

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE - 641 014, TAMILNADU, INDIA

DIAMOND JUBILEE

(1956 - 2016)



DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.E. COMMUNICATION ENGINEERING

Curriculum and Syllabi

Under Choice Based Credit System

(For the students admitted during 2019 - 2020 and onwards)

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COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

VISION AND MISSION OF THE INSTITUTE

VISION

The Institute strives to inculcate a sound knowledge in engineering along with realized social responsibilities to enable its students to combat the current and impending challenges faced by our country and to extend their expertise to the global arena.

MISSION

The Mission of CIT is to impart high quality education and training to its students to make them World-Class Engineers with a foresight to the changes and problems, and pioneers to offer innovative solutions to benefit the nation and the world at large.

COIMBATORE INSTITUTE OF TECHNOLOGY

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION

The Vision of the department is to impart knowledge in the field of Electronics and Communication Engineering so as to nurture excellence in students, mould their capability to meet current and impending challenges and ignite aspiration to become innovators and entrepreneurs, thereby benefit the nation and world.

MISSION

The Mission of Electronics and Communication Engineering Department is

- M1** To impart high quality education and training to the students in the field of Electronics and Communication Engineering
- M2** To promote creation and dissemination of knowledge
- M3** To equip the students with right aptitude and attitude for continuous learning
- M4** To provide a framework for collaborative research with industries leading to innovation

**M.E. COMMUNICATION ENGINEERING
COIMBATORE INSTITUTE OF TECHNOLOGY**

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The following Programme Educational Objectives are designed for M.E. Communication Engineering programme in Electronics and Communication Engineering based on the Department Mission to provide higher engineering education and motivate research in the field of Communication Engineering.

- PEO1** To develop outstanding technical and professional expertise that enables the students to develop competency for career in global industrial, academic and research domains.
- PEO2** To develop communication skills, interpersonal skills, managerial skills, entrepreneurial skills and inculcate professional ethics and values needed for professional success in national and multinational companies, institutions and organizations.
- PEO3** To explore engineering solutions with good ethical standards and professional attitude for significant research in solving contemporary social and human issues within realistic constraints and acquire an aptitude for lifelong learning.

M.E. COMMUNICATION ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

PROGRAM OUTCOMES (POs)

Students in the Department of Electronics and Communication Engineering M.E. Communication Engineering programme should at the time of their graduation are in possession of:

- PO1** an ability to apply knowledge acquired from undergraduate engineering to arrive solutions to complex technical problems related to communication systems and engineering.
- PO2** an ability to apply knowledge of Communication Engineering in an innovative way to develop software and design electronic hardware products useful to the society.
- PO3** an ability to apply advanced technical knowledge in multiple contexts to solve broad research contemporary problems.
- PO4** an ability to understand, analyze, design and create advanced state of art communication systems/products, a strong urge for research with good scientific and engineering knowledge and present their results in the field of Communication Engineering and its related domains.
- PO5** an ability to use modern engineering IT tools in communication engineering, to model and simulate complex systems with an understanding of the limitations.
- PO6** an ability to work as an communication engineer who is capable of identifying solutions to various local and global multidisciplinary research problems faced by the society.
- PO7** an ability to develop effective communication & leadership skills and teamwork spirit that accomplish the goals of an organization.
- PO8** an ability to comprehend, write effective reports and design documentation with appropriate standards and make effective communication with clear instructions to engineering community and society.
- PO9** an ability to recognize the need for self learning and thereby engage themselves for lifelong learning to improve knowledge for better professional career.
- PO10** an ability to communicate effectively with the engineering community and the society at large, to express their knowledge in Communication Engineering.
- PO11** an ability to function as an effective member or a leader in a multidisciplinary team to undertake industrial projects for strengthening Industry-Institute Collaboration.
- PO12** an ability to develop confidence for self learning and lifelong learning in the broadest context of technological change.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.E. COMMUNICATION ENGINEERING

Curriculum from the Academic Year 2019 - 2020 onwards

Semester I

Course Code	Course Name	L	T	P	C	Category
	THEORY					
19MEC11	Applied Mathematics for Communication Engineering	4	0	0	4	FC
19MEC12	Modulation and Coding Techniques	3	0	0	3	PC
19MEC13	RF Circuits and Communication Link Design	3	0	0	3	PC
19MEC14	Statistical Digital Signal Processing	3	0	0	3	PC
19MEC15	Radiation Systems	3	0	0	3	PC
	Professional Elective -I	3	0	0	3	PE
	PRACTICAL					
19MEC16	Signal Processing Laboratory	0	0	4	2	PC
19MEC17	Seminar and Technical Writing	0	0	2	1	EEC
	TOTAL CREDITS				22	

Semester II

Course Code	Course Name	L	T	P	C	Category
	THEORY					
19MEC21	Advanced Wireless Communication Systems	3	0	0	3	PC
19MEC22	Optical Switching and Networking	3	0	0	3	PC
19MEC23	Communication Network Security	3	0	0	3	PC
	Professional Elective-II	3	0	0	3	PE
	Professional Elective-III	3	0	0	3	PE
	Professional Elective-IV	3	0	0	3	PE
	PRACTICAL					
19MEC24	Wireless Communication and Networking Laboratory	0	0	4	2	PC
19MEC25	Mini Project	0	0	4	2	EEC
	TOTAL CREDITS				22	

Semester III

Course Code	Course Name	L	T	P	C	Category
	THEORY					
	Professional Elective-V	3	0	0	3	PE
	Professional Elective-VI	3	0	0	3	PE
	Open Elective - I / Professional Elective-VII	3	0	0	3	OE/PE
	PRACTICAL					
19MEC41	Project Work & Viva Voce					EEC
	TOTAL CREDITS				9	

Semester IV

Course Code	Course Name	L	T	P	C	Category
	PRACTICAL					
19MEC41	Project Work & Viva Voce				18	EEC
	TOTAL CREDITS				18	
	GRAND TOTAL CREDITS				71	

LIST OF PROFESSIONAL ELECTIVE COURSES

Course Code	Course Name	L	T	P	C	Category
19MECE01	Satellite Communication and Applications	3	0	0	3	PE
19MECE02	Modern Networking Technologies	3	0	0	3	PE
19MECE03	Image and Video Processing	3	0	0	3	PE
19MECE04	Network Routing Algorithms	3	0	0	3	PE
19MECE05	High Performance Computer Networks	3	0	0	3	PE
19MECE06	Millimeter Wave Communications	3	0	0	3	PE
19MECE07	Modeling and Simulation of Wireless Systems	3	0	0	3	PE
19MECE08	Communication Network Modeling and Simulation	3	0	0	3	PE
19MECE09	Detection and Estimation Theory	3	0	0	3	PE
19MECE10	Embedded and Real Time Systems	3	0	0	3	PE
19MECE11	Electromagnetic Interference Measurements and Compliance in Design	3	0	0	3	PE
19MECE12	LTE Technology and Standards	3	0	0	3	PE
19MECE13	Software Defined Radio and Cognitive Radio Technologies	3	0	0	3	PE
19MECE14	Space Time Wireless Communication	3	0	0	3	PE
19MECE15	Multimedia Compression and Communication	3	0	0	3	PE
19MECE16	OFDM/OFDMA Communications	3	0	0	3	PE
19MECE17	Information Coding Theory	3	0	0	3	PE
19MECE18	Analog and Mixed Signal Circuit Design	3	0	0	3	PE
19MECE19	Mobile AD HOC and Sensor Networks	3	0	0	3	PE

Course Code	Course Name	L	T	P	C	Category
19MECE20	5G Network Technologies	3	0	0	3	PE
19MECE21	VLSI for Wireless Communication	3	0	0	3	PE
19MECE22	High Speed Digital Design	3	0	0	3	PE
19MECE23	Coding Theory for Wireless Channels	3	0	0	3	PE
19MECE24	Data Converters	3	0	0	3	PE
19MECE25	Speech Processing and Synthesis	3	0	0	3	PE
19MECE26	Multirate Signal Processing	3	0	0	3	PE
19MECE27	Non-Linear Signal Processing	3	0	0	3	PE
19MECE28	Wavelet Transforms and its Applications	3	0	0	3	PE
19MECE29	Social Network Analysis	3	0	0	3	PE
19MECE30	Machine Learning in Communication Networks	3	0	0	3	PE
19MECE31	Web of Things	3	0	0	3	PE
19MECE32	VLSI Signal Processing	3	0	0	3	PE
19MECE33	Bio Signal Processing	3	0	0	3	PE
19MECE34	Machine Learning for Signal and Image Processing	3	0	0	3	PE
19MECE35	Game Theory for Wireless Communication and Networking	3	0	0	3	PE
19MECE36	Internet of Things based Sensing and Actuator Devices	3	0	0	3	PE
19MECE37	Embedded System Design	3	0	0	3	PE
19MECE38	Design of Embedded Control Systems	3	0	0	3	PE
19MECE39	RF MEMS	3	0	0	3	PE
19MECE40	Radio Frequency Integrated Circuit Design	3	0	0	3	PE
19MECE41	Smart Antennas	3	0	0	3	PE
19MECE42	Modern Antennas	3	0	0	3	PE
19MECE43	Electromagnetic Metamaterials	3	0	0	3	PE
19MECE44	Bio MEMS	3	0	0	3	PE
19MECE45	Medical Imaging and Classification	3	0	0	3	PE
19MECE46	Baseband Algorithms on FPGA	3	0	0	3	PE
19MECE47	Wearable Body Area Networks	3	0	0	3	PE
19MECE48	Wireless Transceiver Design	3	0	0	3	PE
19MECE49	Micro Electro Mechanical Systems	3	0	0	3	PE
19MECE50	Long Range Wireless Communication for Internet of Things	3	0	0	3	PE
19MECE51	Sensor Technology	3	0	0	3	PE

LIST OF OPEN ELECTIVE COURSES

Course Code	Course Name	L	T	P	C	Category
19MECOE01	Technology Management	3	0	0	3	OE
19MECOE02	Educational Psychology	3	0	0	3	OE
19MECOE03	Neural Networks	3	0	0	3	OE
19MECOE04	Entrepreneurship Development	3	0	0	3	OE
19MECOE05	Soft Computing	3	0	0	3	OE
19MECOE06	Waste to Energy Conversion	3	0	0	3	OE
19MECOE07	Cost Management of Engineering Projects	3	0	0	3	OE

LIST OF ONE CREDIT COURSES

Course Code	Course Name
19MECOC01	Python for Research
19MECOC02	Vehicular AD HOC Network
19MECOC03	Wearable Technology
19MECOC04	Smart Sensors

Note : L - Lecture, T - Theory, P - Practical, C - Credit

19MEC11 - APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERING

L	T	P	C
4	0	0	4

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : apply the concepts of linear algebra & numerical methods, random variables & random processes and Markovian processes for communication systems

CO2 : apply the concepts of second order processes and special functions for communication systems

LINEAR ALGEBRA

Vector spaces-subspaces-Linear dependence-Basis and Dimension-Inner product spaces Gram Schmidt Orthogonalization Procedure - Linear transformations - Kernels and Images - Matrix representation of linear transformation - Change of basis - Eigen values and Eigen vectors of linear operator -Quadratic form. (12)

RANDOM VARIABLES

Operations on random variables: Random Variables-Distributions and Density functions-Moments and Moment generating function-Multivariate distributions-Independent Random Variables, Marginal and Conditional distributions -Conditional Expectation, Transformation of Random Variables. (12)

MARKOV PROCESSES

Markov Chains Definition, Examples, Transition Probability Matrices of a Markov Chain Classification of states and chains Basic limit theorem Limiting distribution of Markov chains -Continuous Time Markov Chains: General pure Birth processes and Poisson processes, Birth and death processes, Finite state continuous time Markov chains. (12)

SECOND ORDER PROCESSES

Elements of stochastic processes - Classification - Second Order Stochastic Processes - Linear operations and second order calculus - Stationary and non-stationary processes Wide sense Stationary processes, Spectral density function - Low pass and band pass processes-White noise and white noise integrals. (12)

SPECIAL FUNCTIONS

Bessel's equation-Bessel functions - Legendre's equation - Legendre polynomials-Rodrigue's formula - Recurrence relations-generating functions and orthogonal property of Bessel functions-Legendre polynomials. (12)

TOTAL : 60

REFERENCES

1. Larry C Andrews, Ronald L. Philips, "Mathematical Techniques for Engineers and Scientists", Prentice Hall of India, New Delhi, 2005.
2. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 1971.
3. Erwin Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons, 10th Edition, 2010.
4. S. Karlin & H.M Taylor, "An introduction to Stochastic Modelling", 3rd Edition, Academic Press, New York, 1998.
5. S. M. Ross, "Introduction to Probability Models", Harcourt Asia Pvt. Ltd. and Academic Press, 1985.
6. A Papoulis, "Probability, Random Variables and Stochastic Processes", 3rd Edition, McGraw Hill, 1991.

19MEC12 - MODULATION AND CODING TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : analyze and compare advanced digital modulation techniques
- CO2** : design digital communication system for AWGN and fading channels
- CO3** : solve the problems in communication systems using the concepts of information theory
- CO4** : design error control codes to control the occurrence of error in digital communication systems
- CO5** : apply space time coding techniques for wireless communication systems

M-ary DIGITAL MODULATION TECHNIQUES

Base band and band pass communication; Signal space representation, Linear and nonlinear modulation techniques, M-ary modulation techniques Binary and M-ary, QAM, Carrier modulation - M-ary ASK, PSK, FSK, DPSK, Continuous phase modulation - QPSK and variants, MSK, GMSK, Comparison of Power spectral characteristics of digital modulation. (9)

RECEIVERS FOR AWGN AND FADING CHANNELS

Optimum receivers for AWGN channel - Correlation demodulator, matched filter, maximum likelihood sequence detector, envelope detectors for M-ary signals - Characterization of fading multipath channels, RAKE demodulator, Multiuser detection techniques. (9)

INFORMATION THEORY

A Measure of Uncertainty - Sources and Binary Sources - Entropy - Information - BSC and BEC channels - Mutual information - Noiseless and Deterministic channels - Redundancy - Efficiency - Channel capacity of BSC and BEC Channels - Information capacity theorem. (9)

ERROR CONTROL CODES

Linear Block codes - Cyclic codes - Galois fields - Irreducible and primitive polynomials - BCH codes - Reed-Solomon codes - Decoding BCH and RS codes - Convolution codes - Decoding convolution codes - Turbo codes - Encoding Parallel Concatenated codes - LDPC codes - LDPC code construction - Encoding LDPC codes - Serial Concatenated codes - design of LDPC decoders. (10)

SPACE-TIME CODING

Diversity Transmission and Reception: the MIMO channel - Space-time block codes - complex orthogonal Designs - Trellis Coded Modulation - Four & eight state TCM for 8-PSK & QAM signal constellations - Space-time trellis codes. (8)

TOTAL : 45

REFERENCES

1. Bernard Sklar, "Digital Communications - Fundamentals and Applications", 2nd Edition, Pearson Education, 2016.
2. John G. Proakis, "Digital Communications", 5th Edition, McGraw-Hill, 2008.
3. Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003.
4. Todd K. Moon, "Error Correction Coding: Mathematical Methods and Algorithms", Wiley, 2005.
5. Theodore S. Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition, Prentice-Hall, 2010.
6. Hamid Jafarkhani, "Space-Time Coding: Theory and Practice", Cambridge University Press, 2005.

19MEC13 - RF CIRCUITS AND COMMUNICATION LINK DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : formulate, analyze and solve design problems in RF transmission lines, micro-strip lines, passive RF filters and impedance matching networks.

CO2 : i. analyze and design RF amplifier.

ii. comprehend and explain operating principles and design concepts of RF oscillators, mixers and RF Section of Receiver.

iii. analyze and solve problems on microwave link availability, link budget, fade margin, sensitivity and frequency.

RF ISSUES, TRANSMISSION LINE ANALYSIS AND DESIGN

Issues in RF design - Electromagnetic Spectrum - RF behavior of passive components - Transmission line analysis - open ended, short circuited - Sourced and Loaded Transmission line - Smith Chart based analysis - Micro strip Transmission line design - Scattering Parameters - Impedance Matching using Lumped Elements. (10)

RF FILTER DESIGN

Overview - Basic RLC Series and Parallel resonators - RF Filter design using Insertion Loss method: Butterworth, Chebyshev and Linear Phase: LPF, HPF, BPF, BSF- Normalization for Frequency and Type - Impedance Normalization - Filter implementations: Richard's transform, Kuroda's identities - Series to Parallel Element conversion. (8)

RF AMPLIFIER DESIGN, EFFECTS OF NON-LINEARITY

Two Port Power Gains - Stability considerations - Input and Output Stability circles - Unconditional Stability - Design for Maximum Gain and Specified Gain - LNA Design - Limitations for High power Amplifiers: Gain compression, Inter-Modulation products, Dynamic Range, Cascaded systems. (9)

OSCILLATORS, MIXERS & RF FRONT END DESIGN

General Analysis of Oscillator- Oscillators using BJT and FET - Colpitts and Hartley Oscillator design - Crystal Oscillator - Microwave Oscillators - RF Front End and Tuner building blocks - Mixers - RF directional couplers and hybrid couplers - Complete RF Tuner design considerations. (9)

WIRELESS LINK AND NETWORK DESIGN

Microwave transmission - Point-to-Point link design - Theoretical and Practical aspects - Rain effects - Protected and Non Protected Microwave Systems - Link Budget - Fade margin - Path Loss and sensitivity calculations -Design Guidelines -ITU-R Probability model- MW lookup tables -Terrain Roughness factor- Refractive Index gradient-Guidelines for site selection. (9)

TOTAL : 45

REFERENCES

1. Reinhold Ludwig and Gene Bogdanov, "RF Circuit Design - Theory and Applications", Prentice Hall, 2009.
2. David M. Pozar, "Microwave Engineering", 4th Edition, Wiley, 2011.
3. Harvey Lehpamer, "Microwave Transmission Networks: Planning, Design, and Deployment", McGraw Hill Professional, 2004.
4. David Pozar, "Microwave and RF Wireless Systems", Wiley, 2001.
5. William F. Egan "Practical RF System Design", John Wiley and Sons, 2004.
6. Ganesh Prasad Srivastava and Vijay Laxmi Gupta, "Microwave Devices and Circuit Design" PHI Learning, 2006.

