M.E. (Communication Systems)

2015 Regulations, Curriculum & Syllabi

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai
Approved by AICTE - Accredited by NBA New Delhi, NAAC with 'A' Grade and ISO 9001:2008 Certified)
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PROGRAM EDUCATIONAL COURSE OBJECTIVES (PEOs)

I The Graduate will demonstrate their skills and knowledge to design, simulate, evaluate, analyze and develop components for offering solution to real life situations in the field of communication systems.

II The Graduate will be able to function on teams, exhibit leadership, and make effective contributions to the benefit of their workplace and community.

III The Graduate will pursue professional development for continuously renewing and expanding their knowledge base and adapting to a multi-disciplinary situations through graduate work and able to perform engineering practice in context that reflects awareness on the ethics of their profession, and the impacts of their work on the profession and society at large.

PROGRAMME OUTCOMES (POs)

a) The Graduate will able to apply knowledge from basic engineering and other disciplines to identify, formulate and present solutions to technical problems in a variety of specialty areas related to communication engineering technology.

b) The Graduate will able to learn new related technologies in the fields of telecommunication and wireless networks along with the concepts of that require advanced knowledge within the field.

c) The Graduate will able to apply advanced technical knowledge in multiple contexts.

d) The Graduate will able to understand and design advanced state of art communication systems and services and conduct experiments, analyze and interpret data.

e) The Graduate will able to use the techniques, skills, modern engineering tools, software and equipment necessary to evaluate and analyze the systems in telecommunication environments.

f) The Graduate will able to plan, conduct an organized and systematic study on significant research topic within the field.

g) The Graduate will able to convey technical material through formal documents which satisfy accepted global standards.

h) The Graduate will able to communicate professionally.

i) The Graduate will able to become knowledgeable about contemporary developments.

j) The Graduate will able to develop confidence for self-education and use it for lifelong learning.

MAPPING OF PEOs AND POs

PEO(s)	Programme Outcome (s)									
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
I	x	x		x	x					
II						x	x			
III			x					x	x	x

M.E.: Communication Systems (Full Time)

Minimum credits to be earned: 76

First Semester							
Code No.	**Course**	**Course Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15CO11	Linear Algebra and Special functions	I,II	(a), (b), (c),(d) (e)	3	2	0	4
15CO12	Information Theory and Coding	I,III	(a), (b), (c), (d),(e)	3	2	0	4
15CO13	Statistical Signal Processing[$]	I,III	(a), (b), (c),(e),(f)	3	0	0	3
15CO14	Mobile Communication Networks	I,II,III	(a), (b), (c), (d),(e)	3	2	0	4
15CO15	Radiating Systems	I,II,III,	(a), (b), (c), (d),(e), (g)	3	2	0	4
	Elective I			3	0	0	3
15CO17	Signal Processing and Communication Laboratory	I,II,III	(a),(b),(c),(d),(e),(f), (g)	0	0	2	1
15CO18	Wireless Communication Networks Laboratory	I,II,III	(a),(b), (c), (d),(e),(f), (g)	0	0	2	1
15GE19	Business English - I[α]			1	0	2	2
			Total	**19**	**6**	**6**	**26**
Second Semester							
Code No.	**Course**	**Course Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15CO21	Research Methodology			3	0	0	3
15CO22	RF circuit Design	I,II,III	(a), (b), (c), (d),(e), (f), (g),(h)	3	2	0	4
15CO23	Digital Communication Techniques	I,III	(a), (b),(d),(e),(f)	3	2	0	4
15CO24	Optical Communication Networks	I,II,III	(a), (b), (c), (d),(e),(g),(h),(j)	3	0	0	3
	Elective II			3	0	0	3
	Elective III			3	0	0	3
15CO27	RF Laboratory	I,II,III	(a),(b), (c), (d),(e),(f), (g)	0	0	2	1
15CO28	Technical Seminar	III	(a),(c),(e),(f),(g),(h),(i),(j)	0	0	2	1
15GE29	Business English - II[α]			1	0	0	1
			Total	**18**	**4**	**4**	**23**
Third Semester							
Code No.	**Course**	**Course Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
	Elective IV			3	0	0	3
	Elective V			3	0	0	3
	Elective VI			3	0	0	3
15CO34	Project Work - Phase I	I,II,III	(a), (b), (c), (d),(e), (f), (g),(h), (i),(j)				6
			Total	**9**	**0**	**0**	**15**
Fourth Semester							
Code No.	**Course**	**Course Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15CO41	Project Work - Phase II	I,II,III	(a),(c),(d),(e),(f),(g),(h) ,(i),(j)				**12**

[$] Common to Applied Electronics, Embedded Systems and Communication Systems

[α] Common to all M.E. / M.Tech. Programmes

ME Communication Systems (Part Time)

Code No.	Course	Objectives & Outcomes		L	T	P	C
		PEOs	POs				
First Semester							
15CO11	Linear Algebra and Special functions	I,II	(a), (b), (c),(d) (e)	3	2	0	4
15CO12	Information Theory and Coding	I,III	(a), (b), (c), (d),(e)	3	2	0	4
15CO13	Statistical Signal Processing[$]	I,III	(a), (b), (c),(e),(f)	3	0	0	3
15CO17	Signal Processing and Communication Lab	I,II,III	(a),(b),(c),(d),(e), (f),(g)	0	0	2	1
15GE19	Business English - I[α]			1	0	2	2
			Total	**10**	**4**	**4**	**14**
Second Semester							
15CO21	Research Methodology			3	0	0	3
15CO22	RF circuit Design	I,II,III	(a),(b),(c),(d) (e),(f),(g),(h)	3	2	0	4
15CO23	Digital Communication Techniques	I,III	(a), (b),(d),(e),(f)	3	2	0	4
15CO27	RF Laboratory	I,II,III	(a),(b),(c), (d),(e),(f),(g)	0	0	2	1
15GE29	Business English - II[α]			1	0	0	1
			Total	**10**	**4**	**2**	**13**
Third Semester							
15CO14	Mobile Communication Networks	I,II,III	(a), (b), (c), (d),(e)	3	2	0	4
15CO15	Radiating Systems	I,II,III	(a), (b), (c), (d),(e),(g)	3	2	0	4
15CO24	Optical Communication Networks	I,II,III	(a),(b),(c),(d),(e),(g),(h),(j)	3	0	0	3
15CO18	Wireless Communication Networks Lab	I,II,III	(a),(b), (c), (d),(e),(f),(g)	0	0	2	1
			Total	**9**	**4**	**2**	**12**
Fourth Semester							
	Elective I			3	0	0	3
	Elective II			3	0	0	3
	Elective III			3	0	0	3
15CO28	Technical Seminar	III	(a),(c),(e),(f),(g),(h),(i),(j)	0	0	2	1
			Total	**9**	**0**	**2**	**10**
Fifth Semester							
	Elective IV			3	0	0	3
	Elective V			3	0	0	3
	Elective VI			3	0	0	3
15CO34	Project Work - Phase I	I,II,III	(a), (b), (c), (d),(e) (f),(g), (h), (i), (j)	-	-	-	6
			Total	**9**	**0**	**0**	**15**
Sixth Semester							
15CO41	Project Work - Phase II	I,II,III	(a),(c),(d),(e),(f),(g),(h),(i), (j)	-			**12**

