RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2019 – 2021

M. Tech in DIGITAL COMMUNICATION

TELECOMMUNICATION ENGINEERING

I - IV Semester M. Tech

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute:

Ramaiah Institute of Technology (RIT) (formerly known as M. S. Ramaiah Institute of Technology) is a self-financing institution established in Bangalore in the year 1962 by the industrialist and philanthropist, Late Dr. M S Ramaiah. The institute is accredited with "A" grade by NAAC in 2014 and all engineering departments offering bachelor degree programs have been accredited by NBA. RIT is one of the few institutes with prescribed faculty student ratio and achieves excellent academic results. The institute was a participant of the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. All the departments have competent faculty, with 100% of them being postgraduates or doctorates. Some of the distinguished features of RIT are: State of the art laboratories, individual computing facility to all faculty members. All research departments are active with sponsored projects and more than 304 scholars are pursuing PhD. The Centre for Advanced Training and Continuing Education (CATCE), and Entrepreneurship Development Cell (EDC) have been set up on campus. RIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with over 1,35,427 books with subscription to more than 300 International and National Journals. The Digital Library subscribes to several online e-journals like IEEE, JET etc. RIT is a member of DELNET, and AICTE INDEST Consortium. RIT has a modern auditorium, several hi-tech conference halls and all are air-conditioned with video conferencing facilities. It has excellent hostel facilities for boys and girls. RIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association. RIT obtained Academic Autonomy for all its UG and PG programs in the year 2007. As per the National Institutional Ranking Framework, MHRD, Government of India, Ramaiah Institute of Technology has achieved 64th rank in 2019 among the top 100 engineering colleges across India.

About the Department:

The department of Telecommunication Engineering was established in 1996 to address the increasing demand for professionals with expertise in communication and networking technology in India. The department has state of the art laboratories, equipment's, resources and committed faculty having best of the academic and industry recognition. The department started a **M.Tech program in Digital Communication in the year 2004**. The department has a **Research Centre** with 15 students, which was started in the year 2012. Department has collaborations with some of the leading industries like., **Nokia, Honeywell, Intel, ARM-Nuvoton, Ericsson, Samsung, ABB** and with leading national and international universities like **Stanford University, IIT-M**, enabling the department to focus on R&D, and thus providing new avenues for PG/UG students for placement and higher studies. Department is accredited by the **National Board of Accreditation under AICTE**. There are **5 Funded Research projects** (Industry and Government) ongoing in the department involving students to carry out innovative projects. The IEEE Sensor Council focuses on many IEEE student activities.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs

MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

- Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
- Establishing research clusters in emerging areas in collaboration with globally reputed organizations
- Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs

QUALITY POLICY

We at MS Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

To provide an ambience for the students to excel in studies, research and innovation, focusing on meeting global socio-economic needs from a Telecommunication Engineering perspective

MISSION OF THE DEPARTMENT

- Providing high quality technical education to create world class Telecommunication engineers.
- Creating an ambience for skills development, research and entrepreneurial activities to meet socio-economic needs

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1 Post graduates will achieve excellence in Digital Communication to meet the current and future needs of industry and academia

PEO 2 Post graduates will be able to pursue research by applying modern tools to address real life technological problems

PEO 3 Post graduates will develop technical skills in multidisciplinary domains associated with ethical values and lifelong learning abilities

PROGRAM OUTCOMES (POs)

PO1: An ability to independently carry out research /investigations and developmental work to solve practical problems

PO2: Ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Ability to learn and apply modern tools / techniques appropriate to the discipline to excel in the domain of Digital Communication Engineering.

PO5: Engage in lifelong learning to address the current and future needs of the Society/Industry individually and as a leader in diverse and multidisciplinary teams.

Curriculum Course Credits Distribution Batch 2019-2021

Semester	Professional Courses - Core (Hard core, soft core, Lab) (PC-C)	Professional Courses- Electives (PC-E)	Project Work (PW)	Industrial /Internship/Seminar /field work(Research methodology)	Total credits
1	10	12	00	02	24
2	10	12	00	02	24
3	04	04	06	04	18
4	00	00	22	00	22
Total	24	28	28	08	88

SCHEME OF TEACHING

I SEMESTER

Sl. No.	Course Code	Course Name	Category	Credits				Contact Hours
				L	T	P	Total	
1.	MDCE11	Antenna Theory & Design	**PCC**	4	0	0	**4**	**4**
2.	MDCE12	Advanced Digital Communications	**PCC**	4	0	0	**4**	**4**
3.	MDCEPExx	Professional Elective I	**PEC**	3	1	0	**4**	**5**
4.	MDCEPExx	Professional Elective II	**PEC**	4	0	0	**4**	**4**
5.	MDCEPExx	Professional Elective III	**PEC**	4	0	0	**4**	**4**
6.	MDCE13	Seminar - I	**Seminar**	0	0	2	**2**	**4**
7.	MDCEL14	Antenna Design Lab	**PCC**	0	0	1	**1**	**2**
8.	MDCEL15	Advanced Digital Communication Lab	**PCC**	0	0	1	**1**	**2**
Total				**19**	**1**	**4**	**24**	**29**

SCHEME OF TEACHING

II SEMESTER

Sl.No	Subject code	Subject	Category	Credits				Contact hours
				L	T	P	Total	
1.	MDCE21	Wireless Sensor Networks	**PCC**	4	0	0	**4**	**4**
2.	MDCE22	Advanced Digital Signal processing	**PCC**	3	1	0	**4**	**5**
3.	MDCEPExx	Professional Elective IV	**PEC**	x	0	x	**4**	**4/5**
4.	MDCEPExx	Professional Elective V	**PEC**	4	0	0	**4**	**4**
5.	MDCEPExx	Professional Elective VI	**PEC**	4	0	0	**4**	**4**
6.	MDCE23	Seminar - II	**Seminar**	0	0	2	**2**	**4**
7.	MDCEL24	Wireless Sensor Networks Lab	**PCC**	0	0	1	**1**	**2**
8.	MDCEL25	Advanced Digital Signal Processing Lab	**PCC**	0	0	1	**1**	**2**
Total				**15 + x**	**1**	**4 + x**	**24**	**29/30**

Note: Professional elective IV credits may be either 3:0:1 or 4:0:0 as per the choice of students.

SCHEME OF TEACHING

III SEMESTER

Sl.No	Subject code	Subject	Category	Credits				Contact hours
				L	T	P	Total	
1.	MDCE31	3G/4G Wireless Mobile Communication	**PCC**	4	0	0	**4**	**4**
2.	MDCEPExx	Professional Elective VII	**PEC**	4	0	0	**4**	**4**
3.	MDCE32	Internship	**IN**	0	0	4	**4**	**8**
4.	MDCE33	Project Work Phase-I	**PROJ**	0	0	6	**6**	**12**
			TOTAL	**8**	**0**	**10**	**18**	**28**

SCHEME OF TEACHING
IV SEMESTER

Sl.No	Subject code	Subject	Category	Credits				Contact hours
				L	T	P	Total	
1.	MDCEP41	Project work Phase-II	**PROJ**	0	0	22	22	44
			TOTAL	**0**	**0**	**22**	22	**44**

LIST OF PROFESSIONAL ELECTIVE SUBJECTS

The students have to earn a total of 28 credits by choosing from the following list of electives from I to III semesters

Semester	GROUP 1	GROUP 2
	Networks and Embedded Systems	**Communication and Signal Processing**
1	Random Process MDCEPE11	Advanced Mathematics MDCEPE21
1	Simulation, Modeling and Analysis MDCEPE12	Detection and Estimation Techniques MDCEPE22
1	Cryptography and Network Security MDCEPE13	Error Control Coding MDCEPE23
2	Software Defined Wireless System Design MDCEPE14	Wavelet Transforms MDCEPE24
2	Advanced Embedded Systems MDCEPE15	Image and Video Processing MDCEPE25
2	IOT System Design MDCEPE16	Pattern Recognition for Machine Learning MDCEPE26
3	MEMS MDCEPE17	Neural Networks And Fuzzy Logic MDCEPE27

I Semester

ANTENNA THEORY AND DESIGN

Course Code: MDCE11 **Credit: 4:0:0**
Course Co-ordinator: Dr.Swetha Amit **Contact Hours: 56**
Pre requisites: Microwaves and Antenna Engineering

Course contents

UNIT 1

Antenna Fundamentals and Definitions: Concept of Antennas in communication systems, Radiation Mechanism, Ideal Dipole, Radiation Patterns, Directivity and Gain, Antenna Impedance, Radiation Efficiency, Antenna Polarization

UNIT 2

Antenna Arrays: Array Factor for Linear Arrays, Uniformly Excited, Equally Spaced Linear Arrays, Pattern Multiplication, Directivity of Linear Arrays, Non- uniformly excited Linear Arrays, Mutual Coupling, Multidimensional Arrays, Phased Arrays, Feeding Techniques in HFSS

UNIT 3

Broadband Antennas: Helical Antennas, Principle of frequency-independent Antennas

Aperture Antennas: Radiation from aperture and Huygen's principle, Techniques for evaluating Gain, Rectangular and circular apertures, Reflector Antennas, Feed Antennas for Reflectors. Antenna Modeling with MATLAB.

UNIT 4

Antenna Synthesis: Synthesis Problem and Principles, Line Sources Shaped Beam Synthesis, Linear Array Shaped Beam Synthesis — Fourier Series, Woodward — Lawson Sampling Method, Comparison of Shaped Beam Synthesis Methods, Low Side Lobe Narrow Main Beam Synthesis Methods Dolph Chebyshev Linear Array, Taylor Line Source Method.