19MEC14 - STATISTICAL DIGITAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : explain the concepts of random signal processing

CO2 : analyze the spectrum estimation techniques

CO3 : construct adaptive filters

CO4 : suggest suitable adaptive filtering algorithms for an application

CO5 : outline the features of DSP Processors and implement FIR and IIR Filters

DISCRETE RANDOM SIGNAL PROCESSING

Overview of Discrete Time Signal Processing - Discrete Random Processes - Ensemble Averages - Gaussian Processes - Stationary processes - Autocovariance and Autocorrelation - Ergodicity - Parseval's Theorem - Wiener-Khintchine Relation - White Noise - Power Spectrum - Filtering Random Processes - Spectral Factorization. **(9)**

SPECTRAL ESTIMATION

Estimation of Spectra from Finite Duration Signals - Nonparametric Methods: Periodogram, Modified Periodogram, Bartlett, Welch and Blackman-Tukey Methods - Performance Comparisons - Parametric Methods: AR, MA and ARMA Model based Spectral Estimation - Yule-Walker Equations - Solution using Levinson-Durbin Algorithm. **(9)**

ADAPTIVE SYSTEMS

Definition - Characteristics - Properties - Wiener Filters - Wiener filters for linear prediction and noise cancellation - Kalman Filter - Minimum Mean Square Error (MMSE) - Gradient Search Methods - Newton's Method - Steepest Descent Technique. **(9)**

ADAPTIVE FILTERING ALGORITHMS AND APPLICATIONS

Least-Mean-Square (LMS) Algorithm - Recursive Least Squares (RLS) Algorithm - Exponentially Weighted RLS - Sliding Window RLS - Applications of Adaptive Filtering: Adaptive Noise Cancelling - Adaptive Channel Equalization - Cancelling Power Supply Interference in ECG. **(9)**

DSP ARCHITECTURE

Fixed Point and Floating Point DSPs - Features of Digital Signal Processing Architecture - Bus Architecture - DSP Computational Building Blocks - On-Chip Memory - TMS320C67XX, OMAPL138 Architecture - Addressing Modes - Special Function Instructions - Implementing FIR and IIR Filters in DSPs. **(9)**

TOTAL : 45

REFERENCES

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc., Singapore, 2009.
2. Sophocles J. Orfanidis, "Optimum Signal Processing", McGraw Hill, 2007.
3. Dimitris G. Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill, Newyork, 2000.
4. T. Adali and Simon Haykin, "Adaptive Signal Processing - Next Generation Solutions", Wiley India Pvt.Ltd.,2010.
5. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing: A Practical Approach", Addison Wesley, 2002.
6. V. Udayashankara, "Real Time Digital Signal Processing: Fundamentals, Algorithms and Implementation using TMS Processors", Prentice Hall of India, New Delhi, 2010.
7. <http://www.ti.com/lit/ds/symlink/omap-l138.pdf>

19MEEC15 - RADIATION SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon the completion of the course, students will be able to demonstrate an ability to

CO1 : explain the concepts of radiation phenomena

CO2 : analyze and design antenna arrays

CO3 : design and synthesize antennas for various applications

CO4 : understand the radiation characteristics of aperture and special antennas

CO5 : explain the concept of smart antennas and measure the parameters and radiation pattern of an antenna

REVIEW OF ANTENNA RADIATION MECHANISM & PARAMETERS

Antenna parameters - Radiation mechanism, Radiation pattern, power density, radiation intensity, directivity, Gain, bandwidth, polarization, radiation efficiency, effective aperture, Return loss, Single antenna element: - Monopole, Dipole, Field components derivation, Radiation characteristics. Linear, elliptical and circular polarization- Development of the Poincare sphere. (9)

ANTENNA ARRAY

N element linear array - uniform amplitude and spacing - Phased arrays - Directivity of Broadside and End fire arrays - Three dimensional characteristics - Pattern multiplication - Binomial arrays and Dolph-Tchebycheff arrays - Circular array - Planar array - array factor, beam width, directivity. (9)

ANTENNA SYNTHESIS

Synthesis problem - continuous sources - discretization of continuous sources - Schelkunoff polynomial method, Fourier transform method - Woodward - Lawson sampling methods - line source - linear array - Taylor line source (Tschebyscheff error) - Taylor line source (one parameter). (9)

SPECIAL ANTENNAS

Aperture antennas - Huygens Principle. Rectangular apertures -Uniform distribution on an infinite ground plane - Circular apertures and their design considerations - Babinet's principle. Micro strip antennas: feeding methods - Rectangular patch - transmission line model - circular patch - Micro strip array and feed networks. (9)

SMART ANTENNAS AND ANTENNA MEASUREMENTS

Beam steering - degree of freedom - optimal antenna - adaptive antennas - smart antennas - key benefits of smart antennas technology - signal model - conventional beam former, null steering beam former, optimal beam former, optimization using reference signal and beam space processing: Optimal beam space processor- Generalized side lobe cancelor. Antenna ranges -Gain, impedance and radiation pattern measurements. (9)

TOTAL : 45

REFERENCES

1. Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, 4th Edition, 2016.
2. Lal Chand Godara, "Smart Antenna", C.R.C Press, 2004.
3. John D Kraus, Ronald J Marhefka, Ahmad S Khan, "Antennas for all applications", 3rd Edition, John Wiley and Sons, New York, 2002.
4. Edward C. Jordan, Keith G. Balmain "Electromagnetic Waves and Radiating Systems", 2nd Edition, Prentice Hall of India, 1968.
5. Warren L. Stutzman and Gary A. Thiele, "Antenna Theory and Design", 3rd Edition, John Wiley and Sons, New York, 2012.
6. Hubregt.J.Visser "Antenna Theory and Applications", 1st Edition, John Wiley & Sons Ltd, New York, 2012.
7. Theodore S. Rappaport, "Smart Antennas: Adaptive Arrays, Algorithms, & Wireless Position Location", IEEE Press, 1998.

19MEC16 - SIGNAL PROCESSING LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : implement and test FFT, power spectral estimation algorithm and digital filters.

CO2 : implement and test adaptive filter & their applications and multirate systems.

CO3 : develop Communication Skills and capability to work in team and achieve goals.

LIST OF EXPERIMENTS

- Implementation of FFT, Parametric/Non parametric Power Spectral Estimation algorithms
- Design and Implementation of Digital filters
- Design and Implementation of equalization algorithms
- Design and implementation of multirate systems
- Analysis of finite word length effects in digital filters
- Design and implementation of echo and noise cancellation using adaptive filters
- Design and implementation of LMS and RLS algorithm
- Digital filter design, FFT and power spectrum estimation using TMS320C6713 Processor

TOTAL: 60

REFERENCES

1. Monsoon H. Hayes: "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, 2009.
2. Sen M. Kuo, Bob H. Lee, and WenshunTian, "Real-Time Digital Signal Processing: Fundamentals, Implementations and Applications", Wiley, 3rd Edition, 2013.
3. RulphChassaing, Donald S. Reay, "Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416DSK", Wiley, 2nd Edition, 2011.

19MEC17 - SEMINAR AND TECHNICAL WRITING

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

C01 : *use techniques, skills and modern engineering tools for developing solutions using electronic hardware and/or software for solving basic problems of societal needs with the knowledge of contemporary issues.*

C02 : *work as an individual or in teams to achieve goals and to communicate effectively.*

19MEC21 - ADVANCED WIRELESS COMMUNICATION SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of the course, the students will be able to demonstrate an ability to

CO1 : model multipath channel, calculate capacity and diversity techniques of wireless channels

CO2 : illustrate the concepts of multicarrier systems

CO3 : analyze Narrowband MIMO systems

CO4 : explain the concepts of multi user systems

CO5 : describe the 5G Standardization, 5G Spectrum and its Radio Interface Architecture

MULTIPATH CHANNEL MODELS, CAPACITY & DIVERSITY TECHNIQUES

Radio wave propagation - Transmit and receive signal models - Free space path loss - Ray Tracing - Empirical path loss models - Shadow fading - Outage probability - Time varying channel Impulse response - Capacity in AWGN, flat fading channels and frequency selective fading channels - Receiver Diversity techniques. **(9)**

MULTICARRIER SYSTEMS

Data transmission using multiple carriers - Mitigation of subcarrier fading - OFDM - Generation of sub-carriers using the IFFT; Guard Time and Cyclic Extension; Challenges in multicarrier systems - Peak to Average Power reduction schemes. **(9)**

MIMO COMMUNICATIONS

Narrowband MIMO model - Parallel decomposition of the MIMO channel - MIMO channel capacity- MIMO Diversity Gain: Beam forming - Diversity - Multiplexing trade-offs - Space -Time modulation and coding - Frequency selective MIMO Channels. **(9)**

MULTIUSER SYSTEMS

Spread Spectrum Principles - Multiuser Channels: Uplink & Downlink-Multiple access techniques: FDMA, TDMA, CDMA, SDMA, Hybrid Techniques - Random Access - Power control - Downlink and Uplink Channel Capacity - Uplink- Downlink Duality - Multiuser diversity - MIMO-Multiuser systems. **(9)**

5G WIRELESS TECHNOLOGIES

Overview of Wireless Network Generations from 2G to 4G - Advances in 4G - Next generation 5G/NR: Use Cases, Evolving LTE to 5G Capability - 5G Standardization - 5G Spectrum - Radio Interface Architecture: 5G Core Network, Radio Access Network, User Plane Protocols and Control Plane Protocols. **(9)**

TOTAL : 45

REFERENCES

1. Andrea Goldsmith, "Wireless Communications", Cambridge Univ. Press, 2005.
2. Vijay. K. Garg, "Wireless Communication and Networking", Morgan Kaufmann Publishers, 2010.
3. Theodore S. Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition, Prentice-Hall, 2002.
4. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2010.
5. Ajay R Mishra, "Fundamentals of Network Planning and optimization 2G/3G/4G...Evolution to 5G", 2nd Edition, Wiley Publication, 2019.
6. Jonathan Rodriguez "Fundamentals of 5G Mobile Networks", John Wiley & Sons, 2015.
7. <https://www.3gpp.org/>

19MEC22 - OPTICAL SWITCHING AND NETWORKING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon the completion of the course, students will be able to demonstrate an ability to

- CO1** : understand the operation of the components of the optical systems.
- CO2** : understand the characteristics of the client layers of the optical system.
- CO3** : solve the problems of providing redundant capacity within the network and rerouting traffic around the failures.
- CO4** : explore the architectural aspects of the WDM network elements and study the design of wavelength-routed networks.
- CO5** : develop networks to provide services using various architecture.

OPTICAL NETWORKS AND COMPONENTS

Telecommunications Network Architecture - Services, Circuit Switching, and Packet Switching - Optical Networks - Multiplexing Techniques - Second-Generation Optical Networks - The Optical Layer - Transparency and All-Optical Networks - Optical Packet Switching - Single-Mode Fiber - Optical Amplifiers - Couplers - Isolators and Circulators - Multiplexers and Filters - Transmitters - Detectors - Switches - Wavelength Converters (12)

CLIENT LAYERS OF THE OPTICAL NETWORK

SONET/SDH- Optical Transport Network- Generic Framing Procedure- Ethernet- Frame Structure - IP - Multiprotocol Label Switching- Resilient Packet Ring- Storage-Area Networks (8)

NETWORK SURVIVABILITY

Protection in SONET/SDH - Protection in the Client Layer - Service classes based on protection-Optical Layer Protection Schemes- Interworking between Layers (7)

WDM NETWORK ELEMENTS AND NETWORK DESIGN

Optical Line Terminals- Optical Line Amplifiers- Optical Add/Drop Multiplexers- Optical Crossconnects - Cost Trade-Offs: A Detailed Ring Network - LTD and RWA Problems- Dimensioning Wavelength-Routing Networks- Statistical Dimensioning Models- Maximum Load Dimensioning Models (10)

ACCESS NETWORKS AND PHOTONIC PACKET SWITCHING

Network Architecture - Enhanced HFC- Fiber to the Curb (FTTC)- Optical Time Division Multiplexing- Synchronization- Header Processing- Buffering- Burst Switching- Testbeds (8)

TOTAL : 45

REFERENCES

1. *Rajiv Ramaswami and Kumar N. Sivarajan, "Optical Networks: A Practical Perspective", Harcourt Asia Pte Ltd., 3rd Edition, 2009.*
2. *Biswanath Mukherjee, " Optical WDM Network", Springer, 2006.*
3. *J.Gower, "Optical communication systems", Prentice Hall of India, 2001.*
4. *John Senior, "Optical fiber communications-principles and practices", Prentice Hall of India, 1994.*

19MEC23 - COMMUNICATION NETWORK SECURITY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : i. explain the issues, scope and significance of various security mechanisms and services applicable to Communication networks.
ii. explain and analyze, algorithms and techniques of Block and Stream ciphers.
- CO2** : i. explain and analyze mechanisms, algorithms and techniques of key exchange & distribution, authentication and integrity checks.
ii. analyze the concepts and explain the operating principles and applications of security protocols & security mechanisms used in Routing and Transport layers.
iii. explain and analyze Security related Issues, threats and solutions for various layers of wireless networks.

BASICS OF SECURITY

Security Goals - Types and Classification of Attacks - Passive, active - Classification of attacks based on OSI layers, Knowledge of attacker - Distributed DOS attack - Security services and mechanisms-Cryptography - Steganography - Revision on Mathematics for Cryptography - Modular Arithmetic - Fields: Galois Fields. (9)

BLOCK AND STREAM CIPHER ALGORITHMS

Substitutional Ciphers - Transposition Ciphers - Stream and Block Ciphers - Data Encryption Standard - Advanced Encryption Standard (AES) - Modes of Block Cipher operation - Asymmetric key algorithms: RSA Cryptosystem - Stream Ciphers: RC4 (9)

INTEGRITY, AUTHENTICATION AND KEY MANAGEMENT

Message Integrity - Hash functions and their usage - Message Authentication Codes -HMAC, CMAC-Digital signatures - Entity Authentication - Key Distribution: Symmetric and Asymmetric Key Distribution methods - Diffie Hellman Key exchange. (9)

NETWORK SECURITY, FIREWALLS AND WEB SECURITY

Firewalls: Packet Filter Firewalls, Application Level Gateways, Firewall Configurations and Limitations - Tunneling - Virtual Private Networks - Mail Security - PGP - IP security Architecture - IP V4 and V6 Security features - AH and ESP protocols - Security Associations - Secure Sockets Layer - Transport layer security - Secure Electronic Transaction. (10)

WIRELESS NETWORK SECURITY

Security Attacks specific to Wireless systems : Worm hole, Tunneling - Counter Measures - DoS - WEP for Wi-Fi network - GSM security - GPRS Security - 3GPP Security - BlueTooth Security - Secure Ad hoc Network. (8)

TOTAL : 45

REFERENCES

1. William Stallings, "Cryptography and Network security: Principles and practice", 6th Edition, Pearson Education, 2013.
2. Behrouz A. Forouzan, "Cryptography and Network security" Special Indian Edition, Tata McGraw-Hill, 2008.
3. Atul Kahate, "Cryptography and Network security", 3rd Edition, McGraw-Hill Education, 2013.
4. Christos Douligeris, Dimitrios N. Serpanos, "Network Security: Current Status and Future Directions", John Wiley, 2007.
5. Praphul Chandra, Dan Bensky et al, "Wireless Security: Know it all", Newnes, 2011.
6. R.K.Nichols, "Wireless Security" Tata Mc Graw Hill Education, 2006.

19MEC24 - WIRELESS COMMUNICATION AND NETWORKING LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : *model & analyze various types of digital communication techniques and wireless communication systems, implement OFDM systems*

CO2 : *simulate and measure the performance of QoS metric for different layer of wireless Networks*

CO3 : *develop communication skills and capability to work in team*

LIST OF EXPERIMENTS

- Design and performance analysis of error control encoder and decoder
- Design and analysis of Digital communication techniques on an SDR platform
- Wireless Channel emulation and characterization
- Performance analysis of wireless communication systems
- Design and implementation of OFDM system
- Simulation of Wireless Networks and their Performance analysis

TOTAL : 60

REFERENCES

1. Theodore S.Rappaport., 'Wireless Communications', 2nd Edition, Pearson Education, 2002.
2. Robert W Heath, "Digital Wireless communication: Physical layer exploration Lab using NI USRP", 2014.
3. <https://www.tetcos.com/>

19MEC25 - MINI PROJECT

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

C01 : *use techniques, skills and modern engineering tools for developing solutions using electronic hardware and/or software for solving basic problems of societal needs with the knowledge of contemporary issues.*

C02 : *work as an individual or in teams to achieve goals and to communicate effectively.*

19MEC41 - PROJECT WORK & VIVA VOCE

L	T	P	C
0	0	0	18

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

C01 : *use techniques, skills and modern engineering tools for developing solutions using electronic hardware and/or software for solving basic problems of societal needs with the knowledge of contemporary issues.*

C02 : *work as an individual or in teams to achieve goals and to communicate effectively.*

PROFESSIONAL ELECTIVES

19MECE01 - SATELLITE COMMUNICATION AND APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : *explain the elements and subsystems of satellite communication systems*

CO2 : *explain the elements of earth station and payload*

CO3 : *apply and analyze satellite link design, modulation and access techniques for satellite systems*

CO4 : *explain various satellite networks*

CO5 : *explain various satellite systems*

ELEMENTS AND ORBITS OF SATELLITE COMMUNICATION SYSTEM

Characteristics of Satellites- Advantages of Satellite Communication -Frequency Bands- Use of Microwave Frequencies - ITU Spectrum Allocations and Regions - Integration with Terrestrial Wired and Wireless Networks - System Elements - Kepler's laws- Newton's law - Orbital parameters - Eclipses of the sun - Orbits for satellite communication - Perturbations of orbits - Effect of perturbations . **(9)**

EARTH STATION AND COMMUNICATION PAYLOAD

Basic Earth Station Configuration - Performance Requirements - Antennas subsystem - radio-frequency subsystem - Communication subsystems - Network interface subsystem - Monitoring and control - Functions of the payload - Characterization of the payload - Repeaters - Uplink Power Control - Intermediate Frequency and Baseband Equipment-Modulators, Demodulators, Modems - Attitude-Control Subsystem - Solar Cells and Panels - Battery Configuration- Propulsion System - Tracking, Telemetry, and Command -(TT&C) - Thermal Control. **(9)**

LINK PERFORMANCE AND MULTIPLE ACCESS TECHNIQUES

Configuration of a link- Antenna parameters - Radiated power - Received signal power- Noise power spectral density at the receiver input- Individual link performance - Influence of the atmosphere - Overall link performance. MULTIPLE ACCESS : Frequency Division Multiple Access - Time Division Multiple Access - ALOHA Packet Multiple Access - Code Division Multiple Access - Fixed and on-demand assignment- Random access. **(9)**

SATELLITE NETWORKS

General Features of Satellite Networks - Dedicated Bandwidth Services - Circuit-Switched Services - Packet-Switched Services - Point-to-Multipoint (Broadcast) Networks - Video Distribution - Direct-to-Home Television - DTH System Architecture - Basic Elements and Signal Flow - Medium-Power DTH Satellite Systems-Interactive Data Networks -Content Distribution Networks - Mobile Satellite Communications - Point-to-Point Networks - VSAT Networks - Protocols Supported by VSAT Networks. **(9)**

SATELLITE SYSTEMS

Satellites in Telephone Services -Demand Assignment SCPC Network Architecture - Application of FTS - Mobile Satellite Service - GEO MSS Systems - Non-GEO MSS Systems - Iridium - Globalstar System -ICO Communications -Comparison of the Performance of Non-GEO Systems Intelligent MSS Services - Digital Speech Compression. **(9)**

TOTAL : 45

REFERENCES

1. Bruce R. Elbert, *"Introduction to Satellite Communication" 3^d Edition, Artech House Inc, 2008.*
2. Gerard Maral, Michel Bousquet, *"Satellite Communications Systems Techniques and Technology" 5th Edition, Wiley publications, 2009.*
3. M. Richharia, *"Satellite Communications Systems Design Principles", Macmillan Press Ltd., 1st Edition, 1995.*
4. Bruce R. Elbert, *"The Satellite Communication Applications Handbook", 2nd Edition, Artech House Inc, 2004.*

19MECE02 - MODERN NETWORKING TECHNOLOGIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : describe the concepts of Software Defined Network architecture, Data Plane, Control Plane, Application Plane and security issues
- CO2** : discuss the Network Functions Virtualization architecture, Virtualized Network Functions, virtual LANs and security issues
- CO3** : describe the basic techniques to achieve QoS/QoE Compliance
- CO4** : explain about Cloud Services, Types of Clouds, Cloud Architecture and security issues
- CO5** : describe about the components, architecture, standards and security in IoT

SOFTWARE DEFINED NETWORKS

Elastic and Inelastic Traffic - Requirements of Software Defined Network (SDN)- SDN Architecture- SDN Data Plane-Open Flow Logical Network Device- Open Flow Protocol- SDN Control Plane- ITU-T Model for SDN Control Plane- Coordination of Controllers- SDN Application Plane-Network Services- Security in SDN. **(9)**

NETWORK VIRTUALIZATION

Basics of Virtual Machines - Concepts of Network Functions Virtualization (NFV) - NFV Requirements - NFV Reference Architecture- NFV Infrastructure- Virtualized Network Functions- NFV Management and Orchestration- virtual LANs- Virtual Private Networks : IP sec, MPLS- Network Virtualization - NFV Security. **(9)**

QUALITY OF SERVICE AND QUALITY OF EXPERIENCE

Quality of Service (QoS) Architectural Framework - Integrated Services Architecture - Differentiated Services - IP Performance Metrics - Quality of Experience (QoE) Strategies: QoE/QoS Layered Model - Factors Affecting QoE - QoE Measurement Methods. **(9)**

CLOUD COMPUTING

Big data - Fundamentals of Cloud Computing - Cloud Services - Types of Clouds: Public, Private, Community and Hybrid Clouds- NIST Reference and ITU-T Cloud Architecture -SDN and NFV- Cloud Security. **(9)**

INTERNET OF THINGS

Need for IoT- Scope of IoT-Components of IoT enabled systems -IoT architecture: ITU-T IoT reference model, IoT World Forum Reference model- IoT applications- Challenges in IoT applications-IoT standards- IoT security- Case study of IoT System. **(9)**

TOTAL : 45

REFERENCES

1. William Stallings, "Foundations of Modern Networking", Pearson, 1st Impression, 2016.
2. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
3. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
4. Rajkumar Buyya, Christian Vecchiola, and ThamaraiSelvi, "Mastering Cloud Computing", Tata McGraw Hill, 2013.
5. Thomas Nadeau, Ken Gray, "SDN - Software Defined Networks", O'reilly Publishers, 2013.
6. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.