[$] Common to Applied Electronics, Embedded Systems and Communication Systems

[α] Common to all M.E. / M.Tech. Programmes

List of Core Electives							
Code No.	**Course**	**Course Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15CO51	Microwave Integrated Circuits	I,II	(a), (b), (c), (d),(e),(f)	3	0	0	3
15CO52	Multimedia Compression Techniques	I,II	(a), (b), (c), (d),(e)	3	0	0	3
15CO53	Optical Signal Processing	I,II	(a), (b), (c), (d)	3	0	0	3
15CO54	RFIC Design	I,III	(a), (b), (c), (d),(e),(f)	3	0	0	3
15CO55	RF MEMS	I,III	(a), (b), (c), (d),(e)	3	0	0	3
15CO56	Electromagnetic Interference and Compatibility in System Design	I,II,III	(a), (b), (c), (d),(e)	3	0	0	3
15CO57	Beam forming in Wireless Communication	I,III	(a), (b), (c), (d),(e),(f)	3	0	0	3
15CO58	Wireless Sensor Networks	I,III	(a), (b), (c), (d),(e)	3	0	0	3
15CO59	Wireless Security$^{\Omega}$	III	(a), (b), (c), (d),(e)	3	0	0	3
15CO60	Mobile Adhoc Networks	III	(a), (b), (c), (d),(e)	3	0	0	3
15CO61	Broad Band Access Technologies and Distribution Systems	I,III	(a),(b),(c),(d),(e),(f),(i),(j)	3	0	0	3
15CO62	RF System Design for Wireless Communication	I,III	(a), (b), (c), (d),(e),(f)	3	0	0	3
15CO63	Software Defined Radio	III	(a), (b), (c), (d),(e)	3	0	0	3
15CO64	Orthogonal Frequency Division Multiplexing	I,III	(a), (b), (c), (d),(e),(f)	3	0	0	3
15CO65	Speech and Audio Signal Processing	III	(a), (b), (c), (d),(e)	3	0	0	3
15CO66	Biological Effects of Microwave	II,III	(a), (b), (c), (d),(e)	3	0	0	3
15CO67	Base band algorithms on FPGA	I,II,III	(a), (b), (c), (d),(e)	3	0	0	3
15CO68	Satellite Remote Sensing and Data Analysis	I,III	(a), (b), (c), (d),(e),(f)	3	0	0	3
15CO69	Microwave Remote Sensing	II,III	(a), (b), (c), (d),(e),(f)	3	0	0	3
15CO70	Signal Processing Techniques for Biological Systems	III	(a), (b), (c),(d),(e),(f)	3	0	0	3
15CO71	Evolutionary computing	I,III	(a), (b), (c), (d),(e)	3	0	0	3
One Credit Courses							
Code No.	**Course**	**Course Objectives & Outcomes**		**L**	**T**	**P**	**C**
		PEOs	**POs**				
15COXA	Analog Communication System Design	I,III	(b),(c),(d),(e),(f),(g),(i)	1	0	0	1
15COXB	Embedded Systems Design using MSP 430	I,III	(b),(c),(d),(e),(f),(g),(i)	1	0	0	1

$^{\Omega}$ Common to Communication systems and Applied Electronics

15CO11 LINEAR ALGEBRA AND SPECIAL FUNCTIONS

3 2 0 4

Course Objectives

- To impart knowledge on the calculus of variations with emphasis on its applications in several scientific fields.
- To understand the basic concepts of vector spaces and their applications.
- Ability to find the Eigen values and Eigen vectors of the matrix.
- Acquire the knowledge of interest in Special functions.

Course Outcomes (COs)

1. To provide the students with outstanding educational skills that will enable them to integrate under graduate fundamentals with advanced knowledge to solve complex problems.
2. Can get the idea of optimization and its applications.
3. Able to use a combination of theoretical knowledge and independent mathematical thinking using special functions.

Unit I

Calculus of Variations

Introduction to variation problems - Euler's equation - Functional dependent on first and higher order derivatives - Functional dependent on functions of several independent variables - Some applications - Direct methods: Ritz methods.

9 Hours

Unit II

Vector space

Definition and examples of linear space - Linear dependence and independence - Basis and Dimension - lnner product space - Orthogonalization process - Gram - Schmidt process Least - square problems - Applications of inner product spaces.

9 Hours

Unit III

Eigen values and Eigen vectors

Generalized Eigen values and Eigen vectors - Characteristic equation - Diagonalization - Eigen vectors & linear transformations - Complex eigen values - Applications to differential equations - Iterative estimates for Eigen values.

9 Hours

Unit IV

Advance matrix theory

Diagonalization of symmetric matrices - Quadratic forms - Singular values decomposition - Change of basis.

9 Hours

Unit V

Special Functions

Bessel's equation – Bessel functions – Legendre's equation – Legendre's polynomials – Rodrigue's formula – Recurrence relations – Generating functions and orthogonal property for Bessel's functions – Strum-Liouville problem – Error functions.

9 Hours

Unit VI[$]

Matrix norms - Jordan canonical form - Pseudo inverse - Least square approximations - QR algorithm.

Total: **45+30 Hours**

Reference(s):

1. Elsgolts.L, Differential Equation and Calculus of variations, MIR Publishers, 1996.
2. David C Lay,Linear Algebra and its Applications, Pearson Education Asia, New Delhi, 2012.
3. Howard Anton, Elementary Linear Algebra, John Wiley & Sons, 2010.
4. Grewal B S, Higher Engineering Mathematics, Fortieth Edition, Khanna Publications, New Delhi 2014.
5. Raisinghania. M. D, Ordinary and partial differential equations, S. Chand & Co, New Delhi, 2006.

15CO12 INFORMATION THEORY AND CODING

3 2 0 4

Course Objectives

- To have a complete understanding of error–control coding.
- To understand encoding and decoding of digital data streams.
- To introduce methods for the generation of these codes and their decoding techniques.
- To have a detailed knowledge of compression and decompression techniques.

Course Outcomes (COs)

1. Able to design Analog communication systems to meet desired needs.
2. Able to understand the practical implementation issues, such as Error control coding, convolutional code.
3. Able to design and develop digital and analog systems.

Unit I

Information theory

Concept of amount of information -units, Entropy -marginal, conditional and joint entropies -relation among entropies Mutual information, information rate, channel capacity, redundancy and efficiency of channels.

9 Hours

Unit II

Discrete channels

Symmetric channels, Binary Symmetric Channel, Binary Erasure Channel, Cascaded channels, repetition of symbols, Binary unsymmetric channel, and Shannon theorem. Continuous channels – Capacity of band limited Gaussian channels, Shannon-Hartley theorem, Tradeoff between band width and signal to noise ratio, Capacity of a channel with infinite band width, Optimum modulation system.

9 Hours

Unit III

Source coding

Encoding techniques, Purpose of encoding, Instantaneous codes, Construction of instantaneous codes, Kraft's inequality, Coding efficiency and redundancy, Noiseless coding theorem. Construction of basic source codes – Shannon-Fano algorithm, Huffman coding, Arithmetic coding, ZIP coding.

7 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit IV
Error detection and correction

Parity check coding, Linear block codes, Error detecting and correcting capabilities, Generator and Parity check matrices, Standard array and Syndrome decoding, Hamming codes, Encoding and decoding of systematic and unsystematic codes. Cyclic codes – Generator polynomial, Generator and Parity check matrices, Encoding of cyclic codes, Syndrome computation and error detection, Decoding of cyclic codes, BCH codes, RS codes, Burst error correction.

11 Hours

Unit V
Convolutional codes

Encoding- State, Tree and Trellis diagrams, Maximum likelihood decoding of convolutional codes - Viterbi algorithm, Sequential decoding -Stack algorithm. Interleaving techniques – Block and convolutional interleaving, Error Control and Signal Space Coding.

9 Hours

Unit VI[$]

Lloyd-Max Quantizer- Companded Quantization- Vector Quantization-Transform Coding Part I & Part II-Differential entropy-Application of information theories.

Total: 45+30 Hours

Reference(s)

1. Simon Haykin, *Communication Systems,* John Wiley & Sons. Pvt. Ltd, 2009
2. Taub & Schilling, *Principles of Communication Systems,* Tata McGraw-Hill, 2007
3. Das, Mullick& Chatterjee, *Principles of Digital Communication* ,Wiley Eastern Ltd,2002
4. Shu Lin & Daniel J. Costello, *Error Control Coding Fundamentals and Applications*, Jr., Prentice Hall Inc,2004.
   Bernard Sklar, *Digital Communications Fundamentals and Applications,* Person Education Asia, 2001

15CO13/15AE55/15ES52 STATISTICAL SIGNAL PROCESSING
(Common to Communication Systems, Applied Electronics & Embedded Systems)

3 0 0 3

Course Objectives

- To explore the concepts of multi rate signal processing and multi rate filters.
- To study the adaptive filters and its applications.
- To learn fundamental concepts on signal processing in power spectrum estimation.

Course Outcomes (COs)

1. able to design and implement decimator and interpolator and to design multi rate filter bank and acquires knowledge of how a multi rate system work
2. Understanding different spectral estimation techniques and linear prediction.
3. Ability to design LMS and RLS adaptive filters for signal enhancement, channel equalization.

Unit I
Multirate signal Processing

Introduction-Sampling and Signal Reconstruction-Sampling rate conversion – Decimation by an integer factor – interpolation by an integer factor –Sampling rate conversion by a rational factor – poly-phase FIR structures – FIR structures with time varying coefficients - Sampling rate conversion by a rational factor- Multistage design of decimator and interpolator.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

Multirate FIR Filter Design

Design of FIR filters for sampling rate conversion –Applications of Interpolation and decimation in signal processing –Filter bank implementation –Two channel filter banks-QMF filter banks –Perfect Reconstruction Filter banks – tree structured filter banks - DFT filter Banks – M-channel filter banks-octave filter banks

9 Hours

Unit III

Linear Estimation and Prediction

Linear prediction- Forward and backward predictions, Solutions of the Normal equations- Levinson-Durbin algorithms. Least mean squared error criterion -Wiener filter for filtering and prediction, FIR Wiener filter and Wiener IIR filters, Discrete Kalman filter.

