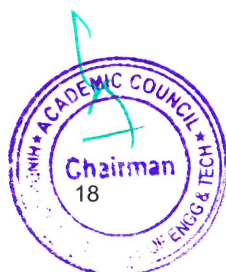
Unit	Description	Instructional Hours
	INTRODUCTION AND METHODOLOGY Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.	06
I		
	THEMATIC OVERVIEW Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.	06
II		
	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
III		
	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
IV		
	RESEARCH GAPS AND FUTURE DIRECTIONS Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.	06
V		
Total Instructional Hours		30

Course Outcome	CO1:	CO2:	CO3:	CO4:	CO5:
	What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?	How can teacher to develop their Professional development support effective pedagogy?	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 Training-Part-I":Janardan Swami Yoga bhyasi Mandal
- R2: "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

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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

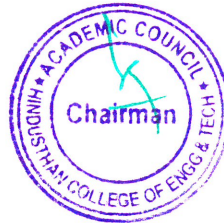
Unit	Description	Instructional Hours
I	NEETISATAKAM-HOLISTIC DEVELOPMENT Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)	10
II	DAY TO DAY WORK AND 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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SYLLABUS

PROFESSIONAL ELECTIVES

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
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BCH AND REED-SOLOMON CODES

I	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
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ITERATIVELY DECODED CODES

II	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
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LOW DENSITY PARITY CHECK CODES

III	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
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DESIGN OF LDPC DECODERS

IV	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
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SPACE-TIME CODING

V	Introduction - Fading Channels - Diversity Transmission and Reception: the MIMO channel - Space-time block codes - complex orthogonal Designs - Space-time trellis codes.	9
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Total Instructional Hours 45

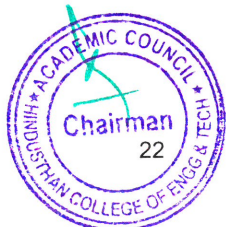
Course Outcome

- 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", Wiley, 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

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

- 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.
 5. To understand network mobility problem in vehicular networks

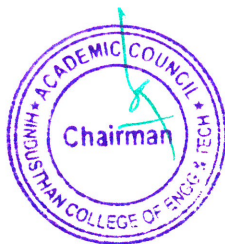
Unit	Description	Instructional Hours
	INTRODUCTION TO VEHICULAR NETWORK	
I.	Vehicular network definition, special characteristics, technical challenges, Evolution and progress, Vehicular network application and services, public safety application, vehicular traffic coordination, road traffic management.	9
	MAC PROTOCOLS & HETEROGENEOUS WIRELESS COMMUNICATION	
II	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
	ROUTING IN VEHICULAR NETWORKS	
III	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
	MESSAGE SCHEDULING	
IV	Context and motivations, congestion control approaches, dynamic message scheduling, Analysis and validation	9
	NETWORK MOBILITY	
V	The network mobility problem, NEMO basic support protocol, NEMO route optimization, NEMO in vehicular scenario, Mobile Adhoc NEMO.	9
Total Instructional Hours		45

- After completion of the course the learner will be able to**
- Course Outcome**
- 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-Hassnaa Moustafa and Yan Zhang, — Vehicular networks – Techniques, Standards and applications| CRC Press, New York, 2009
- R2-Stephen Olariu and Michele C Weigle. — Vehicular networks – From theory to Practice|, CRC Press, New York, 2009.
- R3 - H. Hartenstein and K. P. Laberteaux, —VANET: Vehicular Applications and InterNetworking Technologies, Wiley, 2010
- R4-C. Sommer, F. Dressler, —Vehicular Networking|, Cambridge University Press, 2015

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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