19MECE03 - IMAGE AND VIDEO PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : explain the fundamentals of image processing and its transforms
- CO2** : understand the concepts behind the image enhancement and restoration
- CO3** : explain various compression and segmentation methods
- CO4** : illustrate the image representation, description and recognition methods
- CO5** : understand the fundamentals of video processing and video compression standards

DIGITAL IMAGE FUNDAMENTALS AND TRANSFORMS

Elements of digital image processing systems - Image sampling and quantization- Basic relationships between pixels - Need for transforms - Introduction to Fourier transform - DFT- Properties of 2D FFT - Discrete Cosine Transform - Walsh transform- Hadamard transform- Slant transform- Haar Transform - Karhunen Loeve Transform- Singular Value Decomposition - Wavelet transform. (9)

IMAGE ENHANCEMENT AND RESTORATION

Image Enhancement : Basic intensity transformation functions - Histogram processing: Specification, Equalization - Smoothing and Sharpening spatial filters - Image smoothing and sharpening frequency domain filters. Image restoration: degradation/restoration model- Noise model- Spatial Filtering: Mean, Order statistics, Adaptive Filters - Frequency Domain Filtering: Band pass, Band reject, Notch/ filters - Inverse filtering - Wiener filtering - Constrained least square filtering - Geometric Transformations. (9)

IMAGE SEGMENTATION AND COMPRESSION

Edge detection - Edge linking and boundary detection: Local processing, Global processing - Thresholding - Region based segmentation: Region growing - Region splitting and merging Image compression: Fundamentals- Lossless Compression : Huffman coding, Arithmetic coding, LZW coding, Bit plane coding Lossy compression: Vector Quantization- Wavelet based compression - Block Truncation Coding. (9)

IMAGE REPRESENTATION, DESCRIPTION AND RECOGNITION

Representation : Chain codes, Polygonal approximations-signature- boundary segments - skeletons - boundary descriptors: shape numbers - Fourier descriptors - Regional descriptors - simple descriptors - topological descriptors - texture - Object recognition : pattern and pattern class - Object Recognition : Minimum distance classifiers - Neural Networks. (9)

VIDEO PROCESSING

Digital Video basics : Spatial-temporal sampling- video sampling rate conversion- motion estimation techniques- motion compensation techniques - video compression standards- H.261, H.263, MPEG. (9)

TOTAL : 45

REFERENCES

1. Rafael C.Gonzalez & Richard E.Woods, "Digital Image Processing", 3rd Edition, Pearson Education, 2009.
2. Jayaraman S, Esakkirajan S & Veerakumar T, "Digital Image Processing", Tata McGraw Hill, reprint 2010.
3. William K.Pratt, "Digital Image Processing", John Wiley, 4th Edition, 2006.
4. Anil.K.Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, 1989.
5. Sid Ahmed M.A., "Image Processing - Theory, Algorithm and Architecture", McGraw Hill, 2009.
6. Mark Nixon, Alberto Aguado, "Feature Extraction and Image Processing", Academic Press, 2008.

19MECE04 - NETWORK ROUTING ALGORITHMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : explain the concepts of networking and network routing algorithms
- CO2** : analyze the concepts of determining the shortest and widest path using suitable optimality metric
- CO3** : discuss the concepts of IP routing and variants of distance vector protocol
- CO4** : explain the principle concepts of OSPF, IGRP and EGRP
- CO5** : analyze the different scheduling, queueing and congestion control mechanism for network performance improvements

NETWORKING AND NETWORK ROUTING

Addressing and Internet Service- Network Routing- IP Addressing- Classful Addressing Scheme - Subnetting/Netmask-Classless Inter domain Routing-On Architectures-Service Architecture-Protocol Stack Architecture- OSI Reference Model- IP Protocol Stack Architecture - Router Architecture- Network Topology Architecture- Network Management Architecture. **(8)**

ROUTING ALGORITHMS: SHORTEST PATH AND WIDEST PATH

Bellman-Ford Algorithm and the Distance Vector Approach - Dijkstra's Algorithm - Comparison of the Bellman-Ford Algorithm and Dijkstra's Algorithm-Shortest Path Computation with Candidate Path Caching - Widest Path Computation with Candidate Path Caching - Widest Path Algorithm - Dijkstra-Based Approach - Bellman-Ford-Based Approach - k-Shortest Paths Algorithm. **(10)**

IP ROUTING AND DISTANCE VECTOR PROTOCOL FAMILY

Routing Table - Routing Information Protocol, Version 1 (RIPv1) - Routing Information Protocol, Version 2 (RIPv2)- Interior Gateway Routing Protocol (IGRP) 1- Packet Format - Computing Composite Metric- Enhanced Interior Gateway Routing Protocol (EIGRP) - Packet Format - Route Redistribution. **(9)**

OSPF AND INTEGRATED IS-IS

OSPF:Protocol Features-OSPF Packet Format-Examples of Router LSAs and Network LSAs-Integrated IS-IS - Similarities and Differences Between IS-IS and OSPF. **(9)**

PACKET QUEUEING AND SCHEDULING

Packet Scheduling - First-In, First-Out Queueing - Priority Queueing - Round-Robin and Fair Queueing - Weighted Round-Robin and Weighted Fair Queueing - Deficit Round-Robin Queueing - Modified Deficit Round-Robin Queueing- TCP Congestion Control-Slow Start-Additive Increase, Multiplicative Decrease Fast Retransmit and Fast Recovery - Implicit Feedback Schemes. **(9)**

TOTAL : 45

REFERENCES

1. Deepankar Medhi and Karthikeyan Ramasamy, "Network Routing: Algorithms, Protocols, and Architectures", Elsevier,2007.
2. Martha Steen Strup, "Routing in Communication Networks", Prentice Hall,1995.
3. William Stallings, "Data and Computer Communications", Pearson Education,2006.
4. William Stallings, "High speed networks and Internets Performance and Quality of Service", 2nd Edition, Pearson Education Asia, Reprint India 2002.

19MECE05 - HIGH PERFORMANCE COMPUTER NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : explain the concepts of switching, signaling and routing in ATM network
- CO2** : discuss the best effort services for the multimedia networking applications
- CO3** : describe the concepts of VPN and MPLS
- CO4** : analyze the network performance through different queuing and delay models
- CO5** : explain about the different network attacks and security issues

SWITCHING NETWORKS

Switching-Packet switching-Ethernet, Token Ring, FDDI, DQDB, Frame Relay, SMDS, Circuit Switched SONET, DWDM, DSL, Intelligent Networks - CATV, ATM - Features, Addressing Signaling & Routing, Header Structure, ATM Adaptation layer, Management control, BISDN, Internetworking with ATM. (9)

MULTIMEDIA NETWORKING APPLICATIONS

Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, RSVP- differentiated services. (9)

ADVANCED NETWORKS CONCEPTS

VPN- Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN. MPLS-operation, Routing, Tunneling and use of FEC, Traffic Engineering, and MPLS based VPN, overlay networks- P2P connections - IPv4vs.V6. (9)

PACKET QUEUES AND DELAY ANALYSIS

Little's theorem, Birth and Death process, queuing discipline- Control & stability - Markovian FIFO queuing system, Non-markovian - Pollaczek-Khinchin formula and M/G/1, M/D/1, self-similar models and Batch- arrival model, Networks of Queues - Burke's theorem and Jackson Theorem. (9)

NETWORK SECURITY AND MANAGEMENT

Principles of cryptography - Elliptic-AES- Authentication - integrity - key distribution and certification- Access control and firewalls- DoS- attacks and counter measures-security in many layers. Infrastructure for network management - the internet standard management framework - SMI, MIB, SNMP, Security and administration-ASN.1. (9)

TOTAL : 45

REFERENCES

1. Anurag Kumar, D. Manjunath, Joy Kuri, "Communication Networking", Morgan Kaufmann Publishers, 2011.
2. J.F. Kurose & K.W. Ross, "Computer Networking- A Top Down Approach Featuring the Internet", Pearson, 3rd Edition, 2005.
3. Nader F.Mir, "Computer and Communication Networks", Pearson Education, 2009.
4. Walrand.J. Varatya, "High Performance Communication Network", Morgan Kaufmann - Harcourt Asia Pvt. Ltd., 2nd Edition, 2000.
5. Hersent Gurle & Petit, "IP Telephony, Packet Pored Multimedia Communication Systems", Pearson Education, 2003.
6. Fred Halsall and Lingana Gouda Kulkarni, "Computer Networking and the Internet", 5th Edition, Pearson Education, 2012.

19MECE06 - MILLIMETER WAVE COMMUNICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : explain the concepts of mm wave characteristics, challenges and its propagation effects

CO2 : discuss the principle working of mm wave devices and circuits

CO3 : explain the concepts of mm wave communication systems

CO4 : describe about mm wave MIMO systems

CO5 : analyse the use of different antennas for mm wave systems

INTRODUCTION

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)**

MILLIMETER WAVE DEVICES AND CIRCUITS

Millimeter Wave Generation and Amplification: Peniotrons, Ubitrons, Gyrotrons and Free Electron Lasers - HEMT - Models for mm Wave Transistors - Transistor Configurations - Analog mm Wave Components: Amplifiers, Mixers, VCO, PLL - Metrics for Analog mm Wave Devices - Consumption Factor Theory, Trends and Architectures for mm Wave Wireless, ADC and DAC. **(9)**

MILLIMETER WAVE 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)**

MILLIMETER WAVE 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. **(9)**

ANTENNAS FOR MILLIMETER WAVE SYSTEMS

Antenna Beamwidth, Polarization, Advanced Beam Steering and Beam Forming, mm Wave Design Consideration, On-chip and In package mm Wave Antennas, Techniques to Improve Gain of On-chip Antennas, Implementation for mm Wave in Adaptive Antenna Arrays, Device to Device Communications Over 5G systems, Design Techniques of 5G Mobile. **(9)**

TOTAL : 45

REFERENCES

1. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.
3. Xinag W., Zheng K., Shen X.S., "5G Mobile Communications", Springer, 2016.

19MECE07 - MODELING AND SIMULATION OF WIRELESS SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : analyze and simulate different random process models

CO2 : model and simulate communication subsystems

CO3 : analyze the behavior of various communication channel models

CO4 : estimate parameters like power, delay, phase etc using suitable simulator for wireless communication systems

CO5 : analyze the performance of wireless communication systems from simulators

SIMULATION OF RANDOM VARIABLES AND RANDOM PROCESS

Univariate and multi-variate models - Transformation of random variables - Bounds and approximation - Random process models- Markov and ARMA sequences - Sampling rate for simulation - Computer generation and testing of random numbers. (9)

MODELING OF COMMUNICATION SYSTEMS

Information Sources -Formatting/Source Coding- Digital Waveforms -Line Coding -Channel Coding - Radio frequency and Optical Modulation, Demodulation and Detection - Filtering - Multiplexing/Multiple Access - Synchronization - Calibration of Simulations. (9)

COMMUNICATION CHANNELS & MODELS

Fading & Multipath Channels - Free-Space Channels - Finite State Channel Models - Methodology for Simulating Communication Systems Operating over Fading Channels - Reference Models for Mobile Channels:GSM,UMTS-IMT-2000. (9)

ESTIMATION OF PARAMETERS IN SIMULATION

Quality of an estimator -Estimating the Average Level of a Waveform -Estimating the Average power of a waveform - Estimating the Power Spectral Density of a process - Estimating the Delay and Phase. (9)

ESTIMATION OF PERFORMANCE MEASURES FROM SIMULATION

Estimation of SNR - Performance Measures for Digital Systems -Sampling Method - Efficient Simulation using Sampling - Quasi analytical Estimation - Case Studies: 16-QAM Equalized Line of Sight Digital Radio Link, CDMA Cellular Radio System. (9)

TOTAL : 45

REFERENCES

1. M.C. Jeruchim, Philip Balaban and K.Sam Shanmugam, "Simulation of Communication Systems Modeling, Methodology and Techniques", Kluwer Academic/Plenum Publishers, New York,2000.
2. C. Britton Rorabaugh, "Simulating Wireless Communication Systems: Practical Models In C++", Prentice Hall,2004.
3. William H. Tranter, K. Sam Shanmugan, Theodore S. Rappaport, Kurt L. Kosbar, "Principles of Communication Systems Simulation with Wireless Applications", Prentice Hall PTR, 2002.
4. John G. Proakis, Masoud Salehi, Gerhard Bauch, Bill Stenquist, Tom Ziolkowski, "Contemporary Communication Systems Using MATLAB", Thomson -Engineering, 2nd Edition,2002.

19MECE08 - COMMUNICATION NETWORK MODELING AND SIMULATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : model networks for simulation and learn about Monte Carlo Simulation

CO2 : model the physical layer & link layer and to analyze the performance of wireless system

CO3 : apply modeling techniques for various channel models and to analyze the performance of wireless system

CO4 : analyze the performance of wireless system using various mobility models

CO5 : apply modeling techniques for higher layer for various network topologies

INTRODUCTION TO MODELING AND SIMULATION

Introduction - Discrete-event Simulation -Modeling for Computer Simulation -Tools and Methods for Network Simulation - Simulation Platform -Simulation Framework -Tools and Modeling Approaches for Simulating Hardware. Monte Carlo Simulation - Application to communication systems, Monte Carlo integration, Semi- analytic techniques - Case study: Performance estimation of a wireless system. (9)

PHYSICAL LAYER & LINK LAYER WIRELESS MODELING

Physical Layer Modeling - Description of the Main Components of the PhyLayer - Accurate Simulation of Physical Layers - Physical Layer Modeling for Network Simulations -Link Layer Modeling -Medium Access Control (MAC) Protocols: Logical Link Control, Forward Error Detection and Correction, Backward Error Detection and Correction - Queuing and Processing Delay. (9)

CHANNEL MODELING

Radiation physics - Classification of Propagation Models - Deterministic Approaches by Classical Field Theory - Deterministic Geometric Optical Approaches - Empirical Path Loss Approaches, Stochastic Shadowing Models, Stochastic Fading Models, MIMO Channel Models- Hybrid Models - Noise interference - Antenna Impact. (9)

MOBILITY MODELING

Categorization of Mobility Models - Mobility Models - Selection of Appropriate Mobility Models - Modeling Handoff Methodology - Application examples - handover approaches. (9)

HIGHER LAYER MODELING & MODELING THE NETWORK TOPOLOGY

Modeling the Network Layer and Routing Protocols - Modeling Transport Layer Protocol - Modeling Application Traffic - Abstraction of Network Topologies by Graphs - Characterizing Graphs - Common Topology Models - Modeling the Internet. (9)

TOTAL : 45

REFERENCES

1. K.Wehrle Gunes, J.Gross, "Modeling and Tools for Network simulation", Springer, 2010.
2. Irene Karzela, "Modeling and Simulating Communications Networks", Prentice Hall India, 1999.
3. William.H.Tranter, K. Sam Shanmugam, Theodore. S. Rappaport, Kurt L. Kosbar, "Principles of Communication Systems Simulation", Pearson Education (Singapore) Pvt. Ltd, 2004.
4. M.C. Jeruchim, P.Balaban and K. Sam Shanmugam, "Simulation of Communication Systems: Modeling, Methodology and Techniques", Plenum Press, New York, 2001.
5. Nejat,Bragg,Arnold,"Recent Advances in Modeling and Simulation Tools for Communication Networks and Services", Springer, 2007.

19MECE09 - DETECTION AND ESTIMATION THEORY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : apply hypothesis testing in receivers
- CO2** : analyze signal detection methods in discrete time
- CO3** : apply and analyze parametric estimation
- CO4** : apply and analyze Bayesian estimation
- CO5** : apply and analyze the distribution free estimation

ELEMENTS OF HYPOTHESIS TESTING

Bayesian Hypothesis Testing - Likelihood Ratio Tests - Minimax Hypothesis Testing - Neyman Pearson Hypothesis Testing - Composite Hypothesis Testing - M'ary Hypothesis Testing. **(9)**

SIGNAL DETECTION IN DISCRETE TIME

Deterministic Signals - Stochastic Signals - Models and Detector Structures - Performance Evaluation - Chernoff Bounds - Applications of Detection in Signal Processing. **(8)**

PARAMETER ESTIMATION

Fundamentals of Estimation Theory - Minimum Variance Unbiased Estimation - Cramer Rao Lower bound - Best Linear Unbiased Estimators - Linear Least Squares Estimation - Nonlinear Least Squares Estimation - Maximum Likelihood Estimation. **(10)**

BAYESIAN ESTIMATION

Bayesian philosophy - General Bayesian Estimators - Minimum Mean Square Error Estimators - Maximum A Posteriori Estimators - Linear MMSE Estimation. **(9)**

DISTRIBUTION-FREE ESTIMATION

Orthogonality Principle - Autoregressive Techniques - Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations, Kalman Filter, Extended Kalman Filter - Applications of Estimation in Signal Processing. **(9)**

TOTAL : 45

REFERENCES

1. Poor H V, "An Introduction to Signal Detection and Estimation", Springer-Verlang, 2013.
2. Harry L. Van Trees, Kristine L. Bell with Zhi Tian, "Detection Estimation and Modulation Theory", Wiley, 2004.
3. Thomas Schonhoff and Arthur A Giordano, "Detection and Estimation Theory", Prentice Hall, 2006.
4. Kay S M, "Fundamentals of Statistical Signal Processing, Volume 1: Estimation Theory", Prentice Hall, 2009.
5. Kay S M, "Fundamentals of Statistical Signal Processing, Volume 2: Detection Theory", Prentice Hall, 2009.