9 Hours

Unit IV

Adaptive Filters

FIR Adaptive filters - Newton's steepest descent method – Adaptive filters based on steepest descent method -LMS Adaptive algorithm – other LMS based adaptive filters- RLS
Adaptive filters - Exponentially weighted RLS - Sliding window RLS – Simplified IIR LMS Adaptive filter. **9 Hours**

Unit V

Power Spectral Estimation

Estimation of spectra from finite duration observations of a signal –The Periodogram-Use of DFT in Power spectral Estimation –Non-Parametric methods for Power spectrum Estimation – Bartlett. Welch and Blackman–Tukey methods –Comparison of performance of Non – Parametric power spectrum Estimation methods –Parametric Methods - Relationship between auto correlation and model parameters, Yule-Walker equations, solutions using Durbin's algorithm,AR, MA, ARMA model based spectral estimation.

9 Hours

Unit VI[$]

Applications of adaptive filters: Adaptive channel equalization Adaptive echo canceller - Adaptive noise cancellation-, 1/M-octave-band filter banks, Speech enhancement using spectrum estimation

Total: 45 Hours

Reference(s)

1. H. Monson Hayes, *Statistical Digital Signal Processing and Modeling*, John Wiley and Sons, Inc., 2008.
2. G.. John Proakis and G. DimitrisManolakis, *Digital Signal Processing*, Pearson Education, 2006.
3. P.P.Vaidyanathan, *MultirateSyatems and Filter Banks*, Pearson Education, 2008.
4. N.J.Filege, *Multirate Digital Signal Processing*, John Wiley and Sons, 2000.
5. G..JohnProakis, *Algorithms for Statistical Signal Processing*, Pearson Education, 2002.
6. G.Dimitris and G.Manolakis.,*Statistical and Adaptive Signal Processing*, McGraw Hill, 2002.
7. Sophoncles J. Orfanidis, *Optimum Signal Processing*, McGraw Hill, 2007.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15CO14 MOBILE COMMUNICATION NETWORKS

3 2 0 4

Course Objective

- To understand the basic cellular system concepts.
- To have an insight into the various propagation models and the multiple access techniques in mobile communication.
- To gain knowledge of the various cellular mobile standards.

Course Outcomes (COs)

1. Understand the concepts of Cellular, Mobile Radio propagation and Multiple access techniques and solve engineering problems.
2. Outline the organization of Cellular networks and appreciate the differences with fixed networks
3. Infer on the evolution of cellular networks and evaluate 2G and 3G networks

Unit I

Cellular Concepts and System Design Fundamentals

Evolution of mobile communications, mobile radio systems- Examples, trends in cellular radio and personal communications. Cellular Concepts: Frequency reuse, Channel assignment, Hand off strategies, Interference and system capacity, tracking and grade of service.

9 Hours

Unit II

Mobile Radio Propagation

Free space propagation model, reflection, diffraction, scattering, Outdoor Propagation models, Indoor propagation models, Small scale Multipath propagation, Small scale Multipath measurements, parameters of Mobile multipath channels, fading and its types.

9 Hours

Unit III

Modulation and Multiple Access Techniques

Minimum Shift Keying (MSK), Gaussian MSK, Orthogonal Frequency Division Multiplexing, Multiple Access Techniques**:** TDMA, FDMA, CDMA, SDMA.

9 Hours

Unit IV

2G and 2.5G Networks

Evolution of Cellular networks – AMPS, DECT and TETRA. GSM - GSM Network Architecture, Air Interface, Channel Organization, Protocols and signaling, Authentication and security, Routing of a call to Mobile Subscriber, Handover in GSM 2.5G-GPRS Network Architecture, Mobility Management, Location Management and Roaming

9 Hours

Unit V

3G Networks and Beyond

UMTS Network Architecture, UMTS Interfaces, Channels, FDD and TDD, Time Slots, UMTS Network protocol architecture and transport network, Mobility Management, UMTS Handover. Concepts of Wi-Fi and WiMAX, Spectrum allocation for 3G, Wi-Fi, WiMAX, 4G and beyond

9 Hours

Unit VI[$]

Improving Coverage and capacity in Cellular systems, Statistical models for multipath fading channels, Spectral Efficiency of different Wireless Access Technologies, Role of IP in GPRS and UMTS, Concepts of 5G, Cognitive Radio

Total: 45+30 Hours

Reference(s)

1. Iti Saha Misra, *Wireless Communications and Networks: 3G and Beyond*, McGraw Hill Education (India) Pvt Ltd, 2013
2. W.C.Y.Lee, *Wireless And Cellular Telecommunications*, Third Edition, McGraw- Hill International, 2003.
3. T.S.Rappaport, *Wireless Communications: Principles and Practice, Second Edition*, Pearson Education/ Prentice Hall of India, Third Indian Reprint 2003.
4. T.S.Rappaport and Viswanath, *Fundamentals of wireless communication*, Cambridge Press 2009.
5. R. Blake, *Wireless Communication Technology*, Thomson Delmar, 2003.
6. T.G Palanivelu, R.Nakkeeran, *Wireless and Mobile Communication*,PHI,2009.
7. Andera Goldsmith, *Wireless Communications*, Cambridge University Press,2005

15CO15 RADIATING SYSTEMS

3 2 0 4

Course Objectives

- To understand the relation between the fields and to be familiar with antenna arrays.
- To understand signal propagation at Radio frequencies & to study aperture and Reflector antennas.
- To introduce to the students the basics of Microstrip Patch Antennas and its analysis
- To learn the special antenna arrays and their applications

Course Outcomes (COs)

1. Understanding of various antenna parameters.
2. Knowledge of aperture antennas and the field associated with it.
3. Discussion about Microstrip patch antennas and their design and simulation using software
4. Measurement of antenna parameters and special array antennas design, learn the applications of array antennas,

Unit I

Antenna Fundamentals

Antenna fundamental parameters, Broadband antennas and matching techniques, Balance to unbalance transformer, Introduction to numerical techniques.

9 Hours

Unit II

Aperture Antennas

Huygens' Principle- Radiation Equation- Directivity- Rectangular Aperture- TE10-Mode- Circular Aperture- TE11-Mode- Design Considerations- Fourier Transforms in Aperture Antenna Theory. E-Plane Sectoral Horn- H-Plane Sectoral Horn- Pyramidal Horn- Conical Horn –applications.

9 Hours

Unit III

Analysis and Design of Microstrip Patch Antennas

Configurations- Excitations and radiation mechanism of microstrip patch antennas- Radiation resistance- Power and input impendence. Modeling of rectangular and circular microstrip patch

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

antennas - Transmission line model and cavity model method. Circular polarization and bandwidth of microstrip patch antennas. Simulation of microstrip antennas using Simulation Software-Case studies.

9 Hours

Unit IV

Array Antennas

Linear array and Planar array- Characteristics, synthesis techniques – Fourier Transform method, and Taylor Line Source synthesis and Dolph-Chebyshev distributions. Circular array antennas.

9 Hours

Unit V

Special array antennas and its measurement

Conformal and Phased array antennas- sequential rotation and phasing, reactive loading. Array antenna measurement- Impedance, coupling, radiation pattern, scan element pattern, Gain Directivity, EIRP.

9 Hours

Unit VI[$]

Analog and Digital Beam forming, Ultra Wide Band antennas, Metamaterial based antennas, Smart antennas, Advanced Horn Structures for Reflectors and Phased arrays, Efficient Shaped Beam Synthesis in phased arrays and reflectors.

Total: 45+30 Hours

Reference(s)

1. C.A Balanis., *Antenna Theory*,Wiley,2003
2. Robert J. Mailloux, *Phased Array Antenna Hanbook*, Artech House, 2005.
3. HubRegtJ. Visser, *Array and Phased Array Antenna Basics*, John Wiley and Sons, 2005.
4. J.R James and P.S Hall, *Handbook of Microstrip Antennas*, Peter peregrinus, 1989 www.microstripantenna.com

15CO17 SIGNAL PROCESSING AND COMMUNICATION LABORATORY

0 0 2 1

Course Objectives

- To understand underlying concepts in signal, speech and image processing
- To provide a comprehensive analysis of digital modulation techniques.
- To learn about the adaptive filtering algorithms.
- To understand the mechanism of multirate systems, source control coding, error control coding and OFDM.