UNIT 5

CEM for Antennas : Method of moments: Introduction to Method of Moments, Pocklington's Integral Equation, Integral Equations and Kirchoff's Networking Equations, Source Modeling

Finite difference Time domain method: Introduction, Maxwell's equations for FDTD method, Computer Algorithm and FDTD implementation.

Antenna in systems and Antenna measurements: Antenna as receiver, reciprocity and antenna measurements, Pattern measurements and antenna ranges, Gain measurement, Antenna power budget analysis.

REFERENCE BOOKS:

1. Stutzman and Thiele, "Antenna Theory and Design", 2nd Ed, John Wiley and Sons Inc, 2012
2. C. A. Balanis, "Antenna Theory Analysis and Design", John Wiley, 3rd Ed, John Wiley, 2012
3. Kraus, "Antennas and wave propagation", McGraw Hill, TMH, 4th Edition, 2013
4. John Volakis, "Antenna Engineering Handbook", 4th Edition, McGraw Hill Publications, 2007

COURSE OUTCOMES (COs):

1. Analyze the characteristics of an ideal antenna, arrays, broadband and aperture for its efficient working in practical scenario considering all the limitations. **(PO 1,5)**
2. Analyze smart antenna, ultra wideband and aperture antennas characteristics to understand the algorithms used in direction of arrival and beam forming which are implemented in GSM communication. **(PO 1,3,5)**
3. Analyzing the antenna synthesis methods to use the antenna effectively with reduced sidelobes and increased directivity. **(PO 1,3)**
4. Analyze the implementation of the antennas using numerical methods: MOM and FDTD methods & measure different parameters for source modeling. **(PO 1,3,5)**
5. Design a microstrip antenna using HFSS tool used in various communication applications and analyze the power budget for a reduced radiation effects. **(PO 1, 2, 3, 4, 5)**

ADVANCED DIGITAL COMMUNICATION

Course Code: MDCE12 **Credit: 4:0:0**
Course Coordinator: Nisha S L **Contact Hours: 56**
Prerequisites: Digital Communication

Course contents

UNIT 1

Digital Modulation Techniques: QPSK, DPSK, FQPSK, QAM, M-QAM, OFDM, Optimum Receiver for Signals Corrupted by AWGN, Performance of the Optimum Receiver for Memory-less Modulation, Optimum Receiver for CPM Signals, Optimum Receiver for Signals with Random Phase in AWGN Channel.

UNIT 2

Coding Techniques: Convolutional Codes, Hamming Distance Measures for Convolutional Codes, Various Good Codes, Maximum Likelihood Decoding of Convolutional codes, Error Probability with Maximum Likelihood Decoding of Convolutional Codes, Turbo coding and decoding, Sequential Decoding, Feedback Decoding and Viterbi decoding.

UNIT 3

Communication Through Band Limited Linear Filter Channels: Optimum receiver for channels with ISI and AWGN, Linear equalization, Decision-feedback equalization.
Adaptive equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, The LMS Algorithm, convergence properties of LMS, Recursive least squares algorithms for adaptive equalization.

UNIT 4

Spread Spectrum Signals for Digital Communication: Model of Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Signals, Frequency-Hopped Spread Spectrum Signals, CDMA, time-hopping SS, Synchronization of SS systems

UNIT 5

Digital Communication Through Fading Multipath Channels: Characterization of fading multipath channels, Effect of signal characteristics on the choice of a channel model, frequency-Non Selective, slowly fading channel, diversity techniques for fading multipath channels, Digital signal over a frequency-selective, coded waveforms for fading channels, multiple antenna systems.

REFERENCES

1. John G. Proakis, "Digital Communications", 4th edition, McGraw Hill, reprint 2014.
2. Stephen G. Wilson, "Digital Modulation and Coding", Pearson Education (Asia) Pvt.Ltd, reprint 2013.
3. Kamilo Feher, "Wireless Digital Communications: Modulation and Spread Spectrum
4. Applications", Prentice-Hall of India, reprint 2014.

COURSE OUTCOMES (COs):

1. Understand various digital modulation techniques and optimum receiver for signals corrupted by AWGN. (PO1, 2, 3)
2. Solving problems on different Digital modulation and demodulation Techniques. (PO1, 2, 3, 4, 5)
3. Differentiate various Synchronization and equalization techniques for digital communication. (PO1, 2, 3, 4, 5)
4. Analyze the various modulation, demodulation techniques with Probability error for digital communication. (PO1, 2, 3, 4, 5)
5. Design Convolution, turbo Coders and decoders for Digital communication. (PO1, 2, 3, 4, 5)

ANTENNA DESIGN LAB

Course Code: MDCEL14 **Credit: 0:0:1**

Course Coordinator: Dr. Swetha Amit **Contact Hours: 28**

Prerequisite Courses: Microwaves and Antenna Engineering, Antenna theory and design

Course contents

Laboratory Experiments:

Microstrip Antennas to be designed using Antenna Toolbox in MATLAB and EM Simulation tool HFSS.

Suitable antennas to be design for the following applications:

Basic Experiments:

1. Basic introduction to **EM simulator HFSS** and design considerations of antenna with specified parameters.
2. **Base station**
    a. Isotropic antenna
3. **Cellular Communication**
    a. PIFA
    b. Meanderline
4. **5G communication**
    a. MIMO antenna
5. **WBAN applications**
6. **RFID**
    a. Proximity coupled, circular polarized antenna
7. **Wearable Technologies**
    a. UWB antenna

Advanced Experiments:

8. **SAR analysis** in Human body
9. **RF Energy harvesting** techniques and design of modules for the same and test in a RF vicinity
10. **Travelling wave antenna**
11. **Metamaterial structures** in antenna design for miniaturization and gain enhancement.
12. **Fractal antenna** design with different shapes for better performance of antenna

Research Experiments:

13. Study of smart antennas with **direction of arrival and beamforming algorithms** in MATLAB.
14. **Fabricate an antenna** and test with Network analyser for its impedance matching.

REFERENCE BOOKS:

1. Stutzman and Thiele, "Antenna Theory and Design", 2nd Ed, John Wiley and Sons Inc, 2012
2. C. A. Balanis, "Antenna Theory Analysis and Design", John Wiley, 3rd Ed, John Wiley, 2012
3. Kraus, "Antennas and wave propagation", McGraw Hill, TMH, 4th Edition, 2013
4. John Volakis, "Antenna Engineering Handbook", IV Edition, McGraw Hill Publications, 2007

COURSE OUTCOMES (COs):

1. Identify the parameters associated in designing an antenna for efficient wireless communication considering the radiation effects, range and orientation of EM waves. **(PO 1,4,5)**
2. Design the practical antennas of interest with suitable equations and evaluate them for impedance matching and mutual coupling so that the antenna can be tuned to any RF device. **(PO 1,4)**
3. Analyze the antenna modules with respect to Gain and Directivity by checking the front-to-back ratio, beamwidth, axial ratio and SAR to check the impact in human vicinity **(PO 1,3,4)**
4. Design microstrip antennas by simulating them with different shapes and different feeding techniques in HFSS to understand their impact on directivity, polarization and wideband applications **(PO 1,3,4,5)**
5. Analyze the algorithms for direction of arrival and beam forming to understand the working of smart antennas. **(PO 1,3,4)**

ADVANCED DIGITAL COMMUNICATION LAB

Course Code: MDCEL15 **Credit: 0:0:1**
Course Coordinator: NISHA SL **Contact Hours: 28**
Prerequisites: Digital Communication

Course contents

Basic experiments

1. Introduction to Python. Generation and Plotting of signals.
2. Generation of signals corrupted by additive white Gaussian noise using python.
3. Verification of Sampling Theorem using python
4. Simulation of Amplitude shift keying (ASK) using Python.
5. Simulation of Phase shift keying (PSK) using Python.

Advanced experiments

6. Simulation of Frequency shift keying (FSK) using Python.
7. Simulation of Differential Phase shift keying (DPSK) using Python.
8. Simulation of Quadrature Phase shift keying (QPSK) using Python.
9. Python Code to plot BER for BPSK modulated signal in Rayleigh Fading Channel.
10. Python Code to plot the probability error of BPSK, DPSK and Non Coherent FSK signal.

Research experiments

11. Python Code to generate code word for (7,4) block code .Also display the generator matrix, parity check matrix and Hamming code for the same.
12. Python Code to generate a PN Sequence with shift registers and to verify its properties.
13. Simulation of DSSS (Direct sequence spread spectrum) using Python.
14. Python Code to plot Optimum matched filter output for a rectangular pulse.

REFERENCE BOOKS

1. John G. Proakis, “Digital Communications," 4th edition, McGraw Hill, reprint 2014.
2. Stephen G. Wilson, “Digital Modulation and Coding”, Pearson Education (Asia) Pvt. Ltd, reprint 2013.
3. Kamilo Feher, “Wireless Digital Communications: Modulation and Spread Spectrum Applications”, Prentice-Hall of India, reprint 2014

COURSE OUTCOMES (COs):

1. Various signals generated, corrupted by AWGN and Sampling Theorem was verified and evaluated using python. **(PO1, 2, 3, 4, 5)**
2. ASK, PSK and FSK was simulated and evaluated using python software. **(PO1, 2, 3, 4, 5)**
3. DPSK, QPSK and DSSS was simulated and evaluated using python software. **(PO1, 2, 3, 4, 5)**
4. PN sequence and block code was simulated and evaluated using python software **(PO1, 2, 3, 4, 5)**
5. Matched filter and BPSK modulated signal in Rayleigh Fading Channel was simulated and evaluated using python. **(PO1, 2, 3, 4, 5)**

II Semester

WIRELESS SENSOR NETWORKS

Course Code: MDCE21 **Credit: 4:0:0**
Course Coordinator: Dr. Parimala P **Contact Hours: 56**
Prerequisites: Computer Communication Networks

Course contents

UNIT 1

Introduction to basics of Sensor Networks: Definitions and Background, Challenges and Constraints, Applications, Node Architecture and available Operating Systems 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.