19MECE10 - EMBEDDED AND REAL TIME SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : describe the architecture of embedded system hardware
- CO2** : describe the concepts of interfacing peripheral devices and communication buses
- CO3** : describe the concepts of device drivers
- CO4** : discuss the model real-time applications using embedded system concepts
- CO5** : describe the real time operating system concepts

INTRODUCTION TO EMBEDDED SYSTEMS

Embedded Systems-Applications of Embedded Systems-Processors in the System-Other Hardware Units-Software Embedded into a System-Examples of Embedded Systems-Embedded System-on-Chip (SOC) and use of VLSI Design technology. **(8)**

DEVICES AND BUSES FOR DEVICES NETWORK

I/O Devices-Timer and Counting Devices-Serial Communication using I²C, CAN and USB. Parallel Communication using PCI, PCIX and Advanced Parallel High Speed Buses. **(9)**

DEVICE DRIVERS AND INTERRUPTS SERVICING MECHANISM

Device Drivers-Parallel Port Device Drivers in a System, Serial Port Device Drivers in a System, Device Drivers for Internal Programmable Timing Devices - Interrupt Servicing Mechanism Context and the Periods for Context Switching, Deadline and Interrupt Latency. **(9)**

EMBEDDED SOFTWARE DEVELOPMENT USING IDE

Introduction to Integrated Development Environment (IDE)- Programming Concepts and Embedded Programming in Assembly and C- Creating a New Project - Adding Files to a Project-Building a Project-Debugging and Simulating the application- Host and Target machines - Linking and Locating software - Getting Embedded Software into the Target System - Issues in Hardware - Software design and co-design. **(9)**

REAL TIME SYSTEMS

Real time specifications - Real time Kernels -intertask communication and synchronization. REAL TIME OPERATING SYSTEMS (RTOS): Tasks and Task States, Tasks and Data, Semaphores and Shared Data, Message Queues, Mailboxes and Pipes, Timer functions, Events Memory Management, Interrupt Routines in RTOS Environment - Case study of embedded system Design and coding for an Automatic chocolate vending machine (ACVM) using RTOS Case Study of Programming With RTOS. **(10)**

TOTAL : 45

REFERENCES

1. Rajkamal, "Embedded Systems: Architecture, Programming and Design", 2nd Edition, Tata McGraw- Hill, 2008.
2. David E Simon, "An Embedded Software Primer", Pearson Education Asia, 7th Edition, 2009.
3. Phillip A. Laplante, "Real Time Systems Design and Analysis: An Engineer's Hand book" 3rd Edition, Wiley-Blackwell,2004.
4. Arnold Berger, "Embedded System Design: An Introduction to Processes, Tools, and Techniques", CMP Books, 1st Edition, 2002.
5. Wayne Wolf, "Computers as Components" 3rd Edition, Morgan Kaufmann Publishers, 2012.

19MECE11 - ELECTROMAGNETIC INTERFERENCE MEASUREMENTS AND COMPLIANCE IN DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : explain EMI/EMC concepts and its sources
- CO2** : explain the various coupling principles and standards
- CO3** : describe the various EMI measurement methods and its control techniques
- CO4** : describe the performance of EMC design for PCBs
- CO5** : explain the Measurement techniques for emission and about EMC standards

EMI ENVIRONMENT

EMI/ EMC concepts and definitions - Electromagnetic environment- Natural and Nuclear sources of EMI: Celestial Electromagnetic Noise, Lightning Discharge, Electrostatic Discharge, Electromagnetic Pulse-EMI from apparatus and circuits: Noise from Relays and Switches. (9)

EMI COUPLING PRINCIPLES AND STANDARDS

Conducted, radiated and transient coupling- Common ground impedance coupling - Common mode and ground loop coupling - Differential mode coupling - Near field cable to cable coupling - Field to cable coupling - Power mains and Power supply coupling-Cross talk in transmission lines. (9)

EMI CONTROL TECHNIQUES

Shielding- Filtering- Grounding- Electrical Bonding- Isolation Transformer - EMI Suppression Cables- EMC connectors- Transient suppressors and Surge Suppression Devices. (9)

EMC DESIGN OF PCBs

Component selection and mounting; Choice of capacitors, inductors, transformers and resistors, Power Distribution Decoupling - Zoning - Mother board Designs and Propagation Delay Performance Models. (9)

EMI MEASUREMENTS AND STANDARDS

Open area test site Measurements-Measurement Precautions-Anechoic Chamber- TEM cell- Reverberating Chamber, GTEM cell- Comparison of test facilities- Civilian standards: CISPR, FCC, EN- Military standards: MIL 461/462. (9)

TOTAL : 45

REFERENCES

1. V.P.Kodali, "Engineering EMC principles, Measurements and Technology", IEEE Press, Newyork, Wiley-Blackwell, 2nd Edition, 2016.
2. Clayton R. Paul, "Introduction to Electromagnetic Compatibility", John Wiley & Sons, 2014.
3. David A. Weston, "Electromagnetic compability: Methods, Analysis, Circuits and Measurments", 3rd Edition, CRC Press, 2016.
4. Henry W.Ott, "Noise Reduction Techniques in Electronics System", John Wiley and Sons, Newyork, 1998.
5. Bernhard Keiser, "Principles of Electomagnetic Compatibility", Artech house, 3rd Edition, 1994.

19MECE12 - LTE TECHNOLOGY AND STANDARDS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : analyze the LTE standards and its architecture

CO2 : apply protocols and analyze its functions

CO3 : compare data, transport and control channels and analyze channel coding techniques

CO4 : analyze multiple antenna techniques used in MIMO systems

CO5 : apply and analyze resource scheduling and cell search techniques in different networks

LTE STANDARDS

LTE Standards - LTE Network Architecture - Network Elements and Functions - Requirements and Targets for the Long Term Evolution - Technologies for the Long Term Evolution. (9)

LTE PROTOCOLS AND FUNCTIONS

User Equipment Categories - QoS Architecture - LTE Security - Radio Interface Basics - Multiple Access in OFDM - OFDMA - LTE Network Protocol Architecture. (9)

DOWNLINK PHYSICAL DATA AND CONTROL CHANNELS

Downlink Data - Transporting Channels- Downlink Control Channels - Link Adaptation and CQI Feedback - Channel Coding. (9)

MULTIPLE ANTENNA TECHNIQUES

Multiple Antenna Theory - MIMO Signal Model - Single User MIMO Techniques - Multi-User Techniques - MIMO Schemes in LTE - Practical Considerations - Single-User Schemes, Multi-User Schemes - Physical Layer MIMO Performance. (9)

SCHEDULING AND CELL SEARCH

General Considerations for Resource Allocation Strategies Scheduling Algorithms - Considerations for Resource Scheduling in LTE - Interference Coordination and Frequency Reuse, LTE Cell Search - UMTS Cell Search - GSM Cell Search - Measurements on Campedon LTE - LTE Measurements - Handover to LTE - Handover to UMTS - Handover to GSM. (9)

TOTAL : 45

REFERENCES

1. Stefania Sesia, Issam Toufik and Matthew Baker, "LTE - The UMTS Long Term Evolution: From Theory to Practice", John Wiley & Sons, 2011.
2. Ralf Kreher and Karsten Gaenger, "LTE Signaling, Trouble shooting and Optimization", John Wiley & Sons, 2011.
3. Erik Dahlman, Stefan Parkvall, Johan Skold, "4G:LTE/LTE - Advanced for mobile broadband", Elsevier Ltd.,2014.
4. Christopher Cox, "An Introduction to LTE: LTE,LTE - Advanced SAE and 4G Mobile communication", John Wiley & Sons,2013.
5. Houman Zarrinkouk, "Understanding LTE with MATLAB from Mathematical Modeling to simulation and Prototyping", John Wiley & Sons, 2014.

19MECE13 - SOFTWARE DEFINED RADIO AND COGNITIVE RADIO TECHNOLOGIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : understand the architecture of Software defined radios
- CO2** : relate software defined radio with cognitive radio
- CO3** : analyze the architecture of Cognitive Radio
- CO4** : analyze the technical challenges in cognitive radio design
- CO5** : apply and analyze spectrum sensing methods used in Cognitive Radio

SOFTWARE DEFINED RADIO

Basic SDR - Software and Hardware Architecture of an SDR - Spectrum Management - Managing unlicensed spectrum - Noise Aggregation. (9)

SDR AS PLATFORM FOR COGNITIVE RADIO

Introduction - Hardware and Software architecture - SDR development process and Design - Application software - Component development - Waveform development - cognitive waveform development. (9)

COGNITIVE RADIO TECHNOLOGY

Introduction - Radio flexibility and capability - Aware - Adaptive - Comparison of Radio capabilities and Properties - Available Technologies - IEEE 802 Cognitive Radio related activities-Application. (9)

CR- TECHNICAL CHALLENGES

Design Challenges associated with CR - Hardware requirements - Hidden primary user problem - detecting spread spectrum primary users - sensing duration and frequency - security. (9)

SPECTRUM SENSING

Overview - Classification - Matched filter - waveform based sensing - cyclo stationary based sensing - Energy detector based sensing - Radio Identifier - Cooperative sensing- other sensing methods. (9)

TOTAL : 45

REFERENCES

1. Bruce A Fette, "Cognitive Radio Technology", Academic Press, 2009.
2. Huseyin Arslan, "Cognitive Radio, Software Defined Radio and Adaptive wireless system", Springer, 1st Edition, 2007.
3. Mitola, J. and J. Maguire, G. Q., "Cognitive radio: making software radios more personal," IEEE Personal Commun. Mag., vol. 6, no. 4, pp. 13-18, Aug. 1999.
4. Tervik Yucek and Huseyin Arslan, "A Survey of Spectrum Sensing Algorithms for Cognitive Radio Applications", IEEE Communications Surveys & Tutorials, Vol. 11, No.1, First Quarter 2009, pp. no.: 116-130.
5. Alexander M. Wyglinski, Maziar Nekovee, and Y. Thomas Hou, "Cognitive Radio Communications and Networks - Principles and Practice", Elsevier Inc., 2010.

19MECE14 - SPACE TIME WIRELESS COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : model multipath channel for wireless systems
- CO2** : analyze channel capacity and BER of wireless communication systems
- CO3** : apply diversity techniques at transmitters and receivers
- CO4** : estimate channels using equalizer algorithms
- CO5** : analyze OFDM & Spread Spectrum modulation

SAMPLED SIGNAL AND MULTIPATH FADING CHANNEL MODELS

Physical scattering models - Extended channel models - Signal model for SISO - SIMO - MISO and MIMO- ITU Channel Models - 3GPP Channel Models - Extended ITU Models- Spatial Channel Model SCM Extension Channel Model - WINNER Channel Model. **(9)**

CAPACITY ANALYSIS & BIT ERROR RATE ANALYSIS

Capacity in Frequency Flat Fading channel - Capacity in Frequency Selective Fading Channel- BER Analysis for Space Time Coding - Transmit Beam forming - Receiver Selection Combining - Receiver Equal Combining - Receiver Maximal Ratio Combining. **(9)**

SPATIAL DIVERSITY AT TRANSMITTER AND RECEIVER

Diversity gain - Transmit and receive Antenna diversity - Diversity order and performance - Combined space and path diversity - Indirect transmit diversity - space time coding for frequency flat channels - frequency selective channels - Receivers - frequency flat and selective channels in SISO, SIMO and MIMO. **(9)**

CHANNEL ESTIMATION AND TIMING & FREQUENCY SYNCHRONIZATION

LS Estimation - MMSE Estimation - Robust MMSE Estimation -Coarse Time Synchronization - Fine Time Synchronization - Coarse Frequency Synchronization - Fine Frequency Synchronization. **(9)**

OFDM AND SPREAD SPECTRUM MODULATION

SISO-OFDM - MIMO OFDM - SISO SS modulation - MISO SS modulation - Model - capacity and receiver gain of MIMO MAC - MIMO BC - MIMO MU. **(9)**

TOTAL : 45

REFERENCES

1. A. Paulraj, R. Nabar and D Gore, "Introduction to Space-Time Wireless Communications", Cambridge University Press, 2003.
2. E. Biglieri, R. Calderbank, A. Constantinides, A. Goldsmith, A. Paulraj, "MIMO Wireless Communications", Cambridge University press, 2010.
3. Erik. G. Larsson, "Space Time Block Coding for Wireless Communications", Cambridge University Press, 2008.
4. Y.S.Cho, J.Kim, Won Young Yang, Chung G. Kang, "MIMO OFDM Wireless Communications with MATLAB", John Wiley & sons(Asia) private Ltd, 2010.
5. L. Hanzo, Y.A. Li Wang, M. Jiang "MIMO-OFDM for LTE, Wi-Fi and WiMAX", John Wiley & Sons Ltd, 2011.

19MECE15 - MULTIMEDIA COMPRESSION AND COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : describe information theory and apply different techniques to text compression

CO2 : explain the concept of audio compression and apply techniques to audio compression

CO3 : analyze image compression standards and techniques of image compression

CO4 : apply different techniques to video compression, describe and analyze video compression standards

CO5 : analyze VoIP challenges and protocols

INTRODUCTION AND TEXT COMPRESSION

Special features of Multimedia - Graphics and Image Data Representations - Fundamental Concepts in Video and Digital Audio - Storage requirements for Multimedia Applications -Need for Compression - Taxonomy of compression techniques - Overview of information theory - Static Huffman coding - Dynamic Huffman coding - Lempel-Ziv coding - Lempel-Ziv Welsh coding. **(9)**

AUDIO COMPRESSION

Audio compression techniques - Frequency domain and filtering - Basic sub band coding - Application to speech coding - G.722 - Application of audio coding: MPEG audio - Silence compression - Speech compression techniques - Vocoders - Linear predictive coder. **(9)**

IMAGE COMPRESSION

Approaches to image compression - Graphics interchange format, Tagged image file format, Digitized documents - Digitized pictures - JPEG - Quad trees - DCT coding - Wavelet methods - Filter banks - EZW coding - SPIHT coding - JPEG 2000 standards. **(9)**

VIDEO COMPRESSION

Video signal representation - Video compression techniques - MPEG1,2,4 - Motion estimation - H.261, H.263 - Overview of wavelet based compression - PLV performance Real time compression. **(9)**

VOIP TECHNOLOGY

Basics of IP transport, VoIP challenges, H.323/ SIP Network Architecture, Protocols, Call establishment and release, VoIP and SS7, Quality of Service- CODEC Methods- VoIP applicability. **(9)**

TOTAL : 45

REFERENCES

1. Fred Halsall, James F. Kurose, "Multimedia communication-Applications, Networks, Protocols and standards", Pearson Education Limited, 2004.
2. Sayood Khaleed, "Introduction to Data Compression", Morgan Kauffman, 4th Edition, 2012.
3. Tay Vaughan, "Multimedia: making it work", 7th Edition, TMH 2007.
4. Marcus goncalves "Voice over IP Networks", Mc Graw hill, 1999.
5. Jerry D. Gibson, "Multimedia Communications: Directions and Innovations", Morgan Kaufmann, 2nd Edition, 2001.
6. David Solomon, "Data Compression the complete reference", Springer, 4th Edition, 2007.

19MECE16 - OFDM/OFDMA COMMUNICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : analyze OFDM/OFDMA based systems
- CO2** : design and analyze resource management techniques
- CO3** : apply adaptive modulation techniques in communication system design
- CO4** : analyze the performance of OFDMA system
- CO5** : compare various standards with OFDM/OFDMA

RADIO CHANNEL MODELING, RESOURCE ALLOCATION, AND SPECTRUM EFFICIENCY

Introduction - Statistical characterization - OFDM/OFDMA channel models - OFDMA scheduling and resource allocation - System model - transmit spectra - Egress reduction techniques. (9)

RESOURCE MANAGEMENT AND SYNCHRONIZATION : OFDM VS OFDMA

Resource allocation and scheduling algorithms - Synchronization in OFDMA downlink and uplink - Synchronization for WIMAX. (9)

ADAPTIVE MODULATION AND TRAINING SEQUENCE DESIGN

Adaptive modulation algorithms - Channel feedback - Optimal condition for training sequence - Realization of Optimal training - Differential Space time Block codes - Differential Space frequency block codes. (9)

COOPERATIVE OFDMA, PERFORMANCE AND OPTIMIZATION OF RELAY ASSISTED OFDMA NETWORKS

Cooperative OFDMA uplink - Channel capacity - Frequency offset and channel estimation - Uplink/Downlink optimization - System performance. (9)

OFDMA SYSTEMS AND APPLICATIONS, AND OFDMA BASED MOBILE WIMAX

Mobile WIMAX - Evolved Universal Terrestrial Radio Access - OFDMA, frame structure and sub channelization - Power saving mode - Handover. (9)

TOTAL : 45

REFERENCES

1. Tao Jiang, Lingyang Song, and Yan Zhang, "Orthogonal Frequency Division Multiple Access (OFDMA) Fundamentals and Applications", Auerbach Publishers, Taylor & Francis Group, 2019.
2. Yi (Geoffrey) Li, and Gordon L. Stuber, "Orthogonal Frequency Division Multiplexing", Springer Science Business Media Inc., NY, USA, 2006.
3. Junyi Li, Xinzhou Wu, Rajiv Laroia "OFDMA Mobile Broadband Communications: A Systems Approach", Cambridge University Press, 2013.
4. Jeffrey G. Andrews, Arunabha Ghosh and Riaz Muhamed, "Fundamentals of WIMAX: Understanding broadband wireless networking", 1st Edition, Prentice Hall Inc., NJ, 2008.
5. Lawrence Harte and Kalai Kalaichelvan, "WIMAX explained: System fundamentals", 1st Edition, Althos Publishing, 2007.

19MECE17 - INFORMATION CODING THEORY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : apply and analyze BCH and Reed Solomon coding

CO2 : apply and analyze iterative decoding techniques

CO3 : apply and analyze LDPC and TURBO codes

CO4 : design LDPC decoders

CO5 : analyze fading channels in MIMO system using Space-time codes

BCH AND REED-SOLOMON CODES

BCH codes - Reed-Solomon codes - Decoding BCH and RS codes - finding the Error Locator Polynomial - Non-binary BCH and RS Decoding - Erasure decoding for Non-binary BCH and RS codes - Galois field Fourier Transform method - variations and extensions of Reed-Solomon codes. **(9)**

ITERATIVELY DECODED CODES

Construction and Notation - Tanner Graphs - Transmission through Gaussian Channel - Decoding LDPC codes - The iterative decoder on General Block Codes - Density Evolution - EXIT charts for LDPC codes - Irregular LDPC codes- LDPC code construction - Encoding LDPC codes - Low-Density Generator Matrix codes - Serial Concatenated codes- Repeat - Accumulate codes - Irregular RA codes. **(9)**

LOW DENSITY PARITY CHECK CODES

EG-LDPC codes - PG-LDPC codes - Shortened finite geometry LDPC codes - Gallager LDPC codes - Masked EG-Gallager LDPC codes - Quasi-cyclic codes by circulant decomposition - Random LDPC codes - Graph - Theoretic LDPC codes - Construction of LDPC codes based on Balanced incomplete block designs - Concatenations with LDPC and Turbo codes. **(9)**

DESIGN OF LDPC DECODERS

An Overview of Trellis - coded Modulation - Capacity of Two-dimensional Signal Sets-Bit-interleaved Trellis Coded Modulation Based on Turbo and -LDPC Codes - Design of Flexible Interleavers and Parity - check Matrices - Puncturing Strategies - Parallel Architectures for High-speed Decoders and Their Implementation. **(9)**

SPACE-TIME CODING

Introduction - Fading Channels - Diversity Transmission and Reception: the MIMO channel - Space-time block codes - complex orthogonal Designs - Space-time trellis codes. **(9)**

TOTAL : 45

REFERENCES

1. Todd K Moon, "Error Correction Coding:Mathematical methods and Algorithms", John Wiley, 2005.
2. Richard B.Wells, "Applied Coding and information theory for Engineers", Prentice Hall, 1999.
3. Peter Sweeney, "Error Control Coding : from theory to practice", Wiley,2002.
4. Shu Lin, Daniel J. Costello, "Error control coding", 2nd Edition, Pearson, 2011.
5. Emilio Sanvicente, "Understanding Error Control Coding", Springer (e-book), 2019.