Course Outcomes (COs)

1. Able to learn about signal processing concepts and to implement the adaptive filtering algorithms.
2. Able to understand the image and speech processing algorithms.
3. Able to analyze the various modulation, coding techniques and multirate systems

List of Experiments

1. Implementation of LMS, RLS adaptive filters
    a. to remove noise
    b. to the estimation of Channel.
2 Implementation of Digital Modulation Techniques

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

3 Compare Gaussian minimum shift keying (GMSK) and minimum shift keying (MSK) modulation schemes
4 Simulation of CDMA Transmitter and Receiver and Linear, Convolutional and Cyclic Codes
5 Design and simulation of Multirate systems
6 Simulation and analysis of speech and image compression algorithms
7 Design and implementation of source coding technique
8 Implementation of Pulse Coded Modulation using Simulink
9 Implementation of OFDM physical link using Simulink

Mini project:

- Signal enhancement using spectral subtraction
- Image denoising
- Audio compression
- Adaptive Echo/Noise canceller
- Radar Tracking System
- GSM

Total: 30 Hours

15CO18 WIRELESS COMMUNICATION NETWORKS LABORATORY

0 0 2 1

Course Objectives

- To study the network simulators for implementation of different layered protocols
- To Implement MAC and Routing algorithms
- To perform simulation and analysis of various network protocols, Mobility model

Course Outcomes (COs)

1. Able to analyze characteristics of analog and digital channels in a communication systems
2. Able to understand wireless medium access mechanisms.
3. Able to anise and test performance of routing protocols.
4. Able to analyze IP and TCP traffic in static and mobile adhoc network

List of Experiments

1. Design and Implementation of wired network in open source simulator and performance analysis.
2. Simulation of Distance Vector and Link state routing in NS2
3. Simulation of a multicast routing mechanism in NS2.
4. Simulation and Performance analysis of IEEE 802.11 networks based on Throughput, PDR, Average End to End delay and Jitter.
5. Simulation of IEEE 802.11 networks with Mobility and performance comparison based on Throughput, PDR, Average End to End Delay and Jitter.
6. Simulation and Performance analysis of IEEE 802.16 WiMAX networks.
7. Design and Simulation of Handover mechanism in WiMAX systems and performance analysis based on Packets sent and received.
8. Simulation and Performance analysis of Table Driven routing protocol in Mobile Ad Hoc Networks.
9. Simulation of On-Demand Routing Protocols in Mobile Adhoc networks and Performance comparison with Table Driven Protocols.
10. Simulation of a security attack in Wireless Networks and analysis of performance degradation.

11. Performance analysis of secure routing mechanism in Wireless Networks and study on network performance in the presence of an attack.
12. Design and simulation of Wireless Sensor Networks using Zigbee and performance analysis based on battery model.

Mini Project

1. Design of Vehicular Ad Hoc Network and performance analysis based on different Mobility conditions
2. Design of Wireless sensor networks for a specific application of Patient Health Monitoring
3. Performance analysis and comparison of Battery aware models in Wireless Networks.
4. Performance evaluation of Medium Access Control in Heterogeneous wireless networks.
5. Design and simulation of GSM network and their performance analysis.

Total: 30 Hours

15GE19 BUSINESS ENGLISH I

1 0 2 2

Course Objectives

- To acquire skills for using English in workplace effectively.
- To communicate for essential business needs.
- To prepare students for taking BEC Vantage level examination which is an International Benchmark for English language proficiency of Cambridge English Language Assessment (CELA).

Course Outcomes (COs)

1. To enable students to get International recognition for work and study.
2. To use English confidently in the International business environments.
3. To be able to take part in business discussion, read company literature, write formal and informal business correspondences and listen and understand business conversations.

UNIT I
GRAMMAR AND VOCABULARY

Comparison of adjectives – forming questions – asking complex questions – expressing purpose and function – tenses – conditionals – time statements – modal verbs – active and passive voice – articles – direct and indirect speech – cause and effect – relative pronouns – expressions followed by – *ing* forms – countable / uncountable – acronyms – marketing terms / vocabulary – financial terms – collocations – discourse markers.

10 Hours

UNIT II
LISTENING

Purposes of listening – features of listening texts – potential barriers to listening – specific listening skills – strategies to use when listening– distinguishing relevant from irrelevant information – gap filling exercise – multiple-choice options – note completion – matching and multiple choice questions – listening for specific information, gist, topic, context and function.

7 Hours

UNIT III
SPEAKING

Word and sentence stress – clear individual sounds – turn taking – initiating and responding - intonation patterns – pronunciation – mother tongue intrusion– conversation practice – turn-taking and sustaining the interaction by initiating and responding appropriately.

10 Hours

UNIT IV
READING
Purposes of reading – potential barriers to reading – paraphrasing – identifying facts and ideas – skimming and scanning for information – matching statements with texts– spotting reference words – understanding text structure – understanding the ideas in a text – distinguishing between the correct answer and the distractor – understanding cohesion in a text – deciphering contextual meaning of words and phrases – cloze – proof reading - transcoding.

8 Hours

UNIT V
WRITING
Paragraphing a text – using appropriate connectives – editing practice –Longer Documents: writing a proposal.

10 Hours
Total: 45 Hours

Reference(s)
1. Guy Brook-Hart, "BEC VANTAGE: BUSINESS BENCHMARK Upper-Intermediate – Student's Book", 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE – Self-study Edition", Cambridge University Press, UK, 2005.

15CO21 RESEARCH METHODOLOGY

3 0 0 3

Course Objectives
- To understand some basic concepts of engineering research and its methodologies.
- To identify various sources of information for literature review and data collection.
- To families the various procedures to formulate appropriate research problem and design of experiments.

Course Outcomes (COs)
The students will be able to
1. Demonstrate the concepts of engineering research and its methodologies.
2. Understand the various methods used to collect the data to research.
3. Formulate appropriate research problem and conduct the experiments using systematics methods.

Unit I
Introduction
Definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process- steps.
Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

9 Hours

Unit II
Sampling Methods
Scales – measurement, Types of scale – Thurstone's Case V scale model, Osgood's Semantic Differential scale, Likert scale, Q- sort scale. Sampling methods- Probability sampling methods – simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non-probability sampling method – convenience sampling, judgment sampling, quota sampling.

9 Hours

Unit III

Hypotheses Testing

Testing of hypotheses concerning means -one mean and difference between two means -one tailed and two tailed tests, concerning variance – one tailed Chi-square test.

9 Hours

Unit IV

Research in Communication System design

Communication system concept-Types of sources (Analog and Digital)- data collection–-Types of Transmission Channels, Organizational Infrastructures, Communication Interfaces- parameters for the design of communication interfaces and systems - engineering sample design- Testing - design revision-volume production.

9 Hours

Unit V

Communication systems research forecasting models and Report writing

Short-term forecasting using econometric models- long-term forecasting using technological market models- judgment and nonlinear analysis for enhancing forecast accuracy. Report writing- Types of report, guidelines to review report, typing instructions, oral presentation.

9 Hours

Unit VI[$]

Case Study: apply Research Methodology principles into communication system design and manufacturing field.

Total: 45 Hours

Reference(s)

1. Kothari, C.R., *Research Methodology – Methods and techniques*, New Age Publications, New Delhi, 2009.
2. Panneerselvam, R., *Research Methodology*, Prentice-Hall of India, New Delhi, 2004.
3. IEEE Journal of communication

15CO22 RF CIRCUIT DESIGN

3 2 0 4

Course Objectives

- To learn RF design and circuit board components
- To understand various impedance transformers and biasing networks
- To study the basic RF components
- To acquire knowledge of RF filters and RF switches.

Course Outcomes (COs)

1. Able to understand various RF issues.
2. Able to gain knowledge of impedance transformation.
3. Able to Learn the concepts of RF filter design and their implementation using software.
4. Able to o learn the operation of RF switches and their design.

Unit I

RF Issues

Importance of RF design - Electromagnetic Spectrum - RF behaviour of passive components - Chip components and Circuit Board considerations Single port and Multi port networks-ABCD parameters- interconnection of networks, Scattering Parameters-Conversion– between S-parameters and ABCD parameters. Signal flow chart modeling.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

Impedance Transformation

Smith Chart- Derivation of Smith Chart, Impedance transformation and admittance transformation using Smith chart, Parallel and series connections of R&L elements and R&C elements. Multi section transformers- Binomial and Chebychev Transformers- Tapered Transformers- Bode-Fano constraints.

9 Hours

Unit III

Active RF Components & Applications

RF diodes-Schottky diode, PIN diode, Varactor diode, Tunnel diode, IMPATT, TRAPATT and BARITT diodes. Diode models. Matching and Biasing Networks Impedance matching using discrete components-Microstrip line matching networks - Amplifier classes of operation and biasing networks.

9 Hours

Unit IV

RF Filter design

Basic resonator and filter configurations, special filter realizations-Butterworth and Chebychev filters, Filter implementation- Richard transformation, unit elements, Kuroda's identities, Coupled filters, Filters using Coupled resonators. Analysis of infinite, terminated periodic structures – filter design by image parameter method, insertion loss method -Distributed element (transmission line/TEM) filters.

9 Hours

Unit V

RF Switches

Introduction-switch parameter definitions. Design of switches-device models, types of switches, switch configurations, theory of operation. Multiport switches-multi throw switches, Matrix switches, Diversity switch. High isolation switches, broadband switches, high power switches using different techniques, low distortion switches, switching speed, biasing of switching devices- biasing of PIN diodes, FETs, single power supply operation, switches with integrated control.

9 Hours

Unit VI[$]

Design of lumped element filters – distributed element filters- performance comparison- Design of switches.