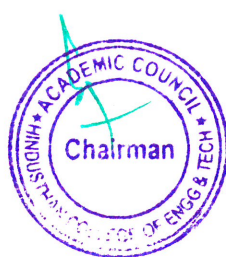
Unit	Description	Instructional Hours
	CONCEPTS OF RADIATION	
I	Physical Concept of Radiation: Radiation from surface and line current distributions - radiation pattern - near and far field regions - reciprocity - directivity and gain – effective aperture - polarization - input impedance - efficiency - Friss transmission equation – radiation integrals and auxiliary potential functions.	12
	APERTURE AND REFLECTOR ANTENNAS	
II	Huygens’s principle - radiation from rectangular and circular apertures – design considerations - Babinet’s principle - radiation from sectoral - pyramidal - conical and corrugated horns - design concepts of parabolic reflectors and cassegrain antennas.	12
	BROADBAND ANTENNAS	
III	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
	MICROSTRIP ANTENNAS	
IV	Microstrip Antennas: Radiation mechanism - parameters and applications - feeding methods - method of analysis - design of rectangular and circular patch - impedance matching of microstrip antennas.	12
	MEASUREMENT TECHNIQUES AND APPLICATIONS	
V	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.

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

The student should be able to

Course Objective

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
	COMPONENTS OF EMBEDDED SYSTEMS	
I	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
	PERIPHERAL INTERFACING TECHNIQUES	
II	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
	INTERNET OF THINGS	
III	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
	CLOUD AND APP FACILITIES FOR IoT	
IV	Amazon Web Services Cloud (AWS), MS Azure, IBM Bluemix, Carriots and Thing Speak, GE predix. MIT App Inventor and Android App Development tools.	9
	CASE STUDY	
V	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

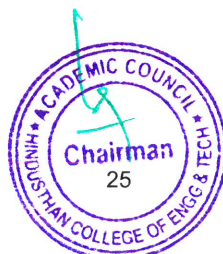
After completion of the course the learner will be able to

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 Madiseti "Internet of Things: A Hands-on Approach", Bahga & Madiseti, 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.


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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.

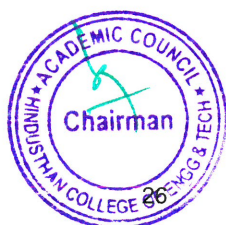
Unit	Description	Instructional Hours
	OVERVIEW OF WIRELESS SENSOR NETWORKS	
I	Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks-Enabling Technologies for Wireless Sensor Networks.	9
	ARCHITECTURES	
II	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
	NETWORKING OF SENSORS	
III	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
	INFRASTRUCTURE ESTABLISHMENT	
IV	Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.	9
	SENSOR NETWORK PLATFORMS AND TOOLS	
V	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.

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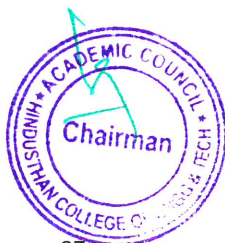
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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX307	COGNITIVE RADIO NETWORK	3	0	0	3

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

Course Objective	Description
	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.

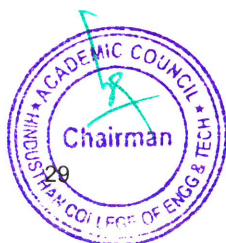
Unit	Description	Instructional Hours
I	UNIT I INTRODUCTION TO MEMS MEMS and Microsystems, Miniaturization, Typical products, Micro sensors, Micro actuation, MEMS with micro actuators, Micro-accelerometers and Micro fluidics, MEMS materials, Micro fabrication	9
II	UNIT II MECHANICS FOR MEMS DESIGN Elasticity, 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	Description
	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 Santerria, "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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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.

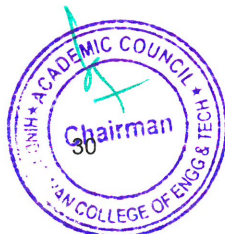
Unit	Description	Instructional
I	UNIT I LAN SWITCHING TECHNOLOGY Switching Concepts, LAN Switching, switch forwarding techniques - cut through and store and forward, Layer 3 switching, Loop Resolution, Switch Flow control, virtual LANs. .	9
II	UNIT II QUEUES IN HIGH SPEED SWITCHES Internal Queueing -Input, 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


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

After completion of the course the learner will be able to

Course Outcome

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.



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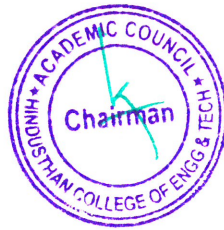




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REFERENCE BOOKS:

- R1 - Wilbur L. Pritchard, Hendri G. Snyderhoud 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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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.