19MECE18 - ANALOG AND MIXED SIGNAL CIRCUIT DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : analyze and design single stage and differential amplifiers

CO2 : analyze and design submicron circuits

CO3 : analyze and design switched capacitor circuits

CO4 : explain the concepts oscillators, PLL and analyze their characteristics

CO5 : analyze the characteristics of data converters architectures

SINGLE STAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIERS

Challenges in analog design-Mixed signal layout issues- MOS I/V characteristics -large signal and small signal model of MOSFET - single stage Amplifier - Common Source Stage - Source follower - Cascade stages -Single - ended and differential operation - Basic differential pair - Common-mode response - Differential pair with MOS loads. (9)

SUBMICRON CIRCUIT DESIGN

Submicron CMOS process flow, Capacitors and resistors, Current mirrors, Digital Circuit Design, Delay Elements - Adders- OP Amp parameters and Design. (9)

NON LINEARITY AND SWITCHED CAPACITOR CIRCUITS

Supply independent biasing - Temperature independent references: negative TC voltage- positive TC voltage - bandgap reference - PTAT current generation - Speed and noise issues - Continuous-time feedback amplifier using resistors - capacitors - switched-capacitor amplifier in sampling mode - amplification mode - transfer of capacitor's charges - Sampling switches - Switched - capacitor amplifiers - Switched -capacitor integrator - Nonlinearity - Mismatch. (9)

OSCILLATORS AND PLLs

Oscillatory system - Ring oscillators - LC oscillators - Voltage Controlled Oscillators (VCO) -Mathematical model of VCO - Simple PLL - Charge pump PLLs - Non ideal effects in PLLs: PFD/CP non idealities - jitter in PLLs - Delay locked loops - PLL applications. (9)

DATA CONVERTERS

Introduction and characterization of DAC - Parallel DAC - Extending the resolution of parallel DAC - Serial DAC - Introduction and characterization of ADC - Serial ADC - Medium ADC -High Speed ADC- Oversampling Converters. (9)

TOTAL : 45

REFERENCES

1. B. Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2002.
2. Phillip E.Allen and Douglas R.Holberg, "CMOS Analog Circuit Design", Oxford University Press, 2002.
3. R.J. Baker, "CMOS Mixed-Signal Circuit Design", Wiley Publications, 2002.
4. Randall L Geiger, Phillip E. Allen and Noel K.Strader, "VLSI Design Techniques for Analog and Digital Circuits", Mc Graw Hill International Company, 1990.
5. Van de Plassche, Rudy J., "CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters", Springer, 2003.

19MECE19 - MOBILE AD HOC AND SENSOR NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : discuss the fundamentals vision of wireless Ad Hoc Networks, MAC protocols for Mobile Ad Hoc Networks(MANETs)
- CO2** : analyze the performance of routing & transport layer protocols for MANETs with respect to QoS metrics
- CO3** : outline the challenges & issues in the Wireless Sensor Network and its network architecture
- CO4** : discuss the features of MAC & Routing protocols for WSNs
- CO5** : explain the principles of infrastructure establishment in WSNs

MAC PROTOCOLS FOR MANET

AD HOC Wireless Networks - Issues, Challenges & Applications - Designing a MAC Protocol for Ad hoc Wireless Networks - Classification of MAC Protocols: Contention-Based, Contention-Based with Reservation Mechanisms, Contention-Based with Scheduling Mechanisms, MAC Protocols that Use Directional Antennas. (9)

ROUTING AND TRANSPORT LAYER PROTOCOLS FOR MANET

Designing a Routing Protocol for Ad hoc Wireless Networks - Classifications of Routing Protocols: Table Driven and On-Demand Routing Protocols. Designing a Transport Layer Protocol for Ad Hoc Wireless Networks - Classification of Transport Layer Solutions - TCP over Ad Hoc Wireless Networks. (9)

WSN ARCHITECTURE

Challenges for Wireless Sensor Networks - Characteristics Requirements - Comparison of Mobile Ad Hoc and Sensor Networks - Applications - Sensor Node Architecture - Hardware Components - Energy Consumption of Sensor Nodes - Network Architecture - Sensor Network Scenarios - Optimization Goals and Figures of Merit - Gateway Concepts. (9)

MAC AND ROUTING PROTOCOLS FOR WSN

MAC Protocols for Wireless Sensor Networks - IEEE 802.15.4 - Zigbee - 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 and Geographic Routing. (9)

INFRASTRUCTURE ESTABLISHMENT

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control. (9)

TOTAL : 45

REFERENCES

1. C. Siva Ram Murthy and B.S. Manoj "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall, June 2004.
2. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.
3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks-s Technology, Protocols, and Applications", John Wiley, 2007.
4. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
5. Basagni S, Marco Conti, Silvia Giordano, Ivan Stojmenovi and Cacete, "Mobile Ad hoc Networking", John Wiley and sons, 2004.
6. Carlos de Moraes Cordeiro, Dharma Prakash Agarwal, "Ad hoc and Sensor Network: Theory and Applications", 2nd Edition, World Scientific Publishing Co, 2011.

19MECE20 - 5G NETWORK TECHNOLOGIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : understand 5G requirements and challenges.

CO2 : design and analyze 5G waveforms.

CO3 : apply Non Orthogonal Multiple Access technique for 5G communication systems.

CO4 : analyze security issues in 5G wireless systems.

CO5 : analyze radio access technologies for 5G networks.

PHYSICAL LAYER FOR 5G TECHNOLOGIES

Introduction - 5G Requirements and Technology Trends - Challenges in 5G wireless communication- 5G network management with Machine Learning. (9)

WAVEFORM DESIGN FOR 5G & BEYOND

Introduction - 5G Waveform Design - 5G use cases and Waveform Requirements - CP: OFDM-Multi carrier schemes- Single carrier schemes. (9)

MULTIPLE ACCESSES FOR 5G

Full duplex for 5G - Non orthogonal multiple access for 5G (NOMA)- Channel capacity in OMA and NOMA - NOMA in MIMO systems - Power domain NOMA - Code domain NOMA. (9)

PHYSICAL LAYER TECHNIQUES FOR 5G WIRELESS SECURITIES

Introduction - 5G Physical layer Architecture - Secure full duplex receiver jamming - Bi directional communications - Relay Communications. (9)

RADIO ACCESS TECHNOLOGY FOR 5G NETWORKS

Universal access in 5G Networks - Potential challenges and opportunities for urban and rural environments- Massive MIMO - Millimeter wave technologies. (9)

TOTAL : 45

REFERENCES

1. Anwer Al-Dulaimi, Xianbin Wang and Chin-Lin I, "5G Networks: Fundamental Requirements, Enabling Technologies, and Operations management", IEEE Press, John Wiley & Sons, 2018.
2. Fei Hu, "Opportunities in 5G Networks, A research and development perspective", CRC Press, Taylor & Francis Group, 2016.
3. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, "5G Mobile Communications", Springer, 2017.
4. Afif Osseiran, Jose F. Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.
5. Jonathan Rodriguez, "Fundamentals of 5G mobile networks", John Wiley & Sons, Ltd, 2015.

19MECE21 - VLSI FOR WIRELESS COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : narrate wireless access methods, modulation schemes and analyze loss characteristics

CO2 : analyze receiver architectures and design low noise amplifiers

CO3 : analyze mixer characteristics

CO4 : explain the concepts PLL and design frequency synthesizer

CO5 : analyze and design transmitter architecture and power amplifiers

COMMUNICATION CONCEPTS

Introduction - Overview of Wireless systems - Standards - Access Methods - Modulation schemes - Classical channel - Wireless channel description - Path loss - Multipath fading - Standard Translation. **(9)**

RECEIVER ARCHITECTURE & LOW NOISE AMPLIFIERS

Receiver front end - Filter design - Non-idealities - Design parameters - Noise figure & Input intercept point. LNA Introduction - Wideband LNA design - Narrow band LNA design: Impedance matching & Core amplifier. **(9)**

MIXERS

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain - Distortion - Noise- A Complete Active Mixer. Switching Mixer - Distortion, Conversion Gain & Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer - Conversion Gain, Distortion, Intrinsic & Extrinsic Noise in Single Ended Sampling Mixer. **(9)**

FREQUENCY SYNTHESIZERS

PLL - Phase detector - Dividers - Voltage Controlled Oscillators - LC oscillators - Ring Oscillators - Phase noise - Loop filters & design approaches - A complete synthesizer design example (DECT) - Frequency synthesizer with fractional divider. **(9)**

TRANSMITTER ARCHITECTURES & POWER AMPLIFIERS

Transmitter back end design - Quadrature LO generator - Power amplifier design. **(9)**

TOTAL : 45

REFERENCES

1. Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2002.
2. B.Razavi, "RF Microelectronics", Prentice-Hall, 1998.
3. Behzad Razavi, "Design of Analog CMOS Integrated Circuits" McGraw-Hill, 1999.
4. Emad N Farag and Mohamed I Elmasry, "Mixed Signal VLSI wireless design - Circuits & Systems", Kluwer Academic Publishers, 2000.
5. J. Crols and M. Steyaert, "CMOS Wireless Transceiver Design," Boston, Kluwer Academic Pub., 1997.

19MECE22 - HIGH SPEED DIGITAL DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : explain Transmission line characteristics
- CO2** : explain the concepts of power distribution and analyze various parameters
- CO3** : analyze clock timing issues
- CO4** : explain the concepts of interconnects and EMC
- CO5** : analyze grounding factors

TRANSMISSION LINES AND CROSSTALK

Transmission line structures, signal propagation, transmission line parameters, line impedance, propagation delay, Transmission line reflections, Cross talk- Mutual inductance, Mutual capacitance, cross talk induced noise, minimizing cross talk. **(10)**

POWER DISTRIBUTION

Losses, the need for low-impedance planes and decoupling capacitors and their selection. **(9)**

CLOCK DISTRIBUTION AND TIMING

High-quality clock signals to components, boards, and systems, Common clock timing and source synchronous timing. **(9)**

INTERCONNECTS & ELECTROMAGNETIC COMPATIBILITY (EMC)

Interconnect technologies, Multilevel multilayer interconnects, propagation delay, crosstalk analysis. Designing for EMC, EMC regulations, typical noise path, methods of noise coupling, and methods of reducing interference in systems. **(9)**

GROUNDING

Safety grounds, signal grounds, single-point ground systems, multi-point ground systems, hybrid grounds, functional ground layout, practical low frequency grounding, hardware grounds, grounding of cable shields, ground loops, shield grounding at high frequencies. **(8)**

TOTAL : 45

REFERENCES

1. Howard Johnson, Martin Graham, "High speed Digital design", Pearson, 2005.
2. Hall S, Hall G and McCall J, " High speed digital system design: A Handbook of Interconnect theory and practices", Wiley Interscience, 2000.
3. Hartmut Grabinski, "Interconnects in VLSI design", Kluwer, 2000.
4. Goel A K, "High speed VLSI interconnections", Wiley 2007.
5. Bogatin E, "Signal integrity-simplified", Prentice Hall, 2003.
6. Paul CR, "Introduction to Electromagnetic compatability", Wiley 2006.

19MECE23 - CODING THEORY FOR WIRELESS CHANNELS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : *apply the Galois field arithmetic in communication system design*
- CO2** : *apply and analyze block codes and cyclic codes*
- CO3** : *apply and analyze BCH & RS codes*
- CO4** : *apply coding algorithms and analyze coding gain for various wireless channels*
- CO5** : *analyze coding in wireless standards*

GALOIS FIELDS

Groups, fields and Vector spaces - Elementary properties of Galois fields - Primitive polynomials and Galois fields of Order pm - Zech's algorithms-Euclidean domains and Euclid's algorithm - Minimal polynomials and Conjugate elements -Factoring Xn -1. (9)

LINEAR BLOCK CODES & CYCLIC CODES

Block error control codes - Linear block codes - Standard array and syndrome-table decoding -Weight distribution of block codes - Hamming codes - Modified linear codes-General theory of linear cyclic codes - Shift register encoders and decoders for cyclic codes -Shortened cyclic codes and CRC error detection. (9)

BCH AND REED SOLOMON CODES

Generator polynomial approach to BCH codes - Weight distribution for some binary BCH codes -Basic properties of Reed Solomon codes - Decoding algorithms for binary BCH codes, non-binary BCH codes, Reed Solomon codes (Berlekamp's algorithm) - Binary and non-binary erasure decoding. (9)

CODING OVER AWGN CHANNELS

AWGN channels-Coding gain-Encoding and decoding in AWGN channels-ML and MAP decoding for Repetition codes- Coding gain performances -Density Parity check (LDPC) codes, Regular LDPC codes, Gallager construction of LDPC codes. LDPC codes -Socket construction of regular LDPC codes, Tanner Graphs- Gallager decoding-Irregular LDPC codes-Degree optimisation to achieve higher thresholds Soft-decision Message Passing Decoder for AWGN channels-Density evolution for AWGN channels. (9)

LDPC/TURBO CODES IN THE WIRELESS STANDARDS

Turbo Encoders & Decoders- Turbo codes in the WiMax/3GPP standards- permutation polynomial interleavers- LDPC codes in the WiMax standard-protograph LDPC codes and their properties Implementation aspects of turbo codes: MAP decoder and MAXLOGMAP decoder for convolutional codes, design and architecture- Implementation aspects of LDPC codes: tanh processing versus minsum decoder-design and architecture-Outlook and the future of the world of error control codes - coding for multi-terminal communication problems. (9)

TOTAL : 45

REFERENCES

1. *Shu Lin, Daniel Costello, "Error control coding - Fundamentals and Applications", 2nd Edition, Prentice Hall, Upper Saddle River, NJ, 2011.*
2. *Rudiger Urbanke and Thomas Richardson, "Modern coding theory", Cambridge University Press, 2008.*
3. *Stephen B. Wicker, "Error control systems for Digital communication and storage", Prentice Hall, Upper Saddle River, NJ, 1995.*
4. *Todd K Moon, "Error Correction Coding - Mathematical methods and Algorithms", John Wiley & Sons, 2005.*
5. *Bernard Sklar, "Digital Communications, Fundamentals and Applications", Pearson Education, 2nd Edition, 2016.*

19MECE24 - DATA CONVERTERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : design and analyze sample and hold circuits.
- CO2** : design and analyze switched capacitor circuits and comparators.
- CO3** : analyze digital to analog converter architectures.
- CO4** : analyze analog to digital converter architectures.
- CO5** : explain and analyze the characteristics of precision techniques.

SAMPLE AND HOLD CIRCUITS

Sampling switches, Conventional open loop and closed loop sample and hold architecture, Open loop architecture with miller compensation, multiplexed input architectures, recycling architecture switched capacitor architecture. (9)

SWITCHED CAPACITOR CIRCUITS AND COMPARATORS

Switched-capacitor amplifiers, switched capacitor integrator, switched capacitor common mode feedback. Single stage amplifier as comparator, cascaded amplifier stages as comparator, latched comparators. (9)

DIGITAL TO ANALOG CONVERTERS

Performance metrics, reference multiplication and division, switching and logic functions in DAC, Resistor ladder DAC architecture, current steering DAC architecture. (9)

ANALOG TO DIGITAL CONVERTERS

Performance metric, Flash architecture, Pipelined Architecture, Successive approximation architecture, Time interleaved architecture. (9)

PRECISION TECHNIQUES

Comparator offset cancellation, Op Amp offset cancellation, Calibration techniques, range overlap and digital correction. (9)

TOTAL : 45

REFERENCES

1. Behzad Razavi, "Principles of data conversion system design", IEEE Press, 1995.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 2008.
3. Franco Malobert, "Data Converters" Springer Publications, 2007.
4. Arthur van Roermund, Herman Casier, Michiel Steyae, "Analog Circuit Design: Smart Data Converters, Filters on Chip, Multimode Transmitters", Springer Publications, 2010.
5. Mikael Gustavsson, J. Jacob Wikner, Nianxiong Tan, "CMOS Data Converters for Communications", Kluwer Academic Publishers, 2002.

19MECE25 - SPEECH PROCESSING AND SYNTHESIS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : discuss the fundamental concepts of speech production and related parameters of speech

CO2 : illustrate the concepts of speech signal representations and coding

CO3 : understand different speech modeling procedures

CO4 : analyze Text inputs using various methods

CO5 : understand the speech synthesis methods

FUNDAMENTALS OF SPEECH PROCESSING

Introduction - Spoken Language Structure - Phonetics and Phonology - Syllables and Words - Syntax and Semantics - Probability, Statistics and Information Theory - Probability Theory - Estimation Theory - Significance Testing - Information Theory. **(9)**

SPEECH SIGNAL REPRESENTATIONS AND CODING

Overview of Digital Signal Processing - Speech Signal Representations - Short time Fourier Analysis - Acoustic Model of Speech Production - Linear Predictive Coding - Cepstral Processing - Formant Frequencies - The Role of Pitch - Speech Coding - LPC Coder, CELP, Vocoders. **(9)**

SPEECH RECOGNITION

Hidden Markov Models - Definition - Continuous and Discontinuous HMMs - Practical Issues - Limitations. Acoustic Modeling - Variability in the Speech Signal - Extracting Features - Phonetic Modeling - Adaptive Techniques - Confidence Measures - Other Techniques. **(9)**

TEXT ANALYSIS

Lexicon - Document Structure Detection - Text Normalization - Linguistic Analysis - Homograph Disambiguation - Morphological Analysis - Letter-to-sound Conversion - Prosody - Generation schematic - Speaking Style - Symbolic Prosody - Duration Assignment - Pitch Generation. **(9)**

SPEECH SYNTHESIS

Attributes - Formant Speech Synthesis - Concatenative Speech Synthesis - Prosodic Modification of Speech - Source-filter Models for Prosody Modification - Evaluation of TTS Systems. **(9)**

TOTAL : 45

REFERENCES

1. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing, Processing and Perception of Speech and Music", Wiley- India Edition, 2006.
2. Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 2004.
3. Daniel Jurafsky and James H Martin, "Speech and Language Processing - An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 2009.
4. Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, 1997.
5. Lawrence Rabiner and Bing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.

19MECE26 - MULTIRATE SIGNAL PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : discuss the fundamental concepts of multi-rate systems

CO2 : design various types of QMF filter banks

CO3 : design perfect reconstruction filter banks and analyze their properties

CO4 : implement filters using polyphase structures

CO5 : design filter banks using cosine modulation techniques and to apply the concepts of multirate signal processing to real time signals

FUNDAMENTALS OF MULTIRATE SYSTEMS

Sampling theorem - sampling at sub Nyquist rate - Basic Formulations and schemes-Multirate operations- Decimation and Interpolation - Digital Filter Banks -Interconnection of Building Blocks- Decimation with transversal filters - Interpolation with transversal filters - Polyphase representation -Decimation with Polyphase filters - Interpolation with polyphase filters - Decimation and Interpolation with Rational sampling factors. (9)

MAXIMALLY DECIMATED FILTER BANKS

Quadrature mirror filter banks -Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank - Bi orthogonal and linear phase filter banks - Transmultiplexer filter banks. (9)

PERFECT RECONSTRUCTION FILTER BANKS

Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity - Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property- Quantization Effects: Types of quantization effects in filter banks coefficient sensitivity effects, dynamic range and scaling. (9)

FILTER BANKS WITH POLYPHASE STRUCTURE

Fundamental polyphase structures - polyphase QMF banks - General two channel polyphase filter banks - General M-channel polyphase filter banks - Paraunitary polyphase filter banks - DFT polyphase filter banks. Application: Digital audio. (9)

COSINE MODULATED FILTER BANKS

Cosine Modulated pseudo QMF Bank- Alias cancellation- Elimination of Phase distortion- Closed form expression- Cosine modulated PR Systems-Sub band coding of speech and Image signals. (9)

TOTAL : 45

REFERENCES

1. Vaidyanathan P P, "Multirate Systems and Filter Banks", Prentice Hall Inc., 2011.
2. Fliege N J, "Multirate Digital Signal Processing", John Wiley and sons, 2000.
3. J.G. Proakis. D.G. Manolakis. "Digital Signal Processing: Principles. Algorithms and Applications", 4th Edition, Prentice Hall India, 2015.
4. Sanjit K Mitra, "Digital Signal Processing-A Computer Based Approach", Tata McGraw Hill, 4th Edition, 2013.
5. R.E. Crochiere, Lawrence R.Rabiner. "Multirate Digital Signal Processing", Prentice Hall Signal processing series, 1st Edition, 2019.