Total: 45+30 Hours

Reference(s)

1. Reinhold Ludwig and Powel Bretchko, *RF Circuit Design – Theory and Applications*, Pearson Education Asia, 2006.
2. David M. Pozar, *Microwave Engineering*, John Wiley and Sons, 2005.
3. Kai Chang, Inder Bahl and Vijay Nair, *RF and Microwave Circuit and Component Design for Wireless Systems*, John Wiley and Sons, 2002.
4. Samuel Y.Liao , *Microwave Devices and Circuits*, Pearson Education, 2012.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15CO23 DIGITAL COMMUNICATION TECHNIQUES

3 2 0 4

Course Objectives

- To have an introduction on different receiver design in the Pulse code modulation scheme
- To understand basics of detection and estimation theory.
- To Design and analyze optimum detection schemes.
- To Study different estimation schemes such as ML and MMSE estimators.
- To understand the concept of third generation error correction and detection codes

Course Outcomes (COs)

1. able to design Analog communication systems to meet desired needs..
2. able to evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ration and data rate.
3. able to understand the practical implementation issues, such as non-ideal filters, non-ideal sampling pulses, aliasing, and intersymbol-interference (ISI)

Unit I

Baseband Data Transmission

Baseband PAM –One Shot Minimum Distance Receiver –Minimum Distance Sequence Detection — M-ary signaling scheme-shaping of the transmitted signal spectrum-Noise in Baseband System - Coherent and Non coherent Technique, Orthogonal Modulation – OFDM modulation and Demodulation –Multidimensional Modulation-Modulation with Memory.

9 Hours

Unit II

Band-limited channels

Pulse shape design for channels with ISI: Nyquist pulse, Partial response signaling (duobinary and modified duobinary pulses), demodulation; Channel Models: Fading Dispersive channel, Time and Frequency Selective, Rayleigh channel, karhunen- Loeve Expansion; Diversity Technique: Space, polarization, path, angle, Time and frequency, Diversity Combining Technique

9 Hours

Unit III

Equalization

Optimal Zero-Forcing Equalization- Generalized Equalization Methods- Fractionally Spaced Equalizer –Transversal Filter Equalizer –ISI and Channel Capacity –Constrained –complexity Equalizers – Adaptive Linear Equalizer – Adaptive DFE.

9 Hours

Unit IV

Detection

Detection of a Single Real-Valued Symbol- Detection of a Signal Vector –Known Signals in Gausian Noise –ML Sequence Detection with the Viterbi Algorithm – A Posteriori Probability Detection with BCJR- Symbol Error Probability for MLSD – incoherent Detection –Shot Noise Signal with known Intensity. Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson Criterion, Sequential Detection.

11 Hours

Unit V

Fundamentals of Estimation Theory

Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems, Properties of Estimators, Bayes Estimation, Minmax Estimation, Maximum-Likelihood Estimation, Comparison of Estimator Parameters.

7 Hours

Unit VI[$]

Non-regenerative MIMO wireless relays, Finite state Markov model of correlated Rician-fading channels, Fractionally Spaced Equalizer Passband Equalization -Optimum Digital Detector in Additive Gaussian Noise Detection of binary data using spectrum estimation techniques.

Total: 45+30 Hours

Reference(s)

1. John R Barry, Edward Lee and David G. Messerschmitt, *Digital Communication*, Springer, 2008.
2. John G. Proakis, *Digital Communications*, McGraw –Hill International Edition, 2009.
3. Simon Haykin, *Communication Systems*, PHI, 2008.
4. BemardSklar, *Digital Communications: Fundamentals and Application*s, Prentice Hall, 2001.
5. Bikash Kumar Dey, *Digital Communication*, NPTEL courseware 2008
6. M. K. Simon, S. M. Hinedi and W. C. Lindsey, Digital Communication Techniques: Signaling and detection, Prentice Hall India, N. Delhi, 1995.
7. Bernard C. Levy, *Principles of Signal Detection and Parameter Estimation*, Springer, 2008.

15CO24 OPTICAL COMMUNICATION NETWORKS

3 0 0 3

Course Objectives

- To develop an in-depth understanding, in terms of architecture, protocols and applications, of major optical networking technologies.
- To provide an exposure to solve numerical or analytical problems pertaining to the optical networking technologies
- To develop the necessary background to perform projects involving optical networks.

Course Outcomes (COs)

1. Understanding of various loss mechanisms and Non-Linear effects in optical communication.
2. Knowledge of optical components and WDM network elements.
3. Discussion about Optical access network architectures
4. Comparison of layered architecture of, IP and MPLS over SONET network.
5. Awareness of the advantages of Photonic packet switching, the impediments involved and the available techniques like switching, buffering, multiplexing & synchronization.

Unit I

Optical Signal propagation and System Components

Propagation in optical fibers – Loss & bandwidth windows, Intermodal dispersion, Optical fiber as waveguide, Chromatic dispersion, , Non-Linear effects; Solitons; Optical Network Components– Couplers, Isolators &Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters.

9 Hours

Unit II

Client layers of Optical Layer

SONET / SDH-Multiplexing, CAT & LCAS, SONET/SDH Layers, SONET Frame structure, Elements of SONET/SDH infrastructure, Optical Transport Network- Hierarchy, Frame structure multiplexing, Generic Framing Procedure, Ethernet-Framing structure, switches, IP over WDM-routing and forwarding, QoS, MPLS-Labels and forwarding, QoS, signaling and routing,. Carrier transport, resilient packet ring, storage area networks.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit III

WDM Network Elements and Design

WDM Network elements - Optical line terminals, Optical line amplifiers, Optical Add/drop multiplexers-Architectures, Reconfigurable OADMs,, Optical cross connects, All optical OXC configurations. WDM Network Design – Cost Trade-Offs: A detailed ring network example, LTD and RWA problems, dimensioning Wavelength routing networks, Stastical dimensioning Models, Maximum load dimensioning models

9 Hours

Unit IV

Packet switching and Access networks

Photonic Packet Switching – OTDM, Multiplexing and De-multiplexing, Synchronization, Header processing, Buffering, Burst switching, OTDM Access Networks – Network Architecture Overview, Enhanced HFC, FTTC, PON – Evolution.

9 Hours

Unit V

Network Design and Management

Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, crosstalk, dispersion; Wavelength stabilization ; Overall design considerations; Control and Management – Network management functions, Optical layer services and interfacing, Layers within optical layer, Multivendor interoperability, Performance and fault management, Configuration Management.

9 Hours

Unit VI[$]

Plastic optical fiber, Fiber optic Connectors, Li-Fi technology, Test equipments-Fault locators, fiber identifiers

Total: 45 Hours

Reference(s)

1. Rajiv Ramaswami and Kumar Sivarajan, *Optical Networks: A Practical Perspective*, Morgan Kaufmann, 2010.
2. VivekAlwayn, *Optical Network Design and Implementation*, Pearson Education, 2006.
3. Hussein T. Mouftab and Pin-Han Ho, *Optical Networks: Architecture and Survivability*, Kluwer Academic Publishers, 2002.
4. Biswanath Mukherjee, *Optical Communication Networks*, Tata McGraw Hill, 2004.
5. C.Siva Ram Moorthy and Mohan Gurusamy, *WDM Optical Networks : Concept, Design and Algorithms*, Prentice Hall of India, 2002.
6. P.E. Green, Jr., *Fiber Optic Networks*, Prentice Hall, NJ, 2005.
7. http://www.mhhe.com/engcs/electrical/keiser

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15CO27 RF LABORATORY

0 0 2 1

Course Objectives

- To provide experience in Simulation & Implementation of the microstrip antennas and planar array antenna.
- To provide experience in design, Implementation and testing of a Microstrip coupler and coplanar waveguides using simulation software.

Course Outcomes (COs)

- Understanding of various MIC technologies.
- Knowledge of microstrip transmission lines and their parameters.
- Discussion about passive and non-passive reciprocal devices and their analysis
- Learn the various coplanar MICs and their applications.
- Design of various microwave circuits like amplifiers, oscillators and mixers.

List of Experiments

1. Characteristics of RF diodes, transistors
2. Determination of S-parameter for MIC components
3. Design and simulation of microstrip filters and switches.
4. Design and implementation of Microstrip Couplers.
5. Design and simulation of Phase shifters.
6. Design parameters of planar waveguides.
7. Design and simulation of wired and microstrip antenna.
8. Design and simulation of microstrip antenna arrays.

Mini Project:

1. Design and implementation of RF circuits like amplifiers, mixers and oscillators.
2. Analysis and testing the performance of thin film resistances.
3. Design and analysis of antenna arrays.

Total: 30 Hours

15GE29 BUSINESS ENGLISH II

1 0 0 1

Course Objective

- To acquire skills for using English in business environment.
- To communicate appropriately in business contexts.
- To prepare students for taking BEC Vantage level examination conducted by the Cambridge English Language Assessment (CELA).