UNIT 2

Medium Access Control: Overview, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols. Hybrid MAC Protocols

UNIT 3

Network Layer: Routing Metrics, Flooding and Gossiping, Data-Centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing, QoS-Based Routing Protocols.

UNIT 4

Power Management: Local Power Management Aspects, Dynamic Power Management, Conceptual Architecture
Time Synchronization: Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols

UNIT 5

Localization: Ranging Techniques, Range-Based Localization, Range-Free Localization, Event-Driven Localization, Data aggregation and Sensor Data fusion in Wireless Sensor Networks.

REFERENCE BOOKS

1. Waltenegus Dargie and Christian Poellabauer, "Fundamentals Of Wireless Sensor Networks Theory And Practice", John Wiley Publication, 2010.
2. Holger Karl, Andreas Willig, "Protocol and Architecture for Wireless Sensor Networks", John Wiley publication, 2007.
3. Feng zhao, Leonidas Guibas, "Wireless Sensor Networks: an information processing approach", Elsevier publication, 2004.
4. Jitendra R.Raol, "Data Fusion Mathematics", CRC Press, 2016

COURSE OUTCOMES (COs):

1. Understand the basics of Sensor networks, Data type, MAC layer, Network layer, need of synchronization and localization. **(PO3)**
2. Understand different architectures, Mac layer and network layer protocols, power management and Localization **(PO 1,3)**
3. Apply the Mac layer protocols and routing algorithms, power management and localization to different areas. **(PO1,3,4)**
4. Analyze and select suitable techniques in MAC layer, routing protocols and data fusion technology relevant to the application. **(PO1,3,4)**
5. Evaluate various protocols and algorithms with necessary parameters like packet loss, mean time to packet transfer, etc **(PO3,4,5)**

ADVANCED DIGITAL SIGNAL PROCESSING

Course Code: MDCE22 **Credit: 3:1:0**

Course Coordinator: Dr. B K Sujatha **Contact Hours: 42+28**

Prerequisites: Signals, and Systems, Digital Signal Processing

Course contents

UNIT 1

Signal Modeling: Signal modeling-Least Squares method, Pade approximation, Prony's method, Finite Data records, Stochastic Models. Model based approach - AR, MA, ARMA Signal modeling – Parameter estimation using Yule-Walker method.

UNIT 2

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

UNIT 3

Linear Prediction and Optimum Linear Filters: Representation of a random process, Forward and backward linear prediction, Solution of normal equations, Properties of the linear error prediction filters, AR lattice and ARMA lattice -ladder filters, Wiener filters for filtering and prediction.

UNIT 4

Multirate Digital Signal Processing: Introduction, Decimation by a factor 'D', Interpolation by a factor 'I', Sampling rate Conversion by a factor 'I/D', Implementation of Sampling rate conversion, Multistage implementation of Sampling rate conversion, Digital Filter banks, Two Channel Quadrature Mirror Filter banks, M-Channel QMF bank, Poly-phase Representation, Perfect Reconstruction Systems, Applications of Multirate Signal Processing,

UNIT 5

Multidimensional Multirate Systems:- Introduction, Multidimensional signals, sampling a multidimensional signal, minimum sampling density, multirate fundamentals, Alias free decimation. Cascade connections, multifilter design, Special filters and filter banks.

REFERENCES:

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., New York, 2012.
2. Proakis and Manolakis, "Digital Signal Processing", Prentice Hall, 4th edition, 2007 reprint
3. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Pearson Education (Asia) Pvt. Ltd, 2010.
4. Alan V. Oppenheim and Ronald W. Schafer, "Discrete -Time Signal Processing", PHI Learning, 2014 reprint.

COURSE OUTCOMES (COs):

1. Understand the basic concepts of signal modelling and multi-dimensional multirate systems **(PO 1, 2, 3, 5)**
2. Identify the design of various filtering models **(PO 1, 2, 3, 5)**
3. Design various filtering models. **(PO 1, 2, 3, 5)**
4. Implement adaptive, linear and multirate filters. **(PO 1, 2, 3, 5)**
5. Distinguish the analysis of signal modelling, adaptive, linear and multirate filters **(PO 1, 2, 3, 5)**

WIRELESS SENSOR NETWORKS LAB

Course Code: MDCEL24 **Credit: 0:0:1**
Course Coordinator: Dr. K.R.Shobha **Contact Hours: 28**
Prerequisites: Computer Communication Networks

Course contents

Laboratory Experiments

Basic Experiments

1. Simulate a point-to-point network with the links Apply relevant application over TCP and UDP agents and determine the number of packets sent by TCP/UDP. plot congestion window for different source/destination
2. Create & Simulate a WAN with FTP over TCP in wireless network and observe its performance
3. 3 experiments using motes

Advanced Experiments

4. Create and Simulate a Wireless network with 50 nodes as two clusters, apply two CBR traffic between clusters, apply low moderate and high mobility to the nodes and compare the performance of the network for two different routing protocols
5. Create and simulate a WSN and study the behavior of the network for different node mobilities
6. 3 experiments using motes

Research Experiments

7. Create and Simulate a Wireless Sensor Network scenario to test the beacon and non-beacon enabled mode.
8. Create and Simulate a Wireless Sensor Network scenario to test the behavior of a mobile device which is transmitting data packets and becomes disassociated (orphaned) from the PAN coordinator.
9. 2 experiments using motes

REFERENCE BOOKS:

1. John G. Proakis, “Digital Communications", 4th edition, McGraw Hill, 2007.
2. Stephen G. Wilson, “Digital Modulation and Coding”, Pearson Education (Asia) Pte. Ltd, 2003.
3. Waltenegus Dargie and Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley Publication, 2010.
4. Holger Karl and Andreas Willig, “Protocol and Architecture for Wireless Sensor Networks”, John Wiley publication, 2007.
5. Feng Zhao and Leonidas Guibas, “Wireless Sensor Networks: an information processing approach”, Elsevier publication, 2004.

COURSE OUTCOMES (COs):

1. Use Qualnet simulator and WSN hardware for implementing different concepts of Network **(PO1, 3, 4, 5)**
2. Design and implement Simulations for different layers of the network **(PO1, 2, 3, 4, 5)**
3. Design and implement scenarios for different configuration of wired and wireless Networks. **(PO1, 2, 3, 4, 5)**
4. Analyze the results to have in depth understanding of information flow in a Network **(PO1, 2, 3, 4, 5)**
5. Compare performance of different protocols under varied scenarios **(PO1, 2, 3, 4, 5)**

ADVANCED DIGITAL SIGNAL PROCESSING LAB

Course Code: MDCEL25 **Credit: 0:0:1**
Course Coordinator: Ramya H R **Contact Hours: 28**
Prerequisites: Signal and systems, Digital Signal Processing

Course contents

Laboratory Experiments
Tools: MATLAB

Basic Experiments:

1)Distribution function and density function of random variables

2)Mean, Autocorrelation, Autocorrelation matrix and power spectrum of a random phase sinusoid

3)Special types of Random Process:
ARMA Process, AR Process, MA process

Advanced Experiments:

Signal Modelling Techniques:

4)Pade approximation method for first and second order all pole model

5)Prony's approximation method first and second order all pole model

6)Periodogram for random phase sinusoid

7)Overlay plot for an ensemble average using Bartlett method for a unit variance white Gaussian noise

Windowing Technique:

8)Bartlett windowing technique to design FIR filter

Research Experiments:

9)Implementation of Integer sampling rate conversion by a factor L and M.

10)Implementation of Fractional sampling rate conversion by a factor (L/M)

Reference Books

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & Sons, (Asia) Pvt. Ltd., 2002.
2. Bernard Widrow and Samuel D. Stearns, "Adaptive Signal Processing", Pearson Education (Asia) Pvt. Ltd., 2001.
3. Simon Haykin, "Adaptive Filters", Pearson Education (Asia) Pte. Ltd., 4th Edition, 2002.

4. J.G. Proakis, C.M. Rader, F.Ling, C. L. Nikias, M. Moonen and I. K. Proudler, "Algorithms for Statistical Signal Processing", Pearson Education (Asia) Pvt. Ltd., 2002

Course Outcomes (COs):

1. Understand Random processes at the receiver end of a communication system. (PO1, PO2, PO3, PO4 ,PO5)
2. Implement various signal modeling techniques and justify which method is the best. (PO1,PO2,PO3,PO4,PO5)
3. Design and Implement an optimum filter that gets adapted to various changes using various LMS and Recursive methods. (PO1,PO2,PO3,PO4,PO5)
4. Estimate various spectral estimation methods like Parametric and Nonparametric. (PO1,PO2,PO3,PO4,PO5)
5. Implement various types of multi-rate operations (PO1,PO2,PO3,PO4,PO5)

III Semester

3G/4G WIRELESS MOBILE COMMUNICATION

Course Code: MDCE31 **Credit: 4:0:0**
Course Coordinator: Kusuma S M **Contact Hours: 56**
Prerequisites : Advanced Digital Communication

Course contents

UNIT1

Introduction to Wireless Communications and Diversity, Broadband Wireless Channel Modeling: Wide-Sense Stationary Uncorrelated Scattering Channel Modeling – RMS Delay Spread – Doppler Fading – Jakes Model, Autocorrelation – Jakes Spectrum – Impact of Doppler Fading.