19MECE27 - NON LINEAR SIGNAL PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : explain the fundamentals of non-linear filtering and its statistical preliminaries

CO2 : design non-linear filters and illustrate their differences

CO3 : design an adaptive non-linear and polynomial filter

CO4 : explain various algorithms and architectures for non-linear filter design and implementation

CO5 : design non-linear filters for image processing applications

INTRODUCTION TO NONLINEAR FILTERS AND STATISTICAL PRELIMINARIES

Nonlinear filters - measure of robustness - M estimators - L estimators - R estimators - order statistics - median filter and their characteristics - impulsive noise filtering by median filters - Recursive and weighted median filters - stock filters. (9)

NON-LINEAR DIGITAL SIGNAL PROCESSING BASED ON ORDER STATISTICS

Time ordered nonlinear filters - rank ordered nonlinear filters - max/median filtering - median hybrid filters - characteristics of ranked order filters - L filters - M filters - R filters - comparison. (9)

ADAPTIVE NONLINEAR AND POLYNOMIAL FILTERS

Definition of polynomial filters - Wiener filters - robust estimation of scale - Adaptive filter based on local statistics - Decision directed filters - Adaptive L filters - Comparison of adaptive nonlinear filters - Neural networks for nonlinear filter. (9)

ALGORITHMS AND ARCHITECTURES

Sorting and selection algorithm - running median algorithm - fast structures for median and order statistics filtering - systolic array implementation - Wave front array implementation - quadratic digital filters implementation. (9)

APPLICATIONS OF NONLINEAR FILTERS

Power spectrum analysis - Morphological image processing - nonlinear edge detection impulse noise rejection in image and bio signals - two component image filtering - speech processing. (9)

TOTAL : 45

REFERENCES

1. Ioannis Pitas, Anastarios, N.Venetsanopoulos, "Nonlinear Digital filters - Principles and Applications", Kluwer Academic Publishers, 1990.
2. Jaakko T.Astola, Jaakko Astola Kuosmanen, "Fundamentals of Nonlinear Digital filtering", CRC Press LLC, 1997.
3. Wing Kuen Ling, "Nonlinear Digital filters: Analysis and Applications", Elsevier Science & Tech. 2007.
4. Gonzalo R. Arce, "Nonlinear Signal Processing - A statistical approach", Wiley Publishers, 2005.
5. W.J.Fitzgerald, R.L.Smith, A.T.Walden, P.C.Young, "Non-linear and Non-Stationary Signal Processing", Cambridge University Press, 2000.

19MECE28 - WAVELET TRANSFORMS AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : understand the basics of wavelet transforms concepts
- CO2** : understand the concepts of multi-resolution and discrete wavelet transform
- CO3** : design wavelet system co-efficient and wavelets
- CO4** : learn the different wavelet families
- CO5** : apply wavelets for various signal processing applications

INTRODUCTION TO WAVELETS

Introduction to Multirate signal processing- Decimation and Interpolation, Quadrature Mirror Filters, Subband coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous Wavelet transform, Time frequency representation, Wavelet System and its characteristics, Orthogonal and Orthonormal functions and function space. **(9)**

MULTIRESOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM

Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banks-Analysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured filter bank, Multichannel filter bank, Undecimated wavelet transform. **(9)**

WAVELET SYSTEM DESIGN

Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets. **(9)**

WAVELET FAMILIES

Continuous Wavelets- Properties of Mexican hat wavelet, Morlet, Gaussian and Meyer wavelets. Orthogonal wavelets- Properties of Haar wavelets, Daubechies wavelets, Symlets, Coiflets and Discrete Meyer wavelets. Properties of Biorthogonal wavelets, Applications of wavelet families. **(9)**

WAVELET APPLICATIONS

Denosing of Signals and Images, Image enhancement, Edge detection, Image Fusion, Image compression, Wavelet based feature extraction, Analysis of phonocardiogram signals, Analysis of EEG signals, Speech enhancement for hearing aids. **(9)**

TOTAL : 45

REFERENCES

1. C.Sidney Burrus, Ramesh Gopinath & Haito Guo, "Introduction to wavelets and wavelet transform", Prentice Hall, 1998.
2. G.Strang and T.Nguyen, "Wavelet and filter banks", Wesley and Cambridge Press, 1997.
3. Metin Akay, "Time frequency and wavelets in biomedical signal processing", Wiley-IEEE Press, October 1997.
4. Lokenath Debnath, Firdous Ahmad Shah, "Wavelet Transforms and Their Applications", 2nd Edition, Springer, 2015.
5. Raguveer M. Rao & Ajith S. Bopardikar, "Wavelet transforms - Introduction to theory and applications", Addison Wesley, 1998.

19MECE29 - SOCIAL NETWORK ANALYSIS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : *understand human behavior in social web and related communities*

CO2 : *learn the knowledge representation using ontology*

CO3 : *understand the concept of semantic web and related applications*

CO4 : *understand and predict the human behavior and private issues*

CO5 : *learn visualization of social networks*

INTRODUCTION

Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web - Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis. **(9)**

MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION

Ontology and their role in the Semantic Web: Ontology-based knowledge Representation - Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language - Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data - Advanced representations. **(9)**

EXTRACTION AND MINING COMMUNITIES IN WEB SOCIAL NETWORKS

Extracting evolution of Web Community from a Series of Web Archive - Detecting communities in social networks - Definition of community - Evaluating communities - Methods for community detection and mining - Applications of community mining algorithms - Tools for detecting communities social network infrastructures and communities - Decentralized online social networks - Multi-Relational characterization of dynamic social network communities. **(9)**

PREDICTING HUMAN BEHAVIOUR AND PRIVACY ISSUES

Understanding and predicting human behaviour for social communities - User data management - Inference and Distribution - Enabling new human experiences - Reality mining - Context - Awareness - Privacy in online social networks - Trust in online environment - Trust models based on subjective logic - Trust network analysis - Trust transitivity analysis - Combining trust and reputation - Trust derivation based on trust comparisons - Attack spectrum and counter measures. **(9)**

VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS

Graph theory - Centrality - Clustering - Node-Edge Diagrams - Matrix representation - Visualizing online social networks, Visualizing social networks with matrix-based representations - Matrix and Node-Link Diagrams - Hybrid representations - Applications - Cover networks - Community welfare - Collaboration networks - Co-Citation networks. **(9)**

TOTAL : 45

REFERENCES

1. Peter Mika, "Social Networks and the Semantic Web", 1st Edition, Springer, 2007.
2. Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.
3. Guandong Xu, Yanchun Zhang and Lin Li, "Web Mining and Social Networking - Techniques and applications", 1st Edition Springer, 2011.
4. Dion Goh and Schubert Foo, "Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.
5. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, "Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling", IGI Global Snippet, 2009.

19MECE30 - MACHINE LEARNING IN COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : demonstrate understanding of the mathematical principles underlying machine learning

CO2 : familiarize with the different machine learning techniques and their use cases

CO3 : formulate machine learning problems corresponding to different applications

CO4 : recognize the characteristics of machine learning techniques that are useful to solve real-world problems

CO5 : read current research papers, understand the issues and the machine learning based solution approaches

MATHEMATICAL BACKGROUND

Linear Algebra - Arithmetic of matrices, Norms, Eigen decomposition, Singular value decomposition, Pseudo inverse, Principal Component analysis. Probability theory - probability distribution, conditional probability, Chain rule, Bayes rule, Information theory, Structured Probabilistic models. (9)

MACHINE LEARNING BASICS

Supervised and Unsupervised learning, Capacity, Overfitting and Underfitting, Cross Validation, Linear regression, Logistic Regression, Regularization, Naive Bayes, Support Vector Machines (SVM), Decision tree, Random forest, K-Means Clustering, k nearest neighbor. (9)

NEURAL NETWORKS

Feedforward Networks, Backpropagation, Convolutional Neural Networks-LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks. Recurrent Neural Network (RNN) - Backpropagation through time (BPTT), Vanishing and Exploding Gradients. (9)

ML IN WIRELESS AND SECURITY

Water-filling power allocation, Optimization for MIMO Systems, OFDM Systems and MIMO-OFDM systems. Optimization in beamformer design - Robust receive beamforming, Transmit downlink beamforming. Application: Radar for target detection, Array Processing, MUSIC, ML in Side channel analysis. (9)

ML IN BIO-MEDICAL

Machine Learning in Medical Imaging. Deep Learning for Health Informatics. Deep Learning Automated ECG Noise Detection and Classification System for Unsupervised Healthcare Monitoring. Techniques for Electronic Health Record (EHR) Analysis. (9)

TOTAL : 45

REFERENCES

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep learning", Cambridge, MA, MIT Press, 2017.
2. Tom M. Mitchell, "Machine Learning", McGraw Hill, 1997.
3. Ethem Alpaydin, "Introduction to machine learning", MIT Press, 3rd Edition, 2014.
4. 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.
5. Ravi et al., "Deep Learning for Health Informatics," IEEE Journal of Biomedical and Health Informatics, vol. 21, no. 1, pp. 4-21, Jan. 2017.

6. 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.
7. U. Satija, "System for Unsupervised Healthcare Monitoring," *IEEE Journal of Biomedical and Health Informatics*, vol. 22, no. 3, pp. 722-732, May 2018.
8. 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.

19MECE31 - WEB OF THINGS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : examine the characteristics and challenges for smart object to assess the different IoT technologies that suits the application.
- CO2** : interpret the architecture and paradigms for the Internet of Things to develop an applications.
- CO3** : infer the programming concepts of PYTHON to develop IoT systems.
- CO4** : design simple IoT systems comprising sensors, edge devices, wireless network connections, data analytics capabilities and cloud storage.
- CO5** : develop IoT based systems for Home, Industry Automation and agriculture productivity Applications.

INTERNET OF THINGS

Definition and Characteristics of IoT - Physical Design of IoT - Logical design of IoT - IoT enabled Technologies: Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols and Embedded Systems - IoT Levels & Deployment Templates - Domain Specific IoTs : Home, City, Environment, Energy, Retail, Logistics, Agriculture, Industry, health and Lifestyle. (6)

IOT ARCHITECTURE

IoT and M2M : Software defined networking, Network function virtualization- IoT System Management with NETCONF-YANG, SNMP, NETOPEER. (9)

PYTHON PROGRAMMING

Language features of Python - Data types - Data structures - Control of flow - Functions - File handling - Data/time operation - Classes - Exception handling - Python packages: JSON, XML, HTTPLib, URLLib, SMTPLib. (10)

IOT PHYSICAL DEVICES AND SERVERS

Building blocks of an IoT device - Programming Inputs and outputs, Serial, SPI and I2C - Sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino)*
Cloud Support : Cloud Storage models and communication APIs Webserver - Web server for IoT - Cloud for IoT - Designing a RESTful web API - Amazon Web services for IoT - Data Analytics for IoT : Apache Hadoop - Using map reduce for batch data analytics. (10)

CASE STUDY AND IOT APPLICATION DEVELOPMENT

Home & Industry Automation - Cities - Environment - Agriculture - Productivity Applications IoT applications in home - infrastructures - security - Industries - IoT electronic equipments - Big Data and Visualization - Industry 4.0 concepts.* (10)

TOTAL : 45

REFERENCES

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.
2. Matt Richardson & Shawn Wallace, "Getting Started with Raspberry Pi", O'Reilly Media Press, 1st Edition, 2012.
3. Luigi Atzori, Antonio Lera, Giacomo Morabito, "The Internet of Things: A Survey", Journal on Networks, Elsevier Publications, October, 2010.
4. Dieter Uckelmann, Mark Harrison, "Architecting the Internet of Things", Springer, 2011.
5. Honbo Zhou, "The Internet of Things in the Cloud : A Middleware Perspective", CRC Press, 2012.
6. Agus Kuniawa, "Getting started with Intel IoT and Intel Galileo", Kindle Edition, 2015.
7. <http://www.theinternetofthings.eu/what-is-the-internet-of-things>

19MECE32 - VLSI SIGNAL PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : *understand the concepts of DSP systems*

CO2 : *learn about retiming concepts to design fast FIR Filter*

CO3 : *understand various fast convolution methods to design LMS adaptive filter for VLSI Signal processing*

CO4 : *design bit-level arithmetic architectures for multiplication*

CO5 : *learn the basics digital signal processors programming and low power considerations*

INTRODUCTION TO DSP SYSTEMS

Introduction to DSP Systems - Typical DSP algorithms; Iteration Bound - data flow graph representations, loop bound and iteration bound, Longest path Matrix algorithm; Pipelining and parallel processing - Pipelining of FIR digital filters, parallel processing, pipelining and parallel processing for low power. **(9)**

RETIMING

Retiming - definitions and properties; Unfolding - algorithm for Unfolding, properties of unfolding, sample period reduction and parallel processing application; Algorithmic strength reduction in filters and transforms - 2-parallel FIR filter, 2-parallel fast FIR filter, DCT algorithm architecture transformation, parallel architectures for rank-order filters, Odd- Even Merge- Sort architecture, parallel rank-order filters. **(9)**

FAST CONVOLUTION

Fast convolution - Cook-Toom algorithm, modified Cook-Toom algorithm; Pipelined and parallel recursive and adaptive filters - inefficient/efficient single channel interleaving, Look Ahead pipelining in first- order IIR filters, Look-Ahead pipelining with power-of-two decomposition, Clustered Look-Ahead pipelining, parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters, pipelined adaptive digital filters, relaxed look-ahead, pipelined LMS adaptive filter. **(9)**

BIT-LEVEL ARITHMETIC ARCHITECTURES

Scaling and roundoff noise- scaling operation, roundoff noise, state variable description of digital filters, scaling and roundoff noise computation, roundoff noise in pipelined first-order filters; Bit-Level Arithmetic Architectures- parallel multipliers with sign extension, parallel carry-ripple array multipliers, parallel carry-save multiplier, 4x4 bit Baugh-Wooley carry save multiplication tabular form and implementation, design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner's rule for precision improvement. **(9)**

PROGRAMMING DIGITAL SIGNAL PROCESSORS

Numerical Strength Reduction - subexpression elimination, multiple constant multiplications, iterative matching. Linear transformations; Synchronous, Wave and asynchronous pipelining synchronous pipelining and clocking styles, clock skew in edge-triggered single-phase clocking, two-phase clocking, wave pipelining, asynchronous pipelining bundled data versus dual rail protocol; Programming Digital Signal Processors - general architecture with important features; Low power Design - needs for low power VLSI chips, charging and discharging capacitance, short-circuit current of an inverter, CMOS leakage current, basic principles of low power design. **(9)**

TOTAL : 45

REFERENCES

1. Keshab K.Parhi, *"VLSI Digital Signal Processing systems, Design and implementation"*, Wiley, Inter Science, 1999.
2. Gary Yeap, *"Practical Low Power Digital VLSI Design"*, Kluwer Academic Publishers, 1998.
3. Mohammed Ismail and Terri Fiez, *"Analog VLSI Signal and Information Processing"*, Mc Graw-Hill, 1994.
4. S.Y. Kung, H.J. White House, T. Kailath, *"VLSI and Modern Signal Processing"*, Prentice Hall, 1985.
5. Jose E. France, Yannis Tsividis, *"Design of Analog & Digital VLSI Circuits for Telecommunication and Signal Processing"*, Prentice Hall, 1994.

19MECE33 - BIO SIGNAL PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : understand the basics of random processes parameters for biomedical signal processing

CO2 : learn various data compression techniques

CO3 : understand the various methods of cardiological signal processing

CO4 : learn about the concepts of signal averaging and polishing methods

CO5 : understand the concepts of neurological signal processing.

RANDOM PROCESSES

Stationary random process, Ergodicity, Power spectral density and autocorrelation function of random processes. Noise power spectral density analysis, Noise bandwidth and noise figure of systems. **(9)**

DATA COMPRESSION TECHNIQUES

Lossy and Lossless data reduction Algorithms. ECG data compression using Turning point, AZTEC, CORTES, Huffman coding, vector quantization, DICOM Standards. **(9)**

CARDIOLOGICAL SIGNAL PROCESSING

Pre-processing, QRS Detection Methods, Rhythm analysis, Arrhythmia Detection Algorithms, Automated ECG Analysis, ECG Pattern Recognition. Adaptive Noise Cancelling: Principles of Adaptive Noise Cancelling, Adaptive Noise Cancelling with the LMS Adaptation Algorithm, Noise Cancelling Method to Enhance ECG Monitoring, Fetal ECG Monitoring. **(9)**

SIGNAL AVERAGING, POLISHING

Mean and trend removal, Prony's method, Prony's Method based on the Least Squares Estimate, Linear prediction, Yule - Walker (Y -W) equations, Analysis of Evoked Potentials. **(9)**

NEUROLOGICAL SIGNAL PROCESSING

Modeling of EEG Signals, Detection of spikes and spindles Detection of Alpha, Beta and Gamma Waves. Auto Regressive (A.R.) modelling of seizure EEG. Sleep Stage analysis, Inverse Filtering, Least squares and polynomial modelling. **(9)**

TOTAL : 45

REFERENCES

1. Peyton Z. Peebles, "Probability, Random Variables & Random Signal Principles", 4th Edition, 2009, TMH.
2. D. C. Reddy, "Biomedical Signal Processing- Principles and Techniques", 2009, TMH.
3. Rangaraj M. Rangayyan, "Biomedical Signal Analysis", 2nd Edition, IEEE Press, Wiley, 2015.
4. Eugene N. Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Sons, 2009.
5. M. Akay, "Biomedical Signal Processing", Academic Press, 1994.

19MECE34 - MACHINE LEARNING FOR SIGNAL AND IMAGE PROCESSING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : understand about the types of machine learning and its concepts
- CO2** : understand about the basics of tree based learning and artificial neural network
- CO3** : learn the concepts of probabilistic models and instance-based learning methods
- CO4** : learn about the concepts of inductive and analytical based learning
- CO5** : develop python programming for machine learning

INTRODUCTION AND CONCEPT LEARNING

Need - Relevant Disciplines -Types of learning and learning Problem - Designing a Learning System - Perspectives and Issues - Evaluating Hypothesis. Concept Learning: Task - Finding a Maximally Specific Hypothesis - Version Spaces and Candidate Elimination Algorithm - Inductive Bias - Linear Discriminants - Perceptron - Linear Separability - Linear Regression. **(9)**

TREE BASED LEARNING AND ANN

Learning with Trees - Decision Trees - Constructing Decision Trees - Classification and Regression Trees - Ensemble Learning - Boosting - Bagging - Different ways to Combine Classifiers- Artificial Neural Networks: Motivation - Representation - Application - Perceptrons - Multilayer Networks - Back Propagation Algorithm. **(9)**

PROBABILISTIC MODELS AND INSTANCE BASED LEARNING

Probability and Learning - Data into Probabilities - Basic Statistics - Gaussian Mixture Models - Nearest Neighbor Methods - Unsupervised Learning - K means Algorithms - Vector Quantization - Self Organizing Feature Map - Instance Based Learning: KNN Learning - Locally Weighted Regression - Radial Bias Functions - Case-Based Reasoning. **(9)**

INDUCTIVE AND ANALYTICAL LEARNING

Learning Sets of Rules: Sequential Covering Algorithm - Learning Rule Sets - Learning First Order Rules - Induction as Inverted Deduction - Inverting Resolution. Analytical Learning: Learning with Perfect Domain Theories. Explanation Based Learning: Combining Inductive and Analytical Learning. Basics of Reinforcement learning. **(9)**

MACHINE LEARNING APPLICATIONS USING PYTHON

Basics of Python programming-Hypothesis testing-Classification problems-Clustering problems-Recommender systems- Text Analytics. **(9)**

TOTAL : 45

REFERENCES

1. Tom M Mitchell, "Machine Learning", 1st Edition, McGraw Hill Education, 2013 (Paper back copy 2017).
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, 2010.
3. Manaranjan Pradhan, U.Dinesh Kumar, "Machine Learning using Python", 1st Edition, John Wiley & sons, 2019.
4. Giuseppe Bonaccorso, "Machine Learning Algorithms", Packt Publishing Ltd, 2017.
5. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.