Course Outcomes (COs)

1. To enable students to acquire business terms for communication.
2. To use English confidently in the business contexts.
3. To be able to take part in business discussion and write formal and informal business correspondences.

UNIT I

SPEAKING

Non-verbal communication – agreeing / disagreeing, reaching decisions, giving and supporting opinions – making mini presentations – extending on conservations – collaborative task – tongue twisters.

6 Hours

UNIT II
WRITING
Business letters – fax – Shorter Documents: e-mail - memo – message - note – report writing – formal / informal styles.

9 Hours
Total: 15 Hours

Reference(s):
1. Guy Brook-Hart, "BEC VANTAGE: BUSINESS BENCHMARK Upper-Intermediate – Student's Book", 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE – Self-study Edition", Cambridge University Press, UK, 2005.

15CO51 MICROWAVE INTEGRATED CIRCUITS

3 0 0 3

Course Objectives
- To study about the technology of IC's and propagation of signals through Microstrip Transmission lines
- To understand how analyzes of fields and microwave circuit design are performed
- To learn coplanar MICs and design of microwave circuits like amplifiers, mixers etc.

Course Outcomes (COs)
1. Able to understand various MIC technologies.
2. Able to gain knowledge of microstrip transmission lines and their parameters.
3. Able to analyze passive and non-passive reciprocal devices and their analysis
4. Able to learn the various coplanar MICs and their applications.
5. Able to design various microwave circuits like amplifiers, oscillators and mixers.

Unit I
Technology of Hybrid MICs & Monolithic MICs
Hybrid MICs: Dielectric substrates - thick film technology and materials - thin film technology and materials – methods of testing – encapsulation of devices for MICs – mounting of active devices. MMICs: Processes involved in fabrication – epitaxial growth of semiconductor layer – growth of dielectric layer – diffusion-ion implantation – electron beam technology.

9 Hours

Unit II
Microstrip Transmission Lines
Strip lines- formulas for propagation constant, characteristic impedance and attenuation, an approximate electrostatic solution, Slot Lines, and Coplanar waveguides -Static TEM parameters and design of microstrip- High frequency dispersion effects in microstrip.

9 Hours

Unit III
Analysis of Passive Reciprocal and Non-Reciprocal Microwave Devices
Passive reciprocal devices: Methods of analysis of passive reciprocal microwave devices, the Even and Odd mode method and the Eigen value method. Applications to Microstrip directional couplers – parallel coupled lines, coupled microstrips design, branch line couplers, Lange couplers, hybrid ring couplers and the Wilkinson power dividers/combiners. Passive Non-Reciprocal Components: Ferromagnetic substrates for non-reciprocal devices – Design of microstrip circulators – latching circulators – isolators – phase shifters.

9 Hours

Unit IV C
oplanar MICs

Coplanar waveguides- transmission properties, discontinuities. Introduction to Coplanar MICs, Coplanar transistors and coplanar switches, coplanar microwave active filters, coplanar microwave active amplifiers, Coplanar Electronic circulators and coplanar frequency doublers.

9 Hours

Unit V
Microwave Circuit Design

Microwave amplifier Design – Two port power gain, stability single stage transistor amplifier design, low noise amplifier design, broad band amplifier design, balanced and distributed amplifiers, design of class A amplifiers. Microwave Oscillator Design, negative resistance oscillator, transistor oscillators design, dielectric resonator oscillator design, oscillator phase noise, microwave mixer, single ended diode mixer, FET mixer, balanced mixer, image reject mixer, double balanced mixer.

9 Hours

Unit VI[$]

Transmit and Receive chipset for 60 GHz applications, GaN-based Microwave High Power Devices, EBG structures for EMI reduction, High Density Integrated Electronics (HDIE).

Total: 45 Hours

Reference(s)

1. K.C.Gupta,, and Amarjitsingh ,*Microwave Integrated Circuits* , John Wiley and sons – Wiley Eastern Reprint, 2004.
2. Reinmut K. Hoffmann, *Handbook of Microwave Integrated Circuits*, Artech House, 1987.
3. Ingo Wolff, *Coplanar Microwave Integrated Circuits,* John Wiley and Sons, 2006.
4. David M.Pozar, *Microwave Engineering*, John Wiley and Sons, 2005.
5. www.microstripantenna.com

15CO52 MULTIMEDIA COMPRESSION TECHNIQUES

3 0 0 3

Course Objectives

- To explore the special features and representations of different data types.
- To analyze different compression techniques for text data and audio signals
- To analyze various compression techniques for image and video signals

Course Outcomes (COs)

1. The ability to perform text and audio compression.
2. The ability to apply various compression techniques in image and video compression.
3. The ability to apply above knowledge and skills to compression techniques.

Unit I
Introduction

Special features of Multimedia – Graphics and Image Data Representations – Fundamental Concepts in Text, Images, Graphics, Video and Digital Audio – Storage requirements for multimedia applications -Need for Compression – Lossy & Lossless compression techniques – Overview of source coding, Information theory & source models- Kraft McMillan Inequality – vector quantization –LBZ algorithm.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

Text Compression

Compression techniques – Huffmann coding – Adaptive Huffmann Coding – Arithmetic coding – Shannon- Fano coding – Dictionary techniques –LZ77, LZ78, LZW family algorithms.

9 Hours

Unit III

Audio Compression

Audio compression techniques - µ- Law and A-Law companding - Frequency domain and filtering - Basic sub- band coding –DPC M- ADPCM-DM-LPC-CELP -Application to speech coding – G.722 – Application to audio coding – MPEG audio, progressive encoding for audio - Silence compression techniques.

9 Hours

Unit IV

Image Compression

MMR coding –Transform Coding – JPEG Standard – Sub-band coding algorithms - Design of Filter banks – Wavelet based compression - Implementation using filters – EZW, SPIHT coders – JPEG 2000 standards - Run length coding.

9 Hours

Unit V

Video Compression

Video compression techniques and standards – MPEG Video Coding I: MPEG – 1 and 2 – MPEG Video Coding II - MPEG – 4 and 7 – Motion estimation and compensation techniques – H.261 Standard .

9 Hours

Unit VI[$]

DVI technology – DVI real time compression -Packet video-Video Compression Algorithm Based on Frame Difference Approaches.

Total: 45 Hours

Reference(s)

1. Khalid Sayood, *Introduction to Data Compression*, Morgan Kauffman Harcourt India, 2007.
2. David Salomon, *Data Compression – The Complete Reference*, Springer Verlang, 2006.
3. Yun Q.Shi and Huifang Sun, *Image and Video Compression for Multimedia Engineering – Fundamentals,Algorithms & Standards*, CRC press, 2003.
4. Peter Symes, *Digital Video Compression*, McGraw Hill Publication, 2004.
5. Mark Nelson, *Data Compression*, BPB Publishers, 2000.
6. Mark S.Drew and Ze-Nian Li, *Fundamentals of Multimedia*, PHI, 2003.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15CO53 OPTICAL SIGNAL PROCESSING

3 0 0 3

Course Objectives

- To learn the basic signal parameters of Optical signal processing.
- To explore the concept of different Spatial Filtering techniques
- To understand the basic operations of spectral analysis.
- To analyze the power spectrum of various Optic devices
- To study about the design of homodyne and heterodyne spectrum analyzers

Course Outcomes (COs)

1. able to analyze optical signal processing systems using its signal parameters.
2. able to understand the spectral filtering and spatial filtering operations in optics.
3. able to get an idea over acousto-optic devices and its applications

Unit I

Basic signal parameters

Characterization, Sample function, geometrical optics, basic laws, refraction by prisms, lens formula, imaging condition, optical invariants, physical optics, Transforms: Fresnel, Fourier, Inverse Fourier and Extended Fourier.

9 Hours

Unit II

Spectral Analysis

Spatial light modulation, spatial light modulators, detection process, system performance process, dynamic range, raster format, spectral analysis.

9 Hours

Unit III

Spatial Filtering and Filtering System

Types of spatial filters, optical signal processing and filter generation, read out module, orientation and sequential search, applications of optical spatial filter.

9 Hours

Unit IV

Acousto-Optic devices and power spectrum analysis

Acousto - optic cells, spatial light modulators , Raman – Nath and Bragg mode, basic spectrum analyzer, aperture weighting, dynamic range and SNR, photo detector, geometric considerations, and radiometer.

9 Hours

Unit V

Homodyne and heterodyne spectrum analyzers

Overlapping of waves, photo detector size, and optimum photo detector size for 1D and 2D structure, optical radio, spatial and temporal frequencies, Distributed and local oscillator, Dynamic range comparison of heterodyne and power spectrum analyzers.