UNIT2

Code Division Multiple Access: Introduction to CDMA–Walsh codes–Variable tree VSF–Multipath diversity- RAKE Receiver – CDMA Receiver Synchronization:

UNIT3

Orthogonal Frequency Division Multiplexing: Introduction to OFDM–Multi carrier Modulation and Cyclic Prefix – Channel model and SNR – Performance – OFDM issues – peak to Average power ratio Frequency anTiming offset issue

UNIT4

Multiple Input Multiple Output Systems: Introduction to MIMO, MIMO Channel–Singular value Decomposition and Eigen Modes of the MIMO Channel – MIMO Spatial Multiplexing –V BLAST – MIMO Diversity techniques –Alamouti Coding , OSTBC, MRT – MIMO and OFDM. Maximal Ratio Transmission in MIMO

UNIT5

Ultrawide Band 3G and 4G Wireless Standards: UWB Definition and Features–UWB Wirelesschannels – UWB Data Modulation – Uniform Pulse Train, 4G network aspects Standards of GPRS, WCDMA, LTE and WiMax Technologies.

REFERENCE BOOKS:

1. Aditya K Jaganatham, "Principles of Modern of wireless communication systems", McGraw Hill Education, 2016
2. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Prentice Hall, 2003.

3. Theodore S Rappaport, “Wireless Communications”, Pearson Education”, Asia , New Delhi, 2010
4. Andrea Goldsmith, “Wireless Communications”, Cambridge University Press”, 2007.
5. ITI SAHA MISRA, “Wireless Communications and Networks: 3G and Beyond”, Tata Mc. Graw Hill education Ltd., New Delhi, 2009.
6. Sumit Kasera and Nishant Narang, “3G Networks Architecture, Protocols and Procedures”, Tata Mc GrawHill Professional series fifth reprint-2008

COURSE OUTCOMES (COs):

1. Understand the concepts of Wireless Communications and broadband Wireless Channel Modeling and tackle the problems on the same. Analysis of BER performance of wireless channel **(PO1, 3, 4, 5)**
2. Analyze CDMA technologies, and analytics relating to coding and multipath diversity issues **(PO1, 3, 4, 5)**
3. Ability to discuss and analyze the OFDM concepts and also to tackle the issues relating to power, frequency and time **(PO1, 3, 4, 5)**
4. Apply MIMO concepts in spatial Multiplexing capabilities along with diversity techniques **(PO1, 3, 4, 5)**
5. Analyze Ultra wide band concepts, LTE and WiMax Technologies **(PO1,3,4,5)**

PROFESSIONAL ELECTIVES
GROUP-1
NETWORKS AND EMBEDDED SYSTEMS

RANDOM PROCESS

Course Code: MDCEPE11 **Credit: 3:1:0**
Course Coordinator: Dr. B K Sujatha **Contact Hours: 42+28**
Prerequisites: Engineering Mathematics

Course contents

UNIT 1

INTRODUCTION TO PROBABILITY THEORY: Experiments. Sample space, Events, Axioms, Assigning probabilities, Joint and conditional probabilities, Baye's Theorem, Independence, Discrete Random Variables, Engineering, Example, Random Variables, Distributions, Density Functions: CDF, PDF, Gaussian random variable, Uniform Exponential, Laplace, Gamma, Erlang, Chi- Square, Raleigh, Rician and Cauchy types of random variables.

UNIT 2

OPERATIONS ON A SINGLE R V: Expected value, EV of Random variables, EV of functions of Random variables, Central Moments, Conditional expected values. Characteristic functions, Probability generating functions, Moment generating functions, Engineering applications, Scalar quantization, entropy and source coding.

UNIT 3

Pairs of Random variables, Joint CDF, joint PDF, Joint probability mass functions, Conditional Distribution, density and mass functions, EV involving pairs of Random variables, Independent Random variables, Complex Random variables, Engineering Application.

UNIT 4

MULTIPLE RANDOM VARIABLES: Joint and conditional PMF, CDF, PDF,.EV involving multiple Random variables, Gaussian Random variable in multiple dimension, Engineering application, linear prediction.

UNIT 5

RANDOM PROCESS: Definition and characterization, Mathematical tools for studying Random Processes, Stationary and Ergodic Random processes, Properties of ACF.
EXAMPLE PROCESSES: Markov processes, Gaussian Processes, Poisson Processes, Engg application, Computer networks, Telephone networks.

REFERENCE BOOKS:

1. Papoullis and S U Pillai, “Probability, Random variables and Stochastic Processes”, McGraw Hill 2012.
2. Peyton Z Peebles, “Probability, Random variables and Random signal principles”, TMH 4th Edition, 2010.
3. H Stark and Woods, “Probability, random processes and applications”, PHI 2010.
4. S L Miller and D C Childers, “Probability and random processes: application to Signal processing and communication”, Academic Press, Elsevier, 2014.

Course Outcomes (COs):

1. Define, list, recall and analyze the basic parameters of Probability such as Sample space, Axioms, Conditional probability, with applications **(PO1, 2, 3)**
2. Analyze and compare the problems related to Single Random variable **(PO1, 2, 3)**
3. Analyze Joint PDF, CDF to pairs of Random Variables with examples **(PO1, 3)**
4. Solve PMF, CDF, PDF, and EV in Multiple Random variables **(PO1, 3)**.
5. Analyze different types of Random Processes **(PO1, 2, 3)**.

SIMULATION, MODELING AND ANALYSIS

Course Code: MDCEPE12 **Credit: 4:0:0**
Course Coordinator: S. J. Krishna Prasad **Contact Hours: 56**
Prerequisites: Engineering Mathematics and Probability theory

Course contents

UNIT 1

Basic Simulation Modeling: Nature of simulation, System models, discrete Event simulation, Single server simulation, Alternative approaches, other types of simulation.

UNIT 2

Building Models: Valid, Credible and Detailed Simulation Models: Techniques for increasing model validity and credibility, comparing real world observations.

UNIT 3

Selecting input Probability Distributions: Useful probability distributions, Assessing sample independence, Activity–I, II and III, Model of arrival process.

UNIT 4

Random variate generation: Approaches of inverse transform and acceptance-rejection. Continuous random variates (8.3.1 to 8.3.7), discrete random variates, correlated random variates.using conditional distributions and multivariate normal and lognormal.

UNIT 5

Output Data Analysis: Statistical analysis for term initiating simulation, Analysis for steady state parameters with problem of initial transient, Comparing alternative system configuration, Confidence interval of expected responses of two systems.

REFERENCE BOOKS:

1. Averill Law, "Simulation modeling and analysis", 4th Edition, McGraw Hill, 2007.
2. Jerry Banks, "Discrete event system simulation", Pearson Education, 2009.
3. Seila Ceric and Tadikamalla, "Applied simulation modeling", Cengage Publishing, 2009.
4. George. S. Fishman, "Discrete event simulation", Springer, 2001.
5. Frank L. Severance, "System modeling and simulation", Wiley, 2009.

COURSE OUTCOMES (COs):

1. Apply theory of simulation to build theoretically and practically valid and credible simulation models, and extrapolate techniques of validating simulation models **(PO1, 3, 4, 5)**
2. Examine probability distributions/arrival process (univariate /multivariate), statistical tests of independence of distributions, deployed in credible simulation models. Indicate their usefulness in building valid credible models **(PO1, 3, 4)**
3. Identify and fit data associated with probability distributions with suitable theoretical ideas of hypothesis testing and estimate parameters of same used in simulation studies **(PO1, 2, 3, 5)**
4. Examine approaches of generation of varieties of random variates and analyze their usage in building valid credible models. **(PO1, 4)**
5. Analyze transient /steady state techniques of analysing output data from valid credible models. Also analyze techniques of comparing two models based on output data and their confidence intervals **(PO1, 3, 5)**

CRYPTOGRAPHY AND NETWORK SECURITY

Course Code: MDCEPE13 **Credit: 4:0:0**
Course Coordinator: Venu K N **Contact Hours: 56**
Prerequisites: Computer Communication Networks and Operating Systems

Course contents

UNIT 1

Overview: Services, Mechanisms and attacks, OSI security architecture, Model for network security. Classical Encryption Techniques: Symmetric cipher model, Substitution techniques, Transposition techniques, Rotor machine, Steganography, Problems.

UNIT 2

Block Ciphers and DES (Data Encryption Standards): Simplified DES, Block cipher principles, DES, Strength of DES, Block cipher design principles, Block cipher modes of operation, Problems. Public Key Cryptography and RSA: Principles of public key cryptosystems, RSA algorithm, Problems. Other

UNIT 3

Public Key Crypto Systems and Key Management: Key management, Diffie-Hellman key exchange, Elliptic curve arithmetic, Elliptic curve cryptography, Problems.

UNIT 4

Message Authentication and Hash Functions: Authentication requirements, Authentication functions, Message authentication codes, Hash functions, Security of hash functions and MAC‘s, Problems. Digital Signature and Authentication Protocol: Digital signature, Authentication protocols, Digital signature standard. Authentication Applications: Kerberos, X.509 authentication service, Kerberos encryption technique, Problems.