19MECE35 - GAME THEORY FOR WIRELESS COMMUNICATION AND NETWORKING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : understand new concept in game theory

CO2 : design non cooperative game theory based models

CO3 : design cooperative game theory based models

CO4 : design Bayesian game theory based models

CO5 : apply game theory to solve network related issues

INTRODUCTION

Introduction to theory of games- conflict, strategy, utility theory, games in extensive and normal forms, Examples. (9)

NON CO-OPERATIVE GAMES

Basics of Non-Cooperative games, Non-Cooperative games in strategic form - Matrix games, Nash Equilibrium, Mixed Strategies. Dynamic Non-Cooperative games - Non-Cooperative game in extensive form, repeated games, and stochastic games. (9)

COOPERATIVE GAMES

Basics of Cooperative games, bargaining theory - Introduction, Nash bargaining solution, Coalition game theory - shape value, Dynamic Coalition formation algorithms. (9)

BAYESIAN GAMES

Overview of Bayesian Games, Bayesian Games in extensive form, Cournot duopoly model with incomplete information, Super-Modular games, Learning in games: Fictitious play, and Regret minimization, Vickrey-Clarke-Groves Auction, Optimal Auction. (9)

APPLICATIONS TO NETWORKING

Cellular & Broadband wireless access networks - Routing & Resource allocation, Power allocation, Network selection in Multi-technology, WLAN - MAC Protocol design, Random Access Control, Rate Selection for VoIP services, throughput efficiency, competition and implication on network performance - Game theoretic solutions for cooperation in ad hoc networks. (9)

TOTAL : 45

REFERENCES

1. Martin J. Osborne, "An Introduction to Game Theory", Oxford Press 2006.
2. Zhu Han, Dusit Niyato, Walid Saad, Tamer Basar, Are Hjorungnes, "Game Theory in Wireless and Communication Networks: Theory, Models, and Applications", University Press Cambridge, 1st Edition, 2012.
3. Allan MacKenzie, Luiz DaSilva, "Game Theory for Wireless Engineers, Synthesis Lectures on Communication", Morgan and Claypool Publishers, 2006.
4. Drew Fudenberg and Jean Tirole, "Game Theory", MIT Press, 1991.
5. Vijay Krishna, "Auction Theory", Academic Press, 2010.

19MECE36 - INTERNET OF THINGS BASED SENSING AND ACTUATOR DEVICES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : examine the characteristics and applications for sensor and actuator to assess the different IoT technologies.

CO2 : interpret the architecture and paradigms for the sensors for Internet of Things to develop applications.

CO3 : interpret the architecture and paradigms for the actuator for Internet of Things to develop an applications.

CO4 : analyze the Market forecast for IoT devices with a focus on sensors.

CO5 : develop IoT based systems for Home, Industry Automation and agriculture productivity applications.

INTRODUCTION

Internet of Things Promises-Definition- Scope- Sensors and actuators for IoT Applications - Structure of IoT - IoT Map Device - Sensor and Actuator Characteristics : Range, Resolution,Sensitivity, Error, Repeatability,Linearity and Accuracy,Impedance, Nonlinearities,Static and Coulomb Friction,Eccentricity, Backlash,Saturation, Dead band, System Response, First-Order System Response, Under damped Second-Order System Response - Frequency Response. (9)

IoT SENSORS

Linear and Rotational Sensors - Acceleration Sensors - Force Measurement - Torque and Power Measurement - Flow Measurement - Temperature Measurements - Distance Measuring and Proximity Sensors - Light Detection, Image, and Vision Systems - Integrated Microsensor. (9)

ACTUATORS

Electromechanical Actuators - Electrical Machines - Piezoelectric Actuators - Hydraulic and Pneumatic Actuation Systems - MEMS: Micro transducers Analysis, Design, and Fabrication. (9)

TECHNOLOGICAL ANALYSIS

Wireless Sensor Structure-Energy Storage Module-Power Management Module-RF Module-Sensing Module - ACOEM Eagle - EnOcean Push Button - NEST Sensor - Ninja Blocks - Wearable Electronics. (9)

IoT DEVELOPMENT BOARDS

Raspberry Pi Hardware - Clayster libraries - Sensor interfacing with Pi hardware:-Internal representation of sensor values, Persisting data, External representation of sensor values, Exporting sensor data - Actuator interfacing with Pi hardware: Representing sensor values, Parsing sensor data, Calculating control states -Accessing the serial port on Raspberry Pi : Creating persistent default settings, Adding configurable properties, Persisting the settings, Working with the current settings - Interfacing the camera. (9)

TOTAL : 45

REFERENCES

1. Dr. Guillaume Girardin, Antoine Bonnabel, Dr. Eric Mounier, "Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024", Yole Développement Copyrights, 2014.
2. Peter Waher, "Learning Internet of Things", Packt Publishing, 2015.
3. Editors OvidiuVermesan Peter Friess, "Internet of Things - From Research and Innovation to Market4. Deployment", River Publishers, 2014.
4. N. Ida, "Sensors, Actuators and Their Interfaces", Scitech Publishers, 2014.

19MECE37 - EMBEDDED SYSTEM DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : describe the Embedded concepts and Embedded system Architecture

CO2 : learn the architecture and programming of ARM Cortex Microcontroller

CO3 : describe the application of Microcontroller

CO4 : discuss the usage of the development and debugging tools

CO5 : learn and apply the knowledge of Memory systems and Peripherals

INTRODUCTION TO EMBEDDED CONCEPTS

Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Architecture of embedded systems, Hardware architecture, Software architecture, Application Software, Communication Software. (9)

OVERVIEW OF ARM AND CORTEX-M3

Background of ARM Architecture, Architecture Versions, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture. Cortex-M3 Basics: Registers, General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence. Cortex-M3 Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions. Cortex-M3 Implementation Overview: Pipeline, Block Diagram, Bus. Interfaces on Cortex-M3, I-Code Bus, DCode Bus, System Bus, External PPB and DAP Bus. (9)

CORTEX EXCEPTION HANDLING AND INTERRUPTS

Exceptions: Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending Behavior, Fault Exceptions, Supervisor Call and Pendable Service Call. NVIC: Nested Vectored Interrupt Controller Overview, Basic Interrupt Configuration, Software Interrupts and SYSTICK Timer. Interrupt Behavior: Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail-Chaining Interrupts, Late Arrivals and Interrupt Latency. (9)

CORTEX-M3/M4 PROGRAMMING

Cortex-M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS (Cortex Microcontroller Software Interface Standard), Using Assembly. Exception Programming: Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation. Memory Protection Unit and other Cortex-M3 features: MPU Registers, Setting Up the MPU, Power Management, Multiprocessor Communication. (9)

CORTEX-M3/M4

DEVELOPMENT AND DEBUGGING TOOLS STM32L15xxx ARM Cortex M3/M4 Microcontroller: Memory and Bus Architecture, Power Control, Reset and Clock Control. STM32L15xxx Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART. Development and Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger, Simulator, In-Circuit Emulator (ICE), Logic Analyzer etc. (9)

TOTAL : 45

REFERENCES

1. Joseph Yiu, "The Definitive Guide to the ARM Cortex-M3", 2nd Edition, Elsevier Inc. 2010.
2. Andrew N Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier Publications, 2006.

3. Steve Furber, "ARM System-on-Chip Architecture", 2nd Edition, Pearson Education, India ISBN:9788131708408, 8131708403, 2015.
4. Dr. K.V.K. Prasad, "Embedded / Real-Time Systems: Concepts, Design and Programming Black Book", New ed (MISL-DT) Paperback - 12 Nov 2003.
5. David Seal "ARM Architecture Reference Manual", Addison Wesley, England; Morgan Kaufmann Publishers,2001.
6. Ajay Deshmukh, "Microcontroller - Theory & Applications", Tata McGraw Hill, 2005.
7. Arnold. S. Berger, "Embedded Systems Design - An introduction to Processes, Tools and Techniques", Easwer Press, 2001.
8. Raj Kamal, "Microcontroller - Architecture Programming Interfacing and System Design" 2nd Edition, Pearson Education, 2011.
9. Cortex-M series-ARM Reference Manual.
10. Cortex-M3 Technical Reference Manual (TRM).
11. STM32L152xx ARM Cortex M3 Microcontroller Reference Manual 5/97.
12. ARM Company Ltd. "ARM Architecture Reference Manual- ARM DDI 0100E" ARM v7-M Architecture Reference Manual (ARM v7-M ARM).

19MECE38 - DESIGN OF EMBEDDED CONTROL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : expose the fundamentals of Embedded System Blocks
- CO2** : describe the real time operating system fundamental concepts
- CO3** : integrate the processor communication protocol
- CO4** : compare types and Functionalities in commercial software tools
- CO5** : discuss the Applications development using interfacing

EMBEDDED SYSTEM ORGANIZATION

Embedded computing - characteristics of embedded computing applications - embedded system design challenges; Build process of Real-time Embedded system - Selection of processor; Memory; I/O devices-Rs-485, MODEM, Bus Communication system using I2C, CAN, USB buses, 8 bit -ISA, EISA bus. (9)

REAL-TIME OPERATING SYSTEM

Introduction to RTOS; RTOS- Inter Process communication, Interrupt driven Input and Output - Nonmaskable interrupt, Software interrupt; Thread - Single, Multithread concept; Multitasking Semaphores. (9)

INTERFACE WITH COMMUNICATION PROTOCOL

Design methodologies and tools - design flows - designing hardware and software Interface - system integration; SPI, High speed data acquisition and interface-SPI read/write protocol, RTC interfacing and programming. (9)

DESIGN OF SOFTWARE FOR EMBEDDED CONTROL

Software abstraction using Mealy-Moore FSM controller, Layered software development, Basic concepts of developing device driver - SCI - Software - interfacing & porting using standard C & C++ ; Functional and performance Debugging with benchmarking Real-time system software - Survey on basics of contemporary RTOS - VXWorks, UC/OS-II. (9)

CASE STUDIES WITH EMBEDDED CONTROLLER

Programmable interface with A/D & D/A interface; Digital voltmeter, control- Robot system - PWM motor speed controller, serial communication interface. (9)

TOTAL : 45

REFERENCES

1. Steven F. Barrett, Daniel J. Pack, "Embedded Systems - Design and Applications with the 68HC12 and HCS12", Pearson Education, 2008.
2. Raj Kamal, "Embedded Systems- Architecture, Programming and Design" Tata McGraw Hill, 2006.
3. Micheal Khevi, "The M68HC11 Microcontroller application in control,Instrumentation & Communication", PH NewJersy, 1997.
4. Chattopadhyay, "Embedded System Design",PHI Learning, 2011.
5. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey, "PIC Microcontroller and Embedded Systems- Using Assembly and C for PIC18", Pearson Education,2008.
6. Daniel W. Lewis, "Fundamentals of Embedded Software", Prentice Hall India, 2004.
7. Keneth J.Ayala, "The 8086 Microprocessor: Programming & Interfacing the PC", Thomson India edition.

19MECE39 - RF MEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : define the concepts of micro electromechanical systems and its components

CO2 : learn about different materials used in MEMS and its fabrication techniques

CO3 : explain about switches used in RF, Microwave and MEMS applications

CO4 : explain the properties of the RF Switches, micromachined transmission lines and filters

CO5 : explain different types of phase shifters & antenna and learn about their performance

MICROELECTROMECHANICAL SYSTEMS(MEMS) AND RADIO FREQUENCY MEMS

Introduction -Microfabrication for MEMS - Electromechanical transducers - Microsensing for MEMS - Materials for MEMS.

(7)

MEMS MATERIALS AND FABRICATION TECHNIQUES

Metals - Semiconductors - Thin films for MEMS and their deposition techniques - Materials for polymer MEMS - Bulk micromachining for silicon-based MEMS - Silicon surface micro matching - Micro stereo lithography for polymer MEMS.

(7)

RF MEMS SWITCHES

Introduction - Switch parameters - Basics of switching - Switches for RF and microwave applications - Electrostatic switching - Approaches for low-actuation -voltage switches - thermal switching -MEMS switch design, modeling and evaluation -MEMS switch design considerations.

(7)

MEMS INDUCTORS AND MICROMACHINED TRANSMISSION LINES

Introduction - MEMS inductors - MEMS capacitors - Micro machined transmission lines and components - Design, fabrication and measurements - Modeling of mechanical filters - Micromechanical filters.

(12)

MICROMACHINED PHASE SHIFTER AND ANTENNA

Micromachined phase shifters: Introduction - Types of phase shifters and their limitations - MEMS phase shifters - Overview of microstrip antenna - Micromachining techniques to improve antenna performance - Micromatching as a fabrication process for small antenna - Micromachined reconfigurable antenna.

(12)

TOTAL : 45

REFERENCES

1. Vijay K Varadan, Vinoy K J and Jose K A, "RF MEMS and Their Applications", Published by John Wiley & Sons Ltd, England, reprinted April 2003.
2. Gabriel M Rebeiz, "RF MEMS Theory, Design and Technology ", John Wiley & Sons Ltd, New Jersey, 2004.
3. Hector J De Los Santos, "RF MEMS Circuit Design for Wireless communications", Artech House, 2002.
4. Julian W.Gardner Vijay, K.Varadan, "Micro Sensors, MEMS, and Smart Devices", John Wiley & Sons, Ltd, 2001.
5. Stephen Beeby, Graham Ensell, "MEMS, Mechanical Sensors", Artech House Publishers, 2004.

19MECE40 - RADIO FREQUENCY INTEGRATED CIRCUIT DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : determine the impedance levels and dynamic range in RF circuits

CO2 : learn noises in RF-BJT & CMOS transistor and analyze the characteristics of capacitance & inductance in transformation network

CO3 : comprehend and explain operating principles and design concepts of RF passive elements for implementation in RF integrated circuits

CO4 : analyze and design RF LNA and power amplifier

CO5 : comprehend and explain operating principles and design concepts of mixers for implementation in RF ICs

RF IC DESIGN FUNDAMENTALS, NOISE AND LINEARITY

Lower frequency analog design and microwave design versus radio frequency integrated circuit design - Impedance levels for microwave and low-frequency analog design- noise - linearity and distortion in RF Circuits - dynamic range - filtering issue.

(9)

REVIEW OF TECHNOLOGY

Small -signal model of bipolar transistor - high frequency effects -noise in bipolar transistors - base shot noise-noise sources in the transistor model - bipolar transistor design considerations-CMOS transistor - impedance matching - tapped capacitors and inductors - the concept of mutual inductance - tuning a transformer - bandwidth of an impedance transformation network-quality factor of an LC resonator.

(8)

DESIGN OF PASSIVE CIRCUIT ELEMENTS IN IC TECHNOLOGIES

Technology backend and metallization in IC technologies - sheet resistance and skin effect -parasitic capacitance and inductance -current handling in metal lines- Design of inductors and transformers - characterization of inductor-layout of spiral inductors - on-chip transmission lines high frequency measurements of on-chip passives and common De-Embedding techniques-packaging.

(9)

LNA AND POWER AMPLIFIER

Basic amplifiers - amplifiers with feed back - noise in amplifiers - linearity in amplifiers - differential pair and other differential amplifiers-low-voltage topologies for LNAs and the use of on-chip transformers - DC bias networks - temperature effects - broad band LNA design. Power amplifier :power capability - efficiency calculations - matching considerations - Class E,F,G,H and S amplifiers -summary of amplifier classes for RF Integrated circuits - AC load line - matching to achieve desired power - packaging -effects and implications of non linearity - linearization techniques - CMOS power-amplifier design.

(10)

MIXERS

Mixing with nonlinearity - basic mixer operation - controlled transconductance mixer - double- balanced mixer - mixer with switching of upper quad - analysis of switching modulator-mixer noise - linearity - improving isolation - image reject and single - sideband mixers-alternative mixer designs general design comments-CMOS mixers.

(9)

TOTAL : 45

REFERENCES

1. John Rogers and Calvin Plett, "Radio Frequency Integrated Circuit Design", Artech House, 2nd Edition, 2014.
2. Stephan A Mass, "Practical Microwave Circuits", Artech House, 2014.
3. Ferri Losee, "RF Systems, Components and Circuits handbook", Artech house, 2nd Edition, 2005.
4. Ulrich L. Rohde, Matthias Rudolph, "RF / Microwave Circuit Design for Wireless Applications" John Wiley and Sons, 2012.
5. Gabriele Manganaro, Domine M. W. Leenaerts, "Advances in Analog and RF IC Design for Wireless Communication Systems", Academic Press, 2013.

19MECE41 - SMART ANTENNAS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : explain about smart antenna concepts and basics of smart antennas
- CO2** : describe the concepts of beam forming and digital concepts in wireless systems
- CO3** : analyze the spatial processing for code division multiple access systems
- CO4** : describe about channel models, spatial and adaptive filtering
- CO5** : estimate Direction of Arrival and direction finding using various estimation techniques

INTRODUCTION TO SMART ANTENNAS

Antenna gain, Phased array antenna, power pattern, beam steering, degree of freedom, optimal antenna, adaptive antennas, smart antenna - key benefits of smart antenna technology, wide band smart antennas. (9)

SPATIAL PROCESSING FOR WIRELESS SYSTEMS

Spatial processing for wireless systems, Adaptive antennas, Beam forming networks, Digital radio receiver techniques and software radios. (9)

SPATIAL PROCESSING FOR CDMA SYSTEMS

Coherent and non-coherent CDMA spatial processors. Dynamic re-sectoring, Range and capacity extension - multi-cell systems. (9)

SPATIO - TEMPORAL CHANNEL MODELS

Environment and signal parameters. Geometrically based single bounce elliptical model. Optimal spatial filtering - adaptive algorithms for CDMA. Multitarget decision - directed algorithm. (9)

DIRECTION OF ARRIVAL ESTIMATION METHODS

DOA estimation - conventional and subspace methods. ML estimation techniques. Estimation of the number of sources using eigen decomposition. Direction finding and true ranging PL systems. Elliptic and hyperbolic PL systems. TDOA estimation techniques. (9)

TOTAL : 45

REFERENCES

1. Warren L Stutzman, Gary A.Thiele, "Antenna Theory and Design" Mc Graw Hill, 3rd Edition, John Wiley & Sons, 2013.
2. T.S.Rappaport & J.C.Liberti, "Smart Antennas for Wireless Communication", Prentice Hall (PTR), 1999.
3. R.Janaswamy, "Radio Wave Propagation and Smart Antennas for Wireless Communication", Kluwer, 2001.
4. John.L.Volakis, "Antenna Engineering Handbook", 4th Edition, McGraw Hill, 2007.
5. Constantine A.Balanis, "Modern Antenna Handbook", John Wiley and Sons, 2008.

19MECE42 - MODERN ANTENNAS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : design, develop and analyze the characteristics of microstrip antenna

CO2 : design and analyze the characteristics of fractal antenna

CO3 : analyze the characteristics of helical, GPS and Bluetooth antenna used in Mobile applications

CO4 : analyze the characteristics of planer antenna for high speed ultra wide applications

CO5 : analyze, design and implement reconfigurable array antennas for personal communication and medical applications

MICROSTRIP ANTENNAS

Advantages and trade-off-material consideration-methods of analysis & design-Excitation methods-Dual polarization & circular polarization techniques-broadband & dual band techniques-antenna miniaturization techniques. (9)

FRACTAL ANTENNAS

Fractal antenna geometries-iterated function systems-fractal antenna elements-fractal antenna arrays-antenna arrays based on fractal and aperiodic tilings. (9)

MOBILE HANDSET ANTENNAS

Impact on antenna design-cellular handset antenna design issues-helical wire antennas and variants-evolution of the PIFA-ceramic chip and resonator antennas-SAR measurement and minimization-provision for GPS and Bluetooth-Measurement of handset antennas-future trends. (9)

BROADBAND PLANAR ANTENNA

Introduction-suspended plate antennas-techniques for broad impedance bandwidth-techniques for enhanced radiation performance-applications in high speed wireless communication-planar monopole antennas - applications in high speed UWB wireless communication. (9)

ANTENNAS FOR MEDICAL APPLICATIONS

Environment-Antennas for medical imaging-heating-bio-telemetry-pulsed electromagnetic fields-sensing-future directions. (9)

TOTAL : 45

REFERENCES

1. John.L.Volakis, "Antenna Engineering Handbook", 4th Edition, McGraw Hill, 2007.
2. Constantine A.Balanis, "Modern Antenna Handbook", John Wiley and Sons, 2008.
3. Debatosh Guha, Yahia M.M. Antar, "Microstrip and Printed Antennas", 1st Edition, John Wiley & Sons, 2011.
4. S.Drabowitch, A.Papiernik,et.al, "Modern Antennas", Springer, 2nd Edition, 2005.
5. Zhi Ning Chen, "Antennas for Portable Devices", John Wiley & Sons, 2007.