9 Hours

Unit VI[$]

Beam Characterization, Acousto-optic processing of images, Visible Light Communication

Total: 45 Hours

Reference(s)

1. P.K. Das, *Optical Signal Processing Fundamentals,* Narosa Publishing, 2006.
2. G. Boone, *Signal processing wing optics Bradley*, Oxford University Press, 2005.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

4. Vanderlught, *Optical Signal Processing,* John Wiley & Sons, 2005.
5. Mahlke Gunther, and Goessing Peter, *Fiber optic cables: Fundamentals, Cable Engineering, Syste*m, *planning,* John Wiley, 2001.
6. Hiroshi Murata, *Handbook of Optical Fibers and Cables* Marcel Dekker Inc., 1998.
7. http://www.mhhe.com/engcs/electrical/keiser
8. http://www.arcelect.com/fiber cable.htm

15CO54 RFIC DESIGN

3 0 0 3

Course Objectives

- To understand the basics of RFICs.
- To understand the technologies used in RFICs.
- To introduce to the students the basics of Impedance matching in RFICs
- To learn the design of active circuits in RFICs

Course Outcomes (COs)

1. Understanding of application of RFICs.
2. Knowledge of various technologies and parameters.
3. Discussion about impedance matching and their design and simulation using software
4. Learn the applications of passive circuits and active circuits in RFICs.

Unit I
RFIC Basics

Low Frequency Analog design and Microwave design versus RFIC design- impedance levels for microwave and low frequency analog design- RFICs used in a communication transceiver. Issues in RFIC design- noise, noise power, noise figure-linearity and distortion in RF circuits- dynamic range-filtering issues.

9 Hours

Unit-II
Technology for RFICs

Transistor and Integrated circuit invention- charge transport in transistors- materials used- types of transistors used-MOSFET, MESFET, HEMT, BJT, HBT, BiCMOS. β Current dependence in BJT, small signal model and small signal parameters- high frequency effects-unity gain frequency-types of noises-thermal noise, shot noise, 1/f noise.

9 Hours

Unit-III
Impedance matching

Review of Smith chart- signal flow analysis- S parameters- parameter conversion- impedance matching- conversion between series and parallel RL and RC circuits- tapped capacitors and inductors- mutual inductance- matching using transformers- tuning a transformer- impedance transformation- bandwidth of impedance transformation network-quality factor of an LC resonator-transmission lines.

9 Hours

Unit IV
Passive circuit elements in RFIC

Technology back end and metallization in IC technologies- sheet resistance and skin effect- parasitic capacitance-parasitic inductance- resistors and types- capacitors and types- varactors- design of inductors and transformers- Q factor and characterization of inductor- multilevel inductor- packaging-signal pads- wiring- simple filters-combiners and dividers.

9 Hours

Unit V
Active circuits in RFIC

Amplifiers- topologies- stabilization networks- bias supply- design strategies- narrowband and wideband design of LNA- power amplifier- choice of topology, current source based amplifiers, switched amplifiers- amplitude control and switches- attenuators and switches, variable gain amplifiers- phase shifters-reflective type and digitally adjustable phase shifters- vector modulators.

9 Hours

Unit VI[$]

RF Energy Harvesting Circuit for Remote Sensors**,** Power Amplifier Design for WLAN Applications and Software Defined Radio applications, RF front-end components for ultra-wideband (UWB) applications, RFIC designs for radar applications.

Total: 45 Hours

Reference(s)

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

15CO55 RF MEMS

3 0 0 3

Course Objectives

- To study the action mechanisms of MEMS Switches and relays.
- To study the modeling of mechanical filters, MEMS phase shifters and pros and cons of micro machined Passive elements.
- To present basic overview of Microstrip antennas and design parameters.

Course Outcomes (COs)

1. able to analyze and design RF MEMS relays and switches
2. able to understand the operations of MEMS Inductors and Capacitors
3. able to know the design and architecture of Micro machined Antennas
4. able to model Mems phase shifters and its applications

Unit I
RFMEMS Relays and Switches

Introduction-Switch parameters Action Mechanisms of RF MEMS Switches –Electro Static, Magnetic & electromagnetic Bi-stable Relays and micro actuators –Dynamics of Switching Operation MEMS Switch Modeling, design evaluation.

9 Hours

Unit II
MEMS Inductors and Capacitors

Micro machining-Micro machining as a Fabrication process, Fabrication techniques- actuator mechanism- pull-in voltage-Micro machined Passive elements pros and cons-MEMS Inductors-Micro machined inductor-Effect of inductor layout-Approaches for Improving quality factor-Modeling and design issues of planar inductor-Polymer based inductor-MEMS capacitors gap tuning and area tuning capacitors-Dielectric tunable capacitors.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit III
Micro-Machined RF Filters

Introduction-Modeling of Mechanical Filters-Micro-machined filters-Electrostatic comb drive-Micromechanical filters using comb drives, electrostatic coupled beam structures –SAW filters Basic /s –Design of Inter Digital Transducers-Capabilities, Limitations and applications-Micro machined filters for mm-wave frequencies.

9 Hours

Unit IV
MEMS Phase Shifters

Introduction-Types of Phase shifters-Limitations-MEMS phase shifters-Switched delay line, Distributed and polymer based-Ferro electric Phase shifters-Distributed and bilateral Inter digitated-Micro machined transmission lines: Losses in Transmission Lines-Coplanar lines-Micro shield and membrane supported transmission lines-Micro machined directional; coupler & Mixer. Design, Fabrication and evaluation.

9 Hours

Unit V
Micro machined Antennas

Introduction-Overview of Microstrip antenna-Design parameters-Micromachining to improve antenna performance-–Reconfigurable antennas.

9 Hours

Unit VI[$]

Electro thermally actuated Bi stable switches, Bulk acoustic wave filters, Integration and Packaging of RF MEMS devices, Micro machined filters for millimeter wave frequencies.

Total: 45 Hours

Reference(s)

1. V.K. Varadan, K.J. Vinoy and K.A. Jose, RF MEMS and their applications, John Wiley & Sons Inc, 2006.
2. G.M. Rebeiz, RF MEMS: THEORY, Design and Technology:, John Wiley & Sons Inc., 2003.
3. Hector J. De Santos, RF MEMS circuit Design for Wireless Communications : Artech House, 2002.
4. www.marubeni-sys.com/mems/coventor/RF_MEMS_Application.pdf

15CO56 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY IN SYSTEM DESIGN

3 0 0 3

Course Objectives

- To explore the concepts of EMI Environment and EMI Coupling Principles.
- To focus on popular EMI/EMC Standards and Measurements.
- To study the control techniques involved in Electromagnetic Interference.

Course Outcomes (COs)

1. able to study electromagnetic concepts and its measuring parameters
2. able to understand the EMI coupling principle and its types.
3. able to know the design and architecture of Micro machined Antennas
4. able to model Mems phase shifters and its applications

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit I

EMI Environment

EMI/EMC concepts and definitions, Sources of EMI, conducted and radiated EMI, Transient EMI, Time domain Vs Frequency domain EMI, Units of measurement parameters, Emission and immunity concepts, ESD.

9 Hours

Unit II

EMI Coupling Principles

Conducted, Radiated and Transient Coupling, Common Impedance Ground Coupling, Radiated Common Mode and Ground Loop Coupling, Radiated Differential Mode Coupling, Near Field Cable to Cable Coupling, Power Mains and Power Supply coupling.

9 Hours

Unit III

EMI/EMC Standards and Measurements

Civilian standards - FCC, CISPR, IEC, EN, Military standards - MIL STD 461D/462, EMI Test Instruments /Systems, EMI Shielded Chamber, Open Area Test Site, TEM Cell, Sensors/Injectors/Couplers, Test beds for ESD and EFT, Military Test Method and Procedures (462).

9 Hours

Unit IV

EMI Control Techniques

Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting.

9 Hours

Unit V

EMC Design of PCBs

PCB Traces Cross Talk, Impedance Control, Power Distribution Decoupling, Zoning, Motherboard Designs and Propagation Delay Performance Models.

9 Hours

Unit VI[$]

Electrical, Magnetic and Thermal analysis of circuits for EMC**.**

Total: 45 Hours

Reference(s)

1. Henry W.Ott, *Noise Reduction Techniques in Electronic System*, John Wiley and Sons, 2008
2. C.R. Paul, *Introduction to Electromagnetic Compatibility*, John Wiley and Sons, Inc, 2005.
3. V.P.Kodali., *Engineering EMC Principles, Measurements and Technologies*, IEEE Press, 1996.
4. Bernhard Keiser, *Principles of Electromagnetic Compatibility*, Artech house, 1986.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15CO57 BEAM FORMING IN WIRELESS COMMUNICATION

3 0 0 3

Course Objectives

- To understand the basics of Beamforming.
- To understand the concepts of adaptive Beamforming and Subband adaptive Beamforming..
- To introduce to the students the design techniques of beamformers.
- To learn the effects of error in DBF.