UNIT 5

Electronic Mail Security: Pretty good privacy, S/MIME, Data compression using ZIP, Radix-64 conversion, PGP random number generator. IP Security: Overview, IP security architecture, Authentication header, ESP (encapsulating security pay load), Security associations, Key management, Problems) Firewalls: Firewall design principles; trusted systems, Problems.

REFERENCE BOOKS

1. William Stallings, "Cryptography and Network Security", 3rd edition, Pearson Education (Asia) Pte. Ltd. / Prentice Hall of India, 2003.
2. Kaufman, R. Perlman, and M. Speciner, "Network Security: Private Communication in a Public World", 2nd edition, Pearson Education (Asia) Pte. Ltd., 2002.
3. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill, 2003.
4. Eric Maiwald, "Fundamentals of Network Security", McGraw- Hill, 2003.
5. John Hershey, "Cryptography Demystified", Mc Graw-Hill, 2002.

COURSE OUTCOMES (COs):

1. Understand the basic models of security, and public key cryptosystems **(PO1,2,3)**
2. Analyze various Block ciphers, Data encryption standards & techniques, and key management **(PO1, 4)**
3. Analyze Kerberos and X.509 authentication service and digital signature **(PO1, 2)**
4. Understand electronic mail security and hash functions **(PO1, 2, 5)**
5. Understand authent and analyze authentication functions and firewalls **(PO1,2)**

SOFTWARE DEFINED WIRELESS SYSTEM DESIGN

Course Code: MDCEPE14 **Credit: 3:0:1**
Course Coordinator: Dr.Umesharaddy **Contact Hours: 42+28**
Prerequisites: Digital System Design.

Course contents

UNIT 1

Introduction: Introduction to ASICs and FPGAs, Digital design flow using FPGAs, CAD tools, simple PLDs and Complex PLDs, Realization of combinational logic circuit using PROM, PLA and PAL, Types of Memory and Composition of Memory.

UNIT 2

Verilog HDL: Data types and operators–Gate Level Modeling–Data Flow Modeling–Behavioral Modeling-structural modeling –Design of combinational logic and sequential logic circuits-Design of Memory module and Finite state machines-test benches, Switch Level Modeling, Delays, Logical verification and Synthesis.

UNIT 3

FPGA Architecture: Xilinx FPGA architectures, Configurable logic blocks, I/O blocks, programmable interconnects, programming technologies, FPGA Fabrics, Digital System Design Using FPGA.

UNIT 4

Software Radio: Block Diagram of Software Radio–Numerically controlled oscillator–Digital Upconverters / Down Converters – Sampling schemes-Coherent Modulator and Demodulator - Incoherent Demodulation – digital approach for I and Q generation- Filter design (CIC) - baseband processing techniques, Digital Modulation & Demodulation using Verilog HDL.

UNIT 5

System Design: Design of Digital signal processing blocks- FFT, IFFT, FIR filters– crest factor reduction, digital pre-distortion blocks- Turbo coders -OFDM modulators/demodulators, Network security-AES encryption- decryption modules, Convolution in Time and Frequency Domain.

LIST OF LAB EXPERIMENTS:

All the Programs to be simulated using VERILOG HDL and downloaded on to XILINX SPARTAN 3/SPARTEN 6 Atlys FPGA boards for synthesis. Tool used: XILINX ISE 14.7i. Simulation tool: ISE Xilinx built-in simulator.

1. Data flow modeling using Verilog HDL (adder, subtractor, multiplier, divider with design block).
2. Gate level /structural modeling using verilog HDL (adder, subtractor, multiplier, divider, comparator).
3. Behavioral modeling for multiplexer, Decoder, encoder, carry look ahead adder, booth multiplier, registers, counters with stimulus block (test-bench).
4. Mixed type and switch level modeling inverter, nand, nor, xor, xnor and simple Boolean expressions like y=ab+c.
5. Verilog module to control the speed and direction of stepper/DC motor.
6. Verilog module for 4×4 keypad scanner.
7. Verilog module for elevator/relay controller.
8. Verilog module for 7-segment LED display
9. Verilog module for LCD display.
10. Behavioral description for ADC/DAC using Verilog HDL.
11. IIR Filter design using Verilog HDL
12. FIR Filter design using Verilog HDL.
13. Implementation of Universal Modulator and Demodulator using CORDIC.
14. Behavioral description for data encryption and decryption using Verilog HDL.

REFERENCE BOOKS

1. Bob Zeidman, "Designing with CPLDs and FPGAs", CMP, 2002.
2. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Prentice Hall, 2003.
3. Jeffrey H Reed, "Software Radio: A Modern Approach to Radio Engineering", Prentice Hall, 2002.
4. Mitra S K, "Digital Signal Processing", Tata McGraw Hill, 2005.
5. Uwe Meyer Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, 2007.
6. Stephen Brown, "Fundamentals of Digital Logic with Verilog Design", Tata McGraw-Hill,2009.

COURSE OUTCOMES (COs):

1. Ability to realize simple & complex digital circuits using PLD's, FPGA and CPLDs. **(PO1,4)**
2. Ability to develop digital logic circuit using different types of descriptions with Verilog HDL. **(PO1, 2, 4,5)**
3. Analyze the basic Configurable Logic Blocks in FPGA. **(PO1, 3)**
4. Describe and design of Software Defined Radio. **(PO1, 3)**
5. Construct and implement different types of filters used in MODEM using FPGA. **(PO3, 5)**

ADVANCED EMBEDDED SYSTEMS

Course Code: MDCEPE15 **Credit: 4:0:0**

Course Coordinator: Dr.S.G.Shiva Prasad Yadav **Contact Hours: 56**

Prerequisites: Microcontrollers, Operating Systems, Digital Electronics

Course contents

UNIT 1

Embedded Systems: Introduction, Architecture of Embedded Systems, Types, Characteristics, Real Time System, Real Time System Design issues, Applications, Basic Model of Real Time System, characteristics, Types of Real time systems, Hardware Considerations – Hardware Interfacing, CPU, Memory, Sensors, Actuators, Input/Output, Other Special Devices (A/D, D/A, USART, Timers, Interrupt Controllers), Device Drivers, Interrupts & Interrupt Latency.

UNIT 2

ARM Cortex Processors Fundamentals and Instruction set: Introduction to ARM Embedded Systems, Introduction to ARM Cortex-M3 Processor, Architecture versions, Instruction Set Development, The Thumb-2 Instruction Set Architecture (ISA), Cortex-M3 Processor Applications, Overview of the Cortex-M3, Fundamentals, Registers, Special Registers, Operation Modes, The Built-In Nested Vectored Interrupt Controller, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Instruction Sets - Assembly Basics, Instruction set descriptions

UNIT 3

ARM Cortex-M3 Implementation and Programming: The Pipeline, A Detailed Block Diagram Bus Interfaces on the Cortex-M3, The I-Code Bus, D-Code Bus, System Bus, External Private Peripheral Bus, Debug Access Port Bus, Other Interfaces on the Cortex-M3, Typical Connections, Reset Signals, NVIC and Interrupt Control, Basic Interrupt Configuration, Interrupt Enable and Clear Enable, Interrupt Pending and Clear Pending, Example Procedures of Setting Up an Interrupt, Software Interrupts, Cortex-M3 Programming - Using Assembly, Using C, The Interface Between Assembly and C, A Typical Development Flow.

UNIT 4

Advanced Programming Features and Memory Protection Unit: Exceptions Programming, Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Example with Exception Handlers, Using SVC, SVC Example, Using SVC with C, Running a System with Two Separate Stacks, Double-Word Stack Alignment, Non-base Thread Enable, Performance Considerations, Lockup Situations, Overview of Memory Protection Unit, MPU Registers, Setting Up MPU, Typical Setup.

UNIT 5

Real Time Operating System: Fundamentals of RTOS, Features, characteristics of RTOS, Real Time Kernel and its Types, Tasks, Task states, State Transition Diagram, Tasks, Task Control Block (TCB), Processes and Threads, Multi-Tasking, Context Switching, Foreground-Background Systems, Real Time Task Scheduling, Need and problems of shared data, Semaphores, Types of semaphores, Problems with semaphores, Deadlock, Priority Inversion and overcoming techniques, Overview of different types of RTOS, Introduction to VX Works / Mucos, their features, Real Time Applications .

REFERENCE BOOKS

1. Phillip A Laplante, “Real-Time Systems Design and Analysis - An Engineer’s Handbook” - Second Edition, PHI Publications, 2012
2. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, Newnes Publications, 2007
3. Jane W.S. Liu, “Real-Time Systems”, Pearson Education Inc., 2001.
4. Rajkamal, “Embedded Systems: Architecture, Programming and Design”, Tata McGraw Hill, New Delhi, 2009
5. Dr. K.V.K. K Prasad, “Embedded Real Time Systems: Concepts Design and Programming”, Dreamtech Press New Delhi, 2003.
6. Andrew N. Sloss, Dominic Symes and Chris Wright, “ARM System Developers Guide”, Morgan Kaufamnn (Elsevier Inc.), 2004
7. David E. Simon, “An Embedded Software Primer”, Addison- Wesley, 2008

COURSE OUTCOMES (COs):

1. Understand the various characteristics, challenges, applications, Hardware and software components and Need for RTOS in embedded system Design **(PO1, 2, 3, 5)**
2. Analyze the architectural features, memory management and peripherals of Industry standard 32-bit popular ARM Cortex M3 microcontroller focusing on performance considerations **(PO1, 3, 5)**
3. Develop application programs in Assembly/ C language for ARM Cortex M-series **(PO1, 3, 4, 5)**
4. Understand the capabilities of ARM Cortex Microcontroller in terms of handling exceptions, Interrupts, Pipelining and configuring Memory protection unit **(PO1, 3)**
5. Analyze the RTOS Concepts, challenges, features, functionalities, problems of RTOS and implementing RTOS based Embedded applications **(PO1, 5)**

IOT SYSTEM DESIGN

Course Code: MDCEPE16 **Credit: 4:0:0**
Course Coordinator: Dr. K. R. Shobha **Contact Hours: 56**
Prerequisites: Computer Networks, Microcontroller

Course contents

UNIT 1

Introduction & concepts: Definition and Characteristics of IoT, Things in IoT, IoT Protocols, IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies, IoT Levels and Deployment Templates IoT and M2M, SDN and NFV for IoT.