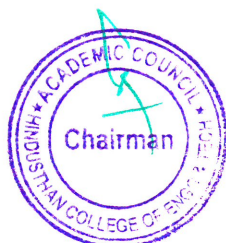
Unit	Description	Instructional Hours
I	INTRODUCTION Massive MIMO: principles, characteristics and transmission/detection techniques; Channel hardening in large dimensions,- Channel Models – Effect of spatial correlation – Channel Estimation – Pilot contamination in massive MIMO – Implementation challenges 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 identify 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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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX312	MACHINE LEARNING	3	0	0	3

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

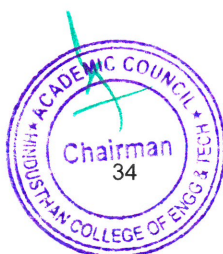
Unit	Description	Instructional Hours
	MATHEMATICAL BACKGROUND	
I	Linear Algebra – Arithmetic of matrices, Norms, Eigen decomposition, Singular value decomposition, Pseudo inverse. Component analysis. Probability theory – probability distribution, conditional probability, Chain rule. Bayes rule, Information theory, Structured Probabilistic models.	9
	MACHINE LEARNING BASICS	
II	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
	NEURAL NETWORKS	
III	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
	ML IN WIRELESS AND SECURITY	
IV	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
	ML IN BIO-MEDICAL	
V	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 Alpaydm, “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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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.

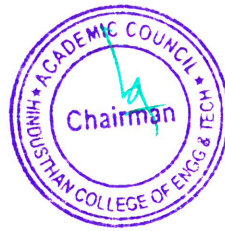
R7-"System for Unsupervised Healthcare Monitoring," IEEE Journal of Biomedical and Health Informatics, vol. 22, no. 3, pp. 722-732, May 2018.

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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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

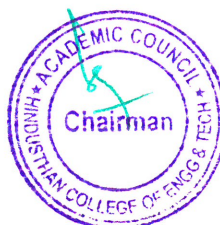
Unit	Description	Instructional Hours
I	INTRODUCTION: Internet of things overview, Design principles for connected devices, Web thinking for connected devices, Internet Principles.	9
II	6LOWPAN AND RPL: 6LoWPAN and RPL Standardization Adaptation Layer RPL Downward Routes, Multicast Membership, Packet 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: Analyze 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, Stamatios 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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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX314	SPEECH SIGNAL PROCESSING	3	0	0	3

The student should be able to

Course Objective

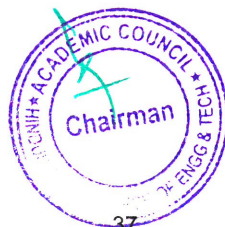
- CO1: Study the mechanism and model of speech production
- CO2: Apply auditory transforms Techniques
- CO3: Estimate LPC parameters and Feature extraction of of speech signal
- CO4: Illustrate Speech synthesis
- CO5: Apply various algorithms for speech and audio signal processing

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 – Vcoders : 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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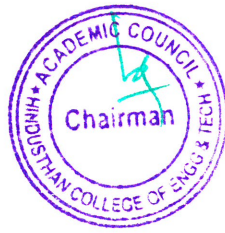


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REFERENCE BOOKS:

- R1 - Lawrence Rabiner and Bing-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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Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX315	MULTIMEDIA COMPRESSION	3	0	0	3

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.

Course Objective


Unit	Description	Instructional Hours
	UNIT I INTRODUCTION	9
I	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.	
	UNIT II ARITHMETIC CODING AND DICTIONARY TECHNIQUES	9
II	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	
	UNIT III AUDIO COMPRESSION	9
III	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.	
	UNIT IV IMAGE COMPRESSION	9
IV	Predictive techniques - DPCM, DM - KL transform – discrete cosine, Walsh- Hadamard transform - JPEG, Wavelet based compression: quad-trees, EZW, SPIHT, JPEG-2000	
	UNIT V VIDEO COMPRESSION	9
V	Video signal representation – Motion compensation – MPEG standards - Motion estimation techniques - H.261 family of standards - Motion video compression.	
Total Instructional Hours		45

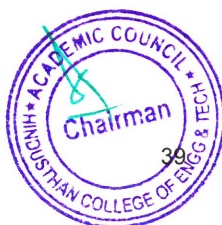
Course Outcome

- 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 Multimedial, AP Press, New York, 1995.
- R4-Alistar Moffat, —Compression and Coding Algorithms, Kluwer Academic Publishers, 2002.