19MECE43 - ELECTROMAGNETIC METAMATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : learn and understand the properties of metamaterials and the effect of properties on fundamental phenomena

CO2 : understand the theory of Transmission line theory of metamaterials

CO3 : discuss different types of SRR and to derive equivalent circuit

CO4 : discuss the metamaterial properties for performance enhancement of antenna

CO5 : learn the design of microwave components using metamaterials

INTRODUCTION

Introduction - Definition of Metamaterials (MTMs) and Left-Handed (LH) MTMs, Theoretical Speculation by Viktor Veselago, Experimental Demonstration of Left-Handedness, Conventional Backward Waves and Novelty of LH MTMs, Terminology, Transmission Line (TL) Approach, Composite Right/Left- Handed (CRLH) MTMs, Left-Handedness from Maxwell's Equations, Boundary Conditions, Reversal of Doppler Effect, Reversal of Snell's Law: Negative Refraction. **(9)**

TRANSMISSION LINES ANALYSIS

Theory of MTMs, Ideal Homogeneous CRLH TLs: Fundamental TL Characteristics, Equivalent MTM Constitutive Parameters, Balanced and Unbalanced Resonances, Lossy Case, LC Network Implementation, Difference with Conventional Filters, Transmission Matrix Analysis, Input Impedance, General Design Guidelines, Microstrip Implementation, Parameters Extraction, Conversion from Transmission Line to Constitutive Parameters. **(9)**

SRR STRUCTURE

An overview of different types of SRR and CSRR, Equivalent circuit model for MSRR, Labyrinth and spiral resonator, Parameters extraction using NRW approach. **(8)**

METAMATERIALS LOADED ANTENNA

LH-TL loaded antenna, Electrically small antenna, Thin wavelength resonator design, Partial metamaterial loading, Sub-wavelength antenna, Metamaterial substrate, Metamaterial superstrate, CSRR loaded antenna, OCSRR loaded monopole antenna, Bandwidth enhancement, Notch function using SRR in UWB antenna, MTM inspired antenna. **(9)**

APPLICATIONS

Guided-Wave Applications - Dual-Band Components: Dual-Band Property of CRLH TLs - Quarter Wavelength TL and Stubs - Passive Component Examples: Quadrature Hybrid and Wilkinson Power Divider - Enhanced-Bandwidth Components: Principle of Bandwidth Enhancement - Rat-Race Coupler Example. **(9)**

TOTAL : 45

REFERENCES

1. Christophe Caloz, Tatsuo Itoh, "Electromagnetic Metamaterials: Transmission Line Theory and Microwave Applications", John Wiley & Sons, Inc., Hoboken, New Jersey, 2006.
2. Ricardo Marqués, Ferran Martín, Mario Sorolla, "Metamaterials with Negative Parameters: Theory, Design, and Microwave Applications", Wiley, Inc., 2008.
3. Filippo Capolin, "Theory and Phenomena of Metamaterials", CRC Press, 2009.
4. John.L.Volakis, "Antenna Engineering Handbook", 4th Edition, McGraw Hill, 2007.
5. Constantine A.Balanis, "Modern Antenna Handbook", John Wiley and Sons, 2008.

19MECE44 - BIO MEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : learn and realize the MEMS applications in Bio Medical Engineering

CO2 : learn the Micro fluidic Principles and study its applications

CO3 : learn the applications of Sensors in Health Engineering

CO4 : learn the principles of Micro Actuators and Drug Delivery system

CO5 : learn the principles and applications of Micro Total Analysis

INTRODUCTION

The driving force behind Biomedical Applications - Biocompatibility - Reliability Considerations-Regularity Considerations - Organizations - Education of Bio MEMS-Silicon Micro fabrication-Soft Fabrication techniques. (9)

MICRO FLUIDIC

Micro fluidic Principles- Introduction-Transport Processes- Electro kinetic Phenomena-Micro valves -Micro mixers- Micro pumps. (9)

SENSOR PRINCIPLES AND MICRO SENSORS

Introduction-Fabrication-Basic Sensors-Optical fibers - Piezo electricity and SAW devices-Electrochemical detection-Applications in Medicine. (9)

MICRO ACTUATORS AND DRUG DELIVERY

Introduction-Activation Methods-Micro actuators for Micro fluidics-equivalent circuit representation-Drug Delivery. (9)

MICRO TOTAL ANALYSIS

Lab on Chip-Capillary Electrophoresis Arrays-cell, molecule and Particle Handling-Surface Modification-Microsphere-Cell based Bioassay Systems Detection and Measurement Methods-Emerging Bio MEMS Technology-Packaging, Power, Data and RF Safety-Biocompatibility, Standards. (9)

TOTAL : 45

REFERENCES

1. Steven S. Saliterman, "Fundamentals of Bio MEMS and Medical Micro devices", Wiley Interscience, 2006.
2. Albert Folch, "Introduction to Bio MEMS", CRC Press, 2012.
3. Gerald A. Urban, "Bio MEMS", Springer, 2006.
4. Wanjun wang, steven A. Soper, "Bio MEMS", 2006.
5. M. J. Madou, "Fundamental of Micro fabrication", 2002.
6. G.T. A. Kovacs, "Micro machined Transducers Sourcebook", 1998.

19MECE45 - MEDICAL IMAGING AND CLASSIFICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : describe the various medical imaging modalities

CO2 : estimate dose and exposures of x-ray, and observe how these influence the imaging System usage

CO3 : analyze about the various reconstruction techniques by solving problems

CO4 : apply the registration techniques and able to choose the selective classifier with respect to the problem

CO5 : visualize and analyze the given 3-D images

INTRODUCTION TO X-RAY IMAGING

Introduction to imaging modalities-X-rays in Diagnostic imaging- Mammography-Computed tomography systems - Image quality artifacts- reconstruction techniques. (9)

MAGNETIC RESONANCE IMAGING & ULTRASOUND IMAGING

Basic principles of nuclear magnetic resonance-Image creation-slice selection-Frequency encoding, phase encoding- pulse sequence- Transducers- Image characteristics and artifacts. (9)

ULTRASOUND IMAGING AND IMAGE RECONSTRUCTION

The wave equation- Impedance, power and reflection - Diagnostic imaging modes- Doppler principles - Image reconstruction from projections in two dimensions- Mathematical preliminaries for two and three dimensional image reconstructions-Radon transform-Sinogram- Two dimensional projection reconstruction-Iterative reconstruction techniques-Fourier reconstruction. (9)

IMAGE REGISTRATION & CLASSIFICATION

Introduction - Physical basis of spatial distortions in Magnetic Resonance imaging- Physical and biological bases of Spatial distortions in Positron Emission Tomography images- spatial transformation models- Bayesian classifier-Neural network. (9)

3D VISUALIZATION

Preprocessing - Scene based visualization- Object based visualization - Manipulation - Tele medicine: Teleradiology- Telepathology: Multimedia databases- color images of sufficient resolution: Dynamic range, spatial resolution, compression methods - case studies for classification: Dental caries detection- Human identification using Dental images. (9)

TOTAL : 45

REFERENCES

1. William.R.Hendee and Russell Ritenour.E. Woods, "Medical Imaging Physics", A John Wiley & sons, Inc. publications, 2002.
2. Jacob Beutel and M.Sonka, "Handbook of Medical Imaging volume 2. Medical Image Processing and Analysis", SPIE press 2000.
3. Issac Bankman and I.N.Bankman, " Handbook of Medical Imaging: Processing and Analysis", Academic press, 2009.
4. Atam. P. Dhawan, "Medical Image Analysis", John Wiley and Sons, 2011.
5. Zang-Hee Cho, Joie P. Jones, Manbir Singh, "Foundations of Medical Imaging", John Wiley & sons, Inc. publications, 1993.
6. Krzysztof Iniewski, "Medical Imaging- Principles, Detectors and Electronics", John Wiley & sons, Inc. publications, 2009.

19MECE46 - BASEBAND ALGORITHMS ON FPGA

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

CO1 : understand FPGA design flow, number representation, and basic building blocks

CO2 : write a VHDL/VerilogHDL program for FIR Filter using distributed arithmetic

CO3 : design and implement filter with pipelining and/or parallel processing

CO4 : explain the different types of FFT algorithms including Cooley Tukey, Winograd and Good-Thomas

CO5 : implement FFT algorithms using Hardware Description languages

FPGA TECHNOLOGY

Introduction to FPGA, FPGA Design flow, Programming languages, programming technology. Basic Building Blocks: Number Representation, Binary adders, Binary dividers, Floating point arithmetic, MAC & SOP unit. (9)

DIGITAL FIR FILTER

FIR filter, Theory and structure, Filter Design, Constant coefficient, FIR Design. (9)

DIGITAL IIR FILTER

IIR theory, Coefficient computation, Implementation detail, Fast IIR filter. (9)

FOURIER TRANSFORM

DFT algorithms, Goertzel algorithm, Hartley transform, Winograd DFT, Bluestein chirp/z transform, Rader algorithm, FFT algorithms, Cooley - Tukey, Good Thomas, Winograd FFT. (9)

COMMUNICATION BLOCKS

Error control codes, Linear block code, Convolution codes, Modulation and Demodulation, Adaptive filters, LMS, RLS, Decimator and Interpolator, High Decimation Rate filters. (9)

TOTAL : 45

REFERENCES

1. Uwe.Meyer-Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, 3rd Edition, May 2007.
2. Keshab K. Parhi, "VLSI Digital Signal Processing systems, Design and implementation", Wiley, Inter Science, 1999.
3. John G. Proakis, "Digital Communications," 4th Edition, McGraw Hill International Edition, 2000.
4. Michael John Sebastian Smith, "Applications Specific Integrated Circuits", Pearson Education, 9th Indian reprint, 13th Edition, 2004.
5. Sophocles J. Orfanidis, "Introduction to Signal Processing", Prentice Hall, 1996.

19MECE47 - WEARABLE BODY AREA NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : define the need for WBAN and the challenges involved in the design
- CO2** : explain about the working of wireless Body Area Network and discuss about the hardware required for the implementation
- CO3** : describe about the types of wearable sensors and their suitability for BAN
- CO4** : discuss and implement the suitable signal processing technique and thus the ways of reducing power consumption
- CO5** : explain the need of wireless health systems and the design an application of wearable systems

INTRODUCTION

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BSN Architecture - Introduction. **(9)**

HARDWARE FOR BAN

Processor-Low Power MCUs, Mobile Computing MCUs, Integrated processor with radio transceiver, Memory, Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes. **(9)**

WEARABLE SENSORS

Need for wearable systems, Sensors for wearable Systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS -Based Biosensors, E-Textiles, Bio compatibility. **(9)**

SIGNAL PROCESSING

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Data mining. **(9)**

APPLICATIONS

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill. **(9)**

TOTAL : 45

REFERENCES

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011. (Unit I, II, III & V).
2. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, "Body Area Networks Safety, Security, and Sustainability", Cambridge University Press, 2013. (Unit IV).
3. Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems", Springer, 2013.
4. Guang-Zhong Yang (Ed.), "Body Sensor Networks", Springer, 2006.
5. Mehmet R. Yuce, Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation, and Applications", Pan Stanford Publishing.

19MECE48 - WIRELESS TRANSCEIVER DESIGN

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : apply knowledge in transceiver design
- CO2** : understand the receiver architecture
- CO3** : analyze the system parameters in receiver
- CO4** : understand the transmitter system design
- CO5** : apply design techniques in the RF transceivers

FUNDAMENTALS OF SYSTEM DESIGN

Linear systems and transformation, Non-linear system representation, Noise and Random process, elements of Digital base band system: Sampling, jitter, modulation techniques, pulse shaping, error probability detection. (9)

RADIO ARCHITECTURES AND DESIGN CONSIDERATIONS

Super heterodyne architecture, direct conversion architecture, Low IF architecture, band-pass sampling radio architecture. (9)

RECEIVER SYSTEM ANALYSIS AND DESIGN

Sensitivity and noise figure of receiver, intermodulation characteristics, single tone desensitization, adjacent channel selectivity and blocking characteristics, receiver dynamic range and AGC system, system design and performance evaluation. (9)

TRANSMITTER SYSTEM ANALYSIS AND DESIGN

Transmission power and spectrum, modulation accuracy, adjacent and alternate channel power, noise emission. (9)

CASE STUDY

Multimode and multiband super heterodyne transceiver: selection of frequency plan, receiver system and transmitter system design - Direct conversion transceiver: receiver system and transmitter system design. (9)

TOTAL : 45

REFERENCES

1. Kai Chang, "RF and Microwave Wireless Systems", John Wiley, 2004.
2. K P Pun, J E D Franca and C A Leme, "Circuit Design for Wireless Communications - Improved Techniques for Image Rejection in Wideband Quadrature Receivers", Springer, 2003.
3. Qizheng Gu, "RF System Design of Transceivers for Wireless Communications", Springer, 2005.
4. Ariel Luzzatto, Motti Haridim. "Wireless Transceiver Design: Mastering the Design of Modern Wireless Equipment and Systems", Wiley, 2nd Edition, 2016.
5. Crols, Jan, Steyaert, Michiel, "CMOS Wireless Transceiver Design", Springer, 1st Edition, 2003.

19MECE49 - MICRO ELECTRO MECHANICAL SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : explain the concepts of MEMS and micro-systems.
- CO2** : explain and analyze the mechanics for MEMS design.
- CO3** : analyze electrostatic design issues.
- CO4** : analyze and model MEMS systems.
- CO5** : analyze optical and RF MEMS design parameters.

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)**

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)**

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. bistable actuators. Electronic Interfaces, Feed back systems, Noise, Circuit and system issues. **(9)**

MEMS APPLICATION

Case studies - Capacitive accelerometer, Piezo electric pressure sensor, Microfluidics application, Modeling of MEMS systems, CAD for MEMS. **(9)**

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 MEMS - Design basics, case study - Capacitive RF MEMS switch, performance issues. **(9)**

TOTAL : 45

REFERENCES

1. Stephen Santerea, "Microsystems Design", Kluwer publishers, 2000.
2. N.P.Mahalik, "MEMS", Tata McGraw hill, 2007.
3. Nadim Maluf, "An introduction to Micro electro mechanical system design", Artech House, 2000.
4. Mohamed Gad-el-Hak, "The MEMS Handbook", CRC press Boca Raton, 2000.
5. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture", Tata McGraw Hill, New Delhi, 2002.

19MECE50 - LONG RANGE WIRELESS COMMUNICATION FOR INTERNET OF THINGS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : distinguish and describe different wireless technologies based on its features and applications
- CO2** : describe the LoRa concepts, difference between LoRa and LoRaWAN, LoRaWAN architecture and its classes
- CO3** : categorize different modulation techniques, LoRaWAN parameters and Encryption standard
- CO4** : analyze the next generation networks and LoRa Application Server
- CO5** : develop IoT based LoRa systems for Agriculture, Smart city, Healthcare, Smart home and other productive applications

INTERNET OF THINGS

Introduction to Internet of Things (IoT)- IoT architecture-IoT End Devices- IoT Gateway- Wireless IoT Network Protocols: Bluetooth Classic- Bluetooth Low Energy-WiFi-Zigbee- Z-Wave-6LoWPAN-NB-IoT-SigFox-Neul-LoRaWAN-Advantages and Features of LoRaWAN. (9)

LoRaWAN SPECIFICATIONS

Introduction to LoRa- Introduction to LoRaWAN- Difference between LoRa and LoRaWAN-LoRaWAN architecture-LoRaWAN Classes-Class A, Class B and Class C Devices. (9)

MODULATION TECHNIQUES AND KEY PARAMETERS

Frequency Shift Keying (FSK)-Chirp Spread Spectrum(CSS)-Spreading Factors- Payload Size- Data Rate- LoRaWAN Regional parameters-IN865-867-Frequency Range-Bandwidth-Security-LoRaWAN Encryption. (9)

NETWORK AND APPLICATION SERVER

Introduction to Network Server-Introduction to Application Server- End Device Types and States-Activation of ABP End Devices- Activation of OTAA End Devices- Received Signal Strength Indicator(RSSI)-Signal to Noise Ratio(SNR)-Open Source LoRaWAN Server Integration. (9)

LoRaWAN REAL FIELD APPLICATIONS

Smart Agriculture-Smart Cities-Smart Environment-Smart Healthcare-Smart Homes & Buildings-Smart Industrial Control-Smart Metering-Smart Supply Chain & Logistics- Asset tracking. (9)

TOTAL : 45

REFERENCES

1. LoRa Alliance Technical Committee, "LoRaWAN Backend Interfaces 1.0 specification", October 11,2017.
2. LoRa Alliance Technical Committee Regional Parameters Workgroup, "LoRaWAN 1.1 Regional Parameters", 2018 January.
3. LoRa Alliance Technical Committee, "LoRaWAN 1.1 Specification", October 11,2017.
4. <https://www.semtech.com/lora/lora-applications>.
5. <https://www.mdpi.com/1424-8220/16/9/1466/html>.
6. <https://www.link-labs.com/blog/complete-list-iot-networks-protocols>.
7. <https://www.rs-online.com/designspark/eleven-internet-of-things-iot-protocols-you-need-to-know-about>.

19MECE51 - SENSOR TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to demonstrate an ability to

- CO1** : *explain the strain and pressure measurement methodologies*
- CO2** : *exemplify the features of Motion sensors for various applications*
- CO3** : *illustrate different light radiation sensors and their applications*
- CO4** : *examine the characteristics of the various types of heat and temperature sensors*
- CO5** : *describe digital and proximity sensors and their applications*

STRAIN AND PRESSURE MEASUREMENT

Resistance strain gauge, piezoelectric pressure gauge, characteristics. Electronic circuits for strain gauge, load cells. Interferometer, Fibre-optic methods. Pressure gauges Aneroid capacitance pressure gauge, ionization gauge, Using the transducers for applications. (9)

MOTION SENSORS

Capacitor plate sensor, Inductive sensors, LVDT Accelerometer systems, rotation sensors drag cup devices, piezoelectric devices. Rotary encoders. (9)

LIGHT RADIATION

Color temperature, light flux, photo sensors, photomultiplier, photo resistor and photoconductors, photodiodes, phototransistors, photovoltaic devices, fiber-optic applications, light transducer, solid-state, transducers liquid crystal devices. (9)

HEAT AND TEMPERATURE

Bimetallic strip, Bourdon temperature gauge, thermocouples, Resistance thermometers, thermistors, PTC thermistors, bolometer, Pyroelectric detector. (9)

ELECTRONIC SENSORS

Proximity detectors - Inductive and capacitive, ultrasonic, photo beam detectors Reed switch, magnet and Hall-effect units, Doppler detectors, liquid level detectors, flow sensors, smoke sensors. (9)

TOTAL : 45

REFERENCES

1. Doebelin E O, "Measurement Systems, Application and Design", McGraw Hill, 5th Edition, 2004.
2. Ian R Sinclair, "Sensors and Transducer", 3rd Edition, Newnes publishers, 2001.
3. Jack P Holman, "Experimental Methods for Engineers", 7th Edition, McGraw Hill, USA, 2001.
4. Robert G Seippel, "Transducers, Sensors and Detectors", Reston Publishing Company, USA, 1983.
5. Jacob Fraden, "Handbook of Modern Sensors Physics, Designs and Applications", Springer, 4th Edition, 2010.