UNIT 2

Protocols for Internet of Things: 6LOWPAN, COAP, MQTT, RPL

UNIT 3

IoT Physical Devices and End Points: Basic Building Blocks of an IoT Device, Raspberry Pi, Linux on Raspberry Pi, Raspberry Pi Interfaces: Serial, SPI, and I2C Programming Raspberry Pi with Python: Controlling LED, Interfacing Switch, Interfacing Light Sensor

UNIT 4

Cloud and Data Analytics: Introduction to cloud storage Models and Communication APIs, Python. What is machine learning? Examples of machine learning applications, key terminologies, key tasks of machine learning, choosing right algorithms, steps in developing machine learning applications, why Python, getting started with numpy
Classifying with k-Nearest Neighbors: Classifying with distance measurements Examples

UNIT 5

Classifying with probability theory: naïve Bayes: classifying with Bayesian decision theory , Conditional probability, Classifying with conditional probabilities, Document classification with naïve Bayes, Classifying text with Python, Examples
Logistic regression: Classification with logistic regression and the sigmoid function: a tractable step function, Using optimization to find the best regression coefficients, Examples

REFERENCE BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A Hands-on Approach”, Universities Press, 2015
2. Zach Shelby and Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, 2009 John Wiley & Sons Ltd, ISBN 9780470747995.
3. Peter Harrington, “Machine Learning in Action”, Manning Publications, 2012, ISBN 978161729018
4. Ovidiu Vermesan, Peter Friess, “Internet of Things-From Research and Innovation to Market Deployment”, River Publishers Series in Communication, 2013.
5. http://www.internet-of-things-research.eu/pdf/IERC_Cluster_Book_2014_Ch.3_SRIA_WEB.pdf
6. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, ISBN 978-81-265-5686-1 Wiley Publication, 2013.
7. Ethem Alpaydin "Introduction To Machine Learning" 2nd Edition, PHI Pvt. Ltd-New Delhi,2010
8. Introduction to Internet of Things - Course – Nptel https://onlinecourses.nptel.ac.in /noc18_cs08/
9. Introduction to Machine Learning - Course – Nptel https:// onlinecourses.nptel.ac.in/ noc17_cs26

COURSE OUTCOMES (COs):

1. Understand the fundamentals and applications of Internet of Things. **(PO1, 3, 5)**
2. Identify the methodologies and tools involved in the design of IoT system **(PO1, 3, 4, 5)**
3. Examine aspects of hardware and software associated with the development of IoT System **(PO1, 2, 3, 4, 5)**
4. Illustrate methods of pushing data to end devices **(PO1, 2, 3, 4, 5)**
5. Design algorithms for some supervised learning techniques **(PO1, 2, 3, 4, 5)**

MEMS

Course Code: MDCEPE17 **Credit: 4:0:0**
Course Coordinator: Venu K N **Contact Hours: 56**
Prerequisites: Solid State Devices and Technology

Course contents

UNIT 1

Introduction To MEMS : Historical background of Micro Electro Mechanical Systems, Feynman‘ svision, Nano Technology and its Applications Multi-disciplinary aspects, Basic Technologies, Applications areas, Scaling Laws in miniaturization, scaling in geometry, electrostatics, electromagnetic, electricity and heat transfer

UNIT 2

Micro And Smart Devices And Systems: Principles: Transduction Principles in MEMS Sensors: Micro sensors-thermal radiation, mechanical and bio-sensors, Actuators: Different actuation mechanisms - silicon capacitive accelerometer, piezo-resistive pressure sensor, blood analyzer, conductometric gas sensor, silicon micro-mirror arrays, piezo-electric based inkjet print head, electrostatic comb-driver, Smart phone application, Smart buildings

UNIT 3

Materials & Micro manufacturing: Semiconducting Materials., Silicon, Silicon dioxide, SiliconNitride , Quartz, Poly Silicon, Polymers, Materials for wafer processing, Packaging Materials Silicon wafer processing, lithography, thin-film deposition, etching (wet and dry), wafer-bonding. Silicon micromachining: surface, bulk, LIGA process, Wafer bonding process.

UNIT 4

Electrical and Electronics Aspects: Electrostatics, Coupled Electro mechanics, stability and Pull-in phenomenon, Practical signal conditioning Circuits for Microsystems, Characterization of pressure sensors, RF MEMS. Switches reactors, tuned filters, Micromirror array for control and switching in optical communication, Application circuits based on microcontrollers for pressure sensor, Accelerometer, Modeling using CAD Tools (Intellisuite)

UNIT 5

Integration and Packaging of Micro electromechanical Systems: Integration of microelectronics and micro devices at wafer and chip levels. Microelectronic packaging: wire and ball bonding, flip-chip. Microsystem packaging examples, testing of Micro sensors, Qualification of MEMS devices

REFERENCE BOOKS

1. T R Hsu, "MEMS and Microsystems Design and Manufacturing", Tata McGraw Hill, 2nd Edition, 2008
2. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat, and V. K. Aatre, "Micro and Smart Systems", Wiley India, 2010.
3. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
4. S. D. Senturia, "Micro System Design", Springer International Edition, 2001.

COURSE OUTCOMES (COs):

1. Understand basics and typical applications of microsystems and different actuation mechanisms **(PO1, 2,3,4)**
2. Analyze scaling laws & microsensors and microactuators and semiconductor materials used for micro manufacturing **(PO1, 2, 3, 5)**
3. Evaluate the various principles of operations of MEMS transducers **(PO1, 2, 3)**
4. Understand basic electrostatics and its applications in MEMS sensors and actuators and circuits for microsensors **(PO1, 3, 5)**
5. To understand ways to fabricate & a packaging needs MEMS device and wafer bonding process **(PO1, 3, 4, 5)**

GROUP-2
COMMUNICATION AND SIGNAL PROCESSING

ADVANCED MATHEMATICS

Course Code: MDCEPE21 **Credit: 3:1:0**
Course Coordinator: Prof. Subba Bhatta **Contact Hours: 42+28**
Prerequisites: UG – Engineering Mathematics

Course contents

UNIT 1

Linear Algebra I: Introduction to linear systems, matrix notation, Rank and Consistency, geometry of linear equations, Gaussian elimination, Gauss-Jordan elimination. Eigen values and Eigen vectors, diagonalization, power of a matrix and solution of ODE.

UNIT 2

Linear Algebra II: Symmetric Matrices, properties, orthogonal diagonalization, Quadratic forms, Canonical form and Nature of Quadratic forms and SVD.
Vector Spaces: Vector spaces and subspaces, linear independence, basis and dimension, Coordinate system, Kernel and Range of linear transformation.

UNIT 3

Linear Algebra III: Orthogonal sets, orthogonal projections, Gram – Schmidt process, Least square problems.

UNIT4

Random Process: definition, Classification, special classes of Random Process – WSS, SSS, Ergodic process, Poisson process, inter arrival and waiting times engineering applications.

UNIT 5

Markov Process and Queuing Theory: Markov Process, Continuous time Markov chain, Pire birth and Pure birth process, Birth and death process, computation of steady state and balancing Equations of birth and death process, renewal process.
(M/M/1): (∞/FIFO), (M/M/1): (κ/FIFO), (M/M/S): (∞/FIFO), (M/M/S): (κ/FIFO)

TEXT BOOKS:

1. David C. Lay, "Linear Algebra and its Applications", 4th Edition, Pearson Education, 2012.
2. T. Veerarajan, "Probability, Statistics and Random Process", 3rd Edition, 2017.

REFERENCE BOOKS:

1. Gilbert Strang, "Introduction to Linear Algebra", 5th Edition, 2016.
2. Athanasios Papoulos and S Unnikrishna Pillai, "Probability, Random Variables and stochastic process", 2011.

COURSE OUTCOMES (COs):

1. Solve system of linear equations and Solve Simultaneous ODEs by a matrix method. **(PO1, 4)**
2. Diagonalizable a matrix by orthogonal diagonalization and discuss the problems related to linear transformations. **(PO1, 4)**
3. Find orthonormal vectors using Gram-Schmidt process and solve problems using least square concepts. **(PO1, 4)**
4. Discuss the nature of stationary processes. **(PO1, 4)**
5. Discuss the characteristics of different queuing models. **(PO1, 4)**

DETECTION AND ESTIMATION

Course Code: MDCEPE22 **Credit: 4:0:0**
Course Coordinator: Dr. Parimala P **Contact Hours: 56**
Prerequisites: Probability Theory and Digital Signal Processing Techniques

Course contents

UNIT 1

Classical Detection and Estimation Theory: Introduction, simple binary hypothesis tests, MHypotheses, estimation theory, composite hypotheses, general Gaussian problem, performance bounds and approximations.