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

Course Objective	Description
	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

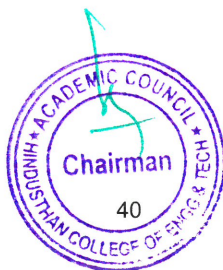
Unit	Description	Instructional Hours
I	INTRODUCTION Signal spaces - concept of Convergence - Hilbert spaces for energy signals. Fourier basis & Fourier Transform – Limitations of standard Fourier analysis – Need for Time-Frequency Analysis, Spectrogram plot – Windowed Fourier transform Tiling of the 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.

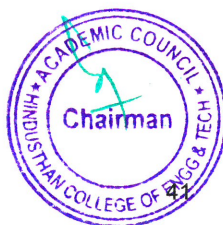
Unit	Description	Instructional Hours
I	INTRODUCTION TO NEURAL NETWORKS Characteristics of Neural Networks, Historical Development of Neural Networks Principles, Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, 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, Yoshua Bengio, Aran Courville.
- R3 - Fundamentals of Neural Networks: Architectures, Algorithms and Applications, by Fausett.

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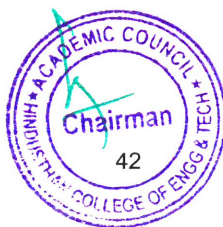
Programme	Course Code	Name of the Course	L	T	P	C
M.E.	20CMX318	SPREAD SPECTRUM COMMUNICATION	3	0	0	3

- 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

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

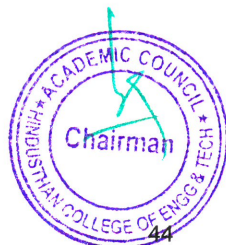
After completion of the course the learner will be able to

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

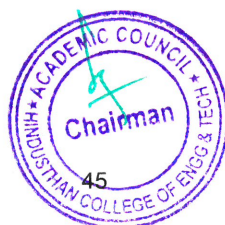
Unit	Description	Instructional Hours
I	5G CHANNEL MODEL Modeling requirements and scenarios, Channel model requirements and Measurements, Propagation scenarios, METIS channel models, Map-based model, stochastic model, Comparison of Models	9
II	MULTI-CARRIER WAVEFORMS FOR 5G Filter-bank based multi-carrier (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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OPEN ELECTIVE

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

- Course Objective**
- To study about fundamentals of green radio networks.
 - To impart the importance of reducing energy consumption.
 - To learn about CO2 emissions and inculcate green concepts for energy efficient approaches.
 - To study about the power management technique.
 - To understand the concept of designing next generation wireless networks.

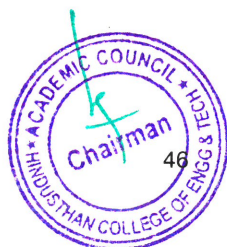
Unit	Description	Instructional Hours
	INTRODUCTION	
I	Fundamental Tradeoffs on the Design of Green Radio Networks: Insight from Shannon's capacity formula - impact of practical constraints - latest research and directions; Algorithms for Energy Harvesting Wireless Networks: Energy harvesting technologies - PHY and MAC layer optimization for energy harvesting wireless networks.	9
	GREEN MODULATION AND CODING	
II	Modulation: Green modulation and coding schemes in energy constrained wireless networks - energy consumption of uncoded scheme - energy consumption analysis of LT coded modulation.	9
	CO-OPERATIVE TECHNIQUES	
III	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
	BASE STATION POWER MANAGEMENT TECHNIQUES	
IV	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
	WIRELESS ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS	
V	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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