UNIT 2

Representations of Random Processes: Introduction, orthogonal representations, random processcharacterization, homogenous integral equations and eigen-functions, periodic processes, spectral decomposition, vector random processes.

UNIT 3

Detection of Signals – Estimation of Signal Parameters: Introduction, detection and estimation inwhite Gaussian noise, detection and estimation in nonwhite Gaussian noise, signals with unwanted parameters, multiple channels and multiple parameter estimation.

UNIT 4

Estimation of Continuous Waveforms: Introduction, derivation of estimator equations, a lower bound on the mean-square estimation error, multidimensional waveform estimation, non-random waveform estimation.

UNIT 5

Linear Estimation: Properties of optimum processors, realizable linear filters, Kalman-Bucy filters, fundamental role of optimum linear filters.

REFERENCE BOOKS

1. Harry L. and Van Trees, “Detection, Estimation, and Modulation Theory”, John Wiley & Sons, USA, 2011.
2. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan, “Introduction to Statistical Signal Processing with Applications”, Pearson Education (Asia) Pte. Ltd. Prentice Hall of India, 2010.

3. Steven M. Kay, “Fundamentals of Statistical Signal Processing Volume I: Estimation Theory”, Prentice Hall, USA,2008;
4. Steven M. Kay, “Fundamentals of Statistical Signal Processing, Volume II: Detection Theory”, Prentice Hall, USA, 2008.
5. K Sam Shanmugam and Arthur M Breipohl, “Random Signals: Detection, Estimation and Data Analysis”, John Wiley & Sons, 2008
6. Louis L, schraf, “Statistical Signal processing, detection, Estimation and Time Series Analysis”, Addison Wesley, 2011

COURSE OUTCOMES (COs):

1. Recognize mathematical models of techniques associated with hypothesis tests and hypothesis estimation theory **(PO1, 3)**
2. Distinguish various techniques associated with representations & types of Random processes **(PO1, 3)**
3. Apply mathematical models associated with the behavior of Continuous signals and waveforms on the channels. **(PO1, 3, 5)**
4. Design optimized realizable linear filters with mathematical aspects. **(PO1, 3, 5)**
5. Evaluate the performance of detection techniques associated with varieties of signals, noise & performance of techniques of signal parameter estimation **(PO1, 3, 5)**

ERROR CONTROL CODING

Course Code: MDCEPE23 **Credit: 4:0:0**

Course coordinator: Dr. Parimala P **Contact Hours: 56**

Prerequisites: Digital Communication and Probability Theory

Course contents

UNIT 1

Introduction to Algebra: Groups, Fields, Binary Field Arithmetic, Construction of Galois Field GF (2m) and its basic properties, Computation using Galois Field GF (2m) Arithmetic, Vector spaces and Matrices.

UNIT 2

Linear Block Codes: Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities, Standard array and Syndrome decoding, Decoding circuits, Hamming Codes, Reed – Muller codes.

UNIT 3

Cyclic Codes: Introduction, Generator and Parity check Polynomials, Encoding using Multiplication circuits, Systematic Cyclic codes – Encoding using Feedback shift register circuits, Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder, Error trapping decoding, Golay code, Shortened cyclic codes.

UNIT 4

BCH Codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Implementation of Error correction. Non – binary BCH codes: q – ary Linear Block Codes, Primitive BCH codes over GF (q), Reed – Solomon Codes, Decoding of Non – Binary BCH and RS codes: The Berlekamp - Massey Algorithm. Majority Logic Decodable Codes: One – Step Majority logic decoding.

UNIT 5

Convolution Codes: Encoding of Convolution codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms, Majority logic decoding, Concatenated Codes: Single level Concatenated codes, Soft decision Multistage decoding, Introduction to Turbo coding and their distance properties, Design of Turbo codes.

REFERENCE BOOKS

1. Shu Lin & Daniel J. Costello, "Error Control Coding", Pearson Prentice Hall, Second Edition, 2014.
2. Blahut, R.E. "Theory and Practice of Error Control Codes", Addison Wesley, 2005.
3. F.J. Mac Williams and N.J.A slone, "The theory of Error Correcting Codes", North Holland, 2006.
4. Peterson & Weldon, "Error Correcting Codes", MIT Press, Combridge, Massachuseats, 2009.
5. Satyanarayana P.S, "Concepts of Information Theory & coding", Dynaram Publication, Bangalore, 2005.

COURSE OUTCOMES (COs):

1. Recall the basic properties of binary arithmetic, Block codes and convolutional codes. **(PO5)**
2. Describe Galois field properties, Block codes and convolutional codes for error detection and correction **(PO1,2,3,4)**
3. Apply the concepts of Galois Field, Linear block codes, Cyclic codes, BCH codes and Convolutional codes with examples **(PO1,2,3,4)**
4. Analyse error controlling with Block codes and convolutional codes **(PO1,2,3,4,5)**
5. Evaluate different error controlling codes with its capacity of error detection and error correction. **(PO1,2,3,4)**

WAVELET TRANSFORMS

Course Code: MDCEPE24 **Credit: 4:0:0**
Course Coordinator: Dr. Parimala P **Contact Hours: 56**
Prerequisites: Digital Signal Processing

Course contents

UNIT 1

Introduction: Continuous wavelet transforms, Properties, Inverse transform, Examples of mother wavelets, Analytic wavelet transform.
Implementation of mother wavelets using Mat software.

UNIT 2

Introduction to Discrete Wavelet Transform: MRA, A wavelet basis for MRA, Digital filtering interpretation, Examples of orthogonal basis –generating wavelets, interpreting orthonormal MRAs for discrete time signals.
Implementation of feature extraction.

UNIT 3

Bi-orthogonal Wavelets: Bi-orthogonal wavelet bases, Filtering relationship for bi-orthogonal filters, Examples of bi-orthogonal scaling functions and wavelets, two dimensional wavelets, Multidimensional wavelets and wavelet packets.
Implementation of classification of data using wavelets.

UNIT 4

Wavelet transform and data compression: Transform coding, DTWT for image compression, Audio compression and video coding 61
Implementation of Image compression using wavelet transforms.

UNIT 5

Applications of Wavelet Transforms: De-noising, Biomedical applications, Applications in communication system, Edge detection and object isolation, Image fusion.Application of wavelets in bio-medical signals.

REFERENCE BOOKS

1. K. P. Soman and K.L. Ramchandran, “Insight into Wavelets from theory to practice”, Eastern Economy Edition, 2008
2. Stephane G. Mallat, “A Wavelet Tour of Signal Processing”, Academic Press, Second Edition, 2011.

3. Raghuveer M. Rao, Ajit S. Bopardikar, “Wavelet Transforms: Introduction to Theory & Applications”, Pearson Education Asia, New Delhi, 2013
4. Agostino Abbate, Casimer M. DeCusatis and Pankaj K. Das, “Wavelets and Subbands Fundamentals and Applications”, Pearson Education Asia, New Delhi, 2012

COURSE OUTCOMES (COs):

1. Describe scaling functions, continuous wavelet transform and different wavelet functions. **(PO1, 2)**
2. Differentiate continuous wavelet and discrete wavelet transforms and analyze multi-resolution analysis. **(PO 1, 2, 3)**
3. Develop bi-orthogonal wavelet basis function and apply to two dimensional signals. **(PO1, 2, 3)**
4. Apply wavelet transform for image and audio compression. **(PO1, 2)**
5. Employ wavelet transforms for de-noising, speckle removal, object detection and data communication **(PO1, 2, 3)**

IMAGE AND VIDEO PROCESSING

Course Code: MDCEPE25 **Credit: 4:0:0**
Course Coordinator: Venu K N **Contact Hours: 56**
Prerequisites: Digital Signal Processing

Course contents

UNIT 1

Introduction: 2D systems, Mathematical preliminaries–Fourier Transform Z Transform, Optical &Modulation transfer function, Matrix theory, Random signals, Discrete Random fields, Spectral density function.

Image Perception: Light, Luminance, Brightness, Contrast, MTF of the visual system, Visibility function, Monochrome vision models, Fidelity criteria, Color representation, Chromaticity diagram, Color coordinate systems, Color difference measures, Color vision model, Temporal properties of vision.

UNIT 2

Image Sampling and Quantization: Introduction, 2D sampling theory, Limitations in sampling &reconstruction, Quantization, Optimal quantizer, Compander, Visual quantization. Image Transforms: Introduction, 2D orthogonal & unitary transforms, Properties of unitary transforms, DFT, DCT, DST, Hadamard, Haar, Slant, KLT, SVD transform.

UNIT 3

Image Representation by Stochastic Models: Introduction, one dimensional Causal models, ARmodels, Non-causal representations, linear prediction in two dimensions. Image Enhancement: Point operations, Histogram modeling, spatial operations, Transform operations, Multi-spectral image enhancement, false color and Pseudo-color, Color Image enhancement.
Image Filtering & Restoration: Image observation models, Inverse & Wiener filtering, Fourier Do-main filters, Smoothing splines and interpolation, Least squares filters, generalized inverse, SVD and Iterative methods, Maximum entropy restoration, Bayesian methods, Coordinate transformation & geometric correction, Blind de-convolution.

UNIT 4

Image Analysis & Computer Vision: Spatial feature extraction, Transform features, Edge detection, Boundary Extraction, Boundary representation, Region representation, Moment representation, Structure, Shape features, Texture, Scene matching & detection, Image segmentation, Classification Techniques.

Image Reconstruction from Projections: Introduction, Radon Transform, Back projection operator, Projection theorem, Inverse Radon transform, Fourier reconstruction, Fan beam reconstruction, 3D tomography.

UNIT 5

Image Data Compression: Introduction, Pixel coding, Predictive techniques, Transform coding, Inter-frame coding, coding of two tone images, Image compression standards.

Video Processing: Fundamental Concepts in Video–Types of video signals, Analog video, Digital video, Color models in video, Video Compression Techniques – Motion compensation, Search for motion vectors, H.261, H.263, MPEG I, MPEG 2, MPEG 4, MPEG 7 and beyond, Content based video indexing.

REFERENCE BOOKS

1. K. Jain, "Fundamentals of Digital Image Processing", Pearson Education (Asia) Pte. Ltd./Prentice Hall of India, 2004.
2. Z. Li and M.S. Drew, "Fundamentals of Multimedia", Pearson Education (Asia) Pte. Ltd., 2004.
3. R. C. Gonzalez and R. E. Woods, "Digital Image Processing", 2nd edition, Pearson Education (Asia) Pte. Ltd/Prentice Hall of India, 2004.
4. M. Tekalp, "Digital Video Processing", Prentice Hall, USA, 2005

COURSE OUTCOMES (COs):

1. Analyze bout different processing operation that can be done on the image and different color models. **(PO1, 2, 4, 5)**
2. Analyze the spatial and frequency domain processing operation on the image and different transforms **(PO1, 2, 4)**
3. Evaluate different stochastic models and an ability to choose and design a filter for the same. **(PO1, 2, 4, 5)**
4. Analyze different color image processing operations, region representations **(PO1, 2, 4, 5)**
5. Analyze different compression algorithms that can be applied on the image and video and image reconstructions from images. **(PO1, 2, 4, 5)**

PATTERN RECOGNITION FOR MACHINE LEARNING

Course Code: MDCEPE26 **Credit: 4:0:0**
Course Coordinator: S J Krishna Prasad **Contact Hours: 56**
Prerequisites: Probability Theory

Course contents

UNIT 1

Introduction to Pattern Recognition: Introduction & applications of pattern recognition Statistical Decision theory Introduction to Image processing analysis its correlations to pattern recognition
Probability Theory: Introduction & definitions of probability. Random variables moments, Conditional probability Uniform exponential distributions & Normal (Gaussian) Distribution functions Joint distribution densities, Normal plot, Bivariate & Multivariate normal densities, correlation matrix. Estimation of density, methods of moments, maximum likelihood & unbiased estimators

UNIT 2

Parametric Decision making: Introduction, Bayes theorem & its applicability for continuous densities, decision regions, multiple features, Classification using ACT scores and ranks using two / three features, Conditionally independent features ,Unequal costs of error & Risk based decision boundary, Error rates ,Model based, Simple and fractional counting techniques. Leaving one out technique, characteristic curves, Confusion matrix & composition of population

UNIT 3

Non Parametric decision making: Introduction, Histogram technique Kernel and window estimators, Distance metrics, Single nearest neighbor technique, Error rates associated & comparison with Bayesian error rate, bound on nearest neighbor error rate & Bayesian error rate, K nearest neighbor technique, Scale factors and other nearest neighborhood techniques
Clustering: Introduction, hierarchical and partitional clustering

UNIT 4

Machine Learning Introduction and concepts: Introduction, Human brain & Mcculloch Pitt’s models.Machine perception, Learning problems Designing learning systems Perspectives and Issues in machine learning ,Concept learning ,vector spaces and Candidate elimination algorithm. Inductive bias Decision tree learning Representation and algorithm.

UNIT 5

Adaptive techniques: Introduction, ADB technique or algorithm, Adaptive & Minimum Squared error discriminant functions & relative comparisons. Choosing decision taking technique.

Linear models for Regression and Artificial neural networks:Linear Basis function models,Maximum likelihood and least squares ,Sequential learning , Bayesian Linear regression Parameter distribution.Nets without hidden layers, Single output & multiple output sequential MSE algorithms. Neural nets with hidden layers, Back propagation algorithm.

REFERENCE BOOKS

1. Earl Gose ,Richard Johnsonburg, Steven Jost, "Pattern Recognition and Image Analysis", PHI, 2nd edition latest reprint 2011
2. Seymour Lipschutz, Marc Lars Lipson, "Probability theory", Tata McGraw Hill, Special Indian Edition, 2nd edition, latest reprint 2010
3. Tom M.Mitchell , " Machine Learning",McGraw-Hill Education(Indian Edition),2013.
4. Christopher M.Bishop"Pattern Recognition and Machine Learning"2006 Springer
5. Richard O Duda,Peter E Hert, "Pattern Classification", John Wiley and Sons, 2nd edition, 2009
6. Robert Schalk, "Pattern Recognition: Statistical, Structural and Neural approaches", John Wiley and Sons, 2nd edition,2010.

COURSE OUTCOMES (COs):

1. Examine Probability & estimation theory applications to parametric and nonparametric pattern recognition problems in multidisciplinary approach. **(PO1, 3, 4, 5)**
2. Analyze parametric and non-parametric decision theory to application of emergent multidisciplinary domains. **(PO1, 3, 4, 5)**
3. Examine the machine learning framework and establish wide ranging applications of machine learning in algorithmic approach **(PO1, 3, 5)**
4. Examine neural network with related algorithms and it applicability to Pattern recognition problems **(PO 3, 4)**
5. Examine various models and algorithms of machine learning **(PO3, 4, 5)**

NEURAL NETWORKS AND FUZZY LOGIC

Course Code: MDCEPE27 **Credit: 4:0:0**
Course Coordinator: Ramya H R **Contact Hours: 56**
Prerequisites: Logic Design ,Programming Knowledge

Course contents

UNIT 1

Introduction: Basic building blocks of ANN, ANN terminologies, comparison between Artificial & Biological neural networks, Learning Rules, Network Architectures, Fundamental Models of ANN, Neural Net for Pattern Classification-Hebb Net, Perceptron, Adaline Network, Madaline Networks examples, Back propagation network- Architecture, training algorithm.Adaptive linear neuron Multilayer Perceptron Model

UNIT 2

Feed Forward and Feedback Networks:, Discrete Hopfield network –architecture, training algorithm and energy analysis, Radial Basis Function network - Architecture, training algorithm. Associative neural network- Hetero associative neural net architecture and Auto associative net architecture, Learning vector quantizer- Architecture, training algorithm, Brain state networks- training algorithm,, Boltzmann machines- training algorithm, Support Vector Machines-training algorithm.Unsupervised learning networks: Kohonen self-organizing feature maps, LVQ – CP networks, ART network.

UNIT 3

Fuzzy Set Theory: Fuzzy vs crisp sets, crisp sets, Operations on crisp sets, properties of crisp sets,partition and covering. Membership function, Basic fuzzy set operations, properties of Fuzzy sets, Crisp relations and Fuzzy relations.Fuzzy Inference Systems - Mamdani Fuzzy Models - Sugeno Fuzzy Models - Tsukamoto Fuzzy Models - Input Space Partitioning and Fuzzy Modeling.

UNIT 4

Fuzzy systems: Crisp logic: Laws of propositional logic, inference in propositional logic. Predicate logic: Interpretations of predicate logic formula, inference in predicate logic. Fuzzy logic: Fuzzy Quantifiers, Fuzzy inference. Fuzzy rule based system, Defuzzification. Applications: Greg Viot’s Fuzzy cruise controller, Air conditioner controller.Introduction to GA and its applications, Differences & similarities between GA & other traditional methods

UNIT 5

Applications: Pattern classification using Hebb net and McCulloch-Pitts net, Pattern recognition using Perceptron Networks, Process identification, control, fault diagnosis and load forecasting, Implementation of all fuzzy operations on both discrete and continuous fuzzy sets, Defuzzification, Fuzzy inference system. Soft computing based hybrid fuzzy controllers

TEXT BOOKS

1. S. Rajasekaran, G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy logic and Genetic algorithms", PHI, 2011.
2. Timothy Ross, "Fuzzy Logic with Engineering Applications", John Wiley and Sons, 2010.
3. S. N. Sivanandam, S. Sumathi and S N Deepa, "Introduction to Soft computing using Matlab 6.0", Tata McGraw Hill, 2016.

REFERENCES

1. Jacek M. Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House.
2. Laurene Fausett, "Fundamentals of Neural Networks, Architectures, Algorithms, and Applications", Pearson Educaation, 2004
3. B. Kosko, "Neural Networks and Fuzzy systems", Prentice Hall, 1992.

COURSE OUTCOMES (COs):

1. Understand the basic concepts of Neural networks, Fuzzy Logic and Genetic Algorithms. (PO1, PO2, PO3, PO5)
2. Understand different training algorithms of neural networks and properties of fuzzy sets.(PO1, PO2, PO3, PO5)
3. Apply the concept of back propagation Network, feedforward, feedback networks and fuzzy systems, (PO1, PO2, PO3, PO5)
4. Examine supervised and unsupervised learning algorithms, the rules of fuzzy logic for fuzzy controller and hybrid fuzzy logic controllers. (PO1, PO2, PO3, PO5)
5. Evaluate Pattern classification for different neural networks, defuzzification process of fuzzy systems for various applications. (PO1, PO2, PO3, PO4, PO5)