Course Outcomes (COs)

1. Understanding of application of Beamforming.
2. Knowledge of various Beamforming techniques.
3. Discussion about design and simulation of various beamformers using software
4. Learn the effects of error in DBF and methods of reducing it.

Unit I

Introduction to Beamforming

Array signal processing- narrowband Beamforming-wideband Beamforming- wideband beamsteering- multiple access- digital Beamforming- fundamentals of digital Beamforming-introduction to antenna arrays, analog Beamforming, phased arrays, element-space Beamforming, beam-space Beamforming, two dimensional Beamforming.

9 Hours

Unit-II

Adaptive Beamforming

Basic concepts- criteria for optimal weights- adaptive algorithms- LMS algorithm, direct sample covariance matrix inversion, RLS algorithm, neural networks. Partial adaptivity- Reference signal based beamformer- linearly constrained minimum variance Beamforming- constraints in LCMV Beamforming- generalized side lobe canceller-soft constrained minimum variance beamformer-correlation constrained minimum variance beamformer- robust Beamforming.

9 Hours

Unit-III

Subband adaptive Beamforming

Fundamentals of filter banks- Subband adaptive filtering- generalized Subband adaptive Beamforming- Generalized Subband Canceller (GSC)- Subband adaptive GSC- temporally/spatially Subband selective Beamforming-frequency domain adaptive Beamforming- transform domain adaptive Beamforming.

9 Hours

Unit IV

Digital Beamforming

Iterative optimization- least squares approach- Eigen filter approach- digital Beamforming networks-element-space and beam-space networks- DBF with multiple access schemes- DBF with TDMA, DBF with FDMA and DBF with CDMA.

9 Hours

Unit V

Error effects in DBF

Error sources in DBF antenna arrays- random errors and nonlinearities in receivers- quantization errors in DBF arrays- complex signal quantization error and quantization noise in Beamforming-random errors in DBF arrays-beam pattern, fractional loss in main beam gain, pointing error, side lobes and effect of element failure-nonlinearities in DBF arrays- modeling of nonlinearities, receiver nonlinearity effects on fixed Beamforming and receiver nonlinearity effects on adaptive Beamforming.

9 Hours

Unit VI[$]

Application of Beamforming in Wireless Location Estimation, Signal Enhancement Using Beamforming and Nonstationarity with Applications to Speech- Beamforming in LTE

Total: 45 Hours

Reference(s)

1. Wei Liu and Stephen Weiss, *Wideband Beamforming-concepts and techniques*, John Wiley and Sons, 2010
2. John Litva and Titus Kwok-Yeung Lo, *Digital Beamforming in Wireless Communication*, Artech House, 1996.
3. By Yikun. Yu, Petrus Gerardus Maria Baltus, Arthur H. M. Van, *Roermund Integrated 60GHz RFBeamforming in CMOS*, springer 2011

15CO58 WIRELESS SENSOR NETWORKS

3 0 0 3

Course Objectives

- To obtain a broad understanding of the technologies and applications for the emerging and exciting domain of wireless sensor networks.
- To study the challenges and latest research results related to the design and management of wireless sensor networks.
- To focus on network architectures and security.

Course Outcomes (COs)

1. able to learn the basics of wireless sensor networks and its applications in enabling technologies.
2. able to understand the architecture and elements of wireless sensor networks.
3. able to get an idea on MAC protocols for wireless sensor networks.
4. able to study the tools and platforms needed to establish sensor networks.

Unit I

Overview of wireless sensor networks

Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks- Enabling Technologies for Wireless Sensor Networks.

9 Hours

Unit II

Architectures

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

9 Hours

Unit III

Networking of sensors

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.

9 Hours

Unit IV

Infrastructure establishment

Topology Control – Motivation and Clustering, Time Synchronization - LTS, RBS, Localization and

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Positioning – Possible approaches, single hop localization.

9 Hours

Unit V

Sensor network platforms and tools

Operating Systems for Wireless Sensor Networks, Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

9 Hours

Unit VI[$]

In-network processing, The Mediation Device Protocol, TRAMA, Ad hoc Network Design Algorithm (ANDA).

Total: 45 Hours

Reference(s)

1. Holger Karl and Andreas Willig, *Protocols And Architectures for Wireless Sensor Networks* , John Wiley, 2005.
2. Feng Zhao and Leonidas J. Guibas, *Wireless Sensor Networks - An Information ProcessingApproach*, Elsevier, 2007.
3. KazemSohraby, Daniel Minoli and TaiebZnati, *Wireless Sensor Networks-Technology, Protocols, AndApplications*, John Wiley, 2007
4. Anna Hac, *Wireless Sensor Network Designs*, John Wiley, 2003.
5. BhaskarKrishnamachari, *Networking Wireless Sensors*, Cambridge Press, 2005.
6. Mohammad Ilyas and Imad Mahgaob, *Handbook of Sensor Networks: Compact Wireless and Wired Sensing Systems*, CRC Press, 2005.
7. Wayne Tomasi, *Introduction To Data Communication And Networking*, Pearson Education, 2007

15CO59/15AE54 WIRELESS SECURITY
(Common to Communication Systems & Applied Electronics)

3 0 0 3

Course Objectives

- To explore variety of attacks and threats and its impact on MAC layer and Network layer
- To study characteristics, vulnerabilities and challenges of ad hoc networks
- To provide solution for covering the security principles and flaws of popular wireless technologies
- To evaluate the performance of secured routing protocols in MANETs.

Course Outcomes (COs)

1. Ability to identify the various attacks and threads of wireless Networks.
2. Understand and recognize the architectures, vulnerabilities and challenges of mobile protocols.
3. Analyze the solutions for covering the security principles of wireless networks.
4. Analyze and design security systems for wireless networks.

Unit I

Attacks on Routing Protocols

Vulnerability of MANET to attack - review of AODV and DSR - type of attack - active and passive - internal and external - behavior of malicious node - black hole, DoS, Routing table overflow, Impersonation, Energy consumption, Information Disclosure - Misuse type – Misuse goals – Security flaw in AODV -attack on AODV - wormhole and rushing attack -Performance analysis of AODV in the presence of malicious node.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit II

Intrusion Detection in Wireless Ad Hoc Networks

Problem in current IDS techniques - requirements of IDS - classification of IDS – Network and host based - anamoly detection, misuse detection, specification based - intrusion detection in MANETs using distributed IDS and mobile agents - AODV protocol based IDS - Intrusion resistant routing algorithms - Comparison of IDS.

9 Hours

Unit III

Mitigating Techniques for Routing Misbehavior

Watchdog, Parthrater, Packet leashes and RAP.

9 Hours

Unit IV

Secure Routing Protocols:

Self organized network layer security in MANETs - mechanism to improve authentication and integrity in AODV using hash chain and digital signatures - on demand secure routing protocol resilent to Byzantine failures - ARIADNE, SEAD, SAR, and ARAN.

9 Hours

Unit V

Challenges in Routing Security

Security - Challenges and solutions - Providing Robust and Ubiquitous security support - Adaptive security for multilevel Ad Hoc Network - Denial of service Attack at the MAC layer - Detection and handling of MAC layer Misbehavior.

9 Hours

Unit VI[$]

Opportunistic routing to mitigate attacks in MANET-The Security of Vehicular Adhoc Networks-Asymmetric and dynamic encryption for routing security in MANET.

Total: 45 Hours

Reference(s)

1. C.Siva Ram Murthy and B.S.Manoj, AdHoc Wireless Networks: Architectures and Protocols, Prentice Hall PTR, 2004.
2. Ivan Stojmenović, Handbook of Wireless Networks and Mobile Computing, Wiley, 2002.
3. Hongmei Deng, Wei Li and Dharma P. Agrawal, Routing Security in Wireless Ad Hoc Networks, IEEE Communication Magazine, Oct 2002.
4. Peng Ning, Kun Sun, How To Misuse AODV: A Case Study of Insider Attacks Again Mobile AdHoc Routing Protocols in proceeding of the 4th annaul IEEE information assurance workshop, page 60 – 67west point, June 2003.
5. Amitabh Mishra, Intrusion Detection in Wireless Ad Hoc Networks, IEEE Wireless Communication, February 2004.
6. S.Marti, Mitigating Routing Misbehaviour in Mobile Ad Hoc Networks, ACM MOBICOM, 2000.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15CO60 MOBILE ADHOC NETWORKS

3 0 0 3

Course Objectives

- To study characteristics, vulnerabilities and challenges of ad hoc networks
- To explore issues and challenges in designing MAC and TCP Protocols in the context of AdHoc networks
- To understand adaptation of the routing protocols in mobile networks
- To explore issues and challenges variety of attacks and threats over different layer
- To evaluate the performance of MAC, routing protocols in MANETs.

Course Outcomes (COs)

1. Ability to identify the various challenges and vulnerabilities in MANET
2. Obtain an awareness cyber attacks and threads in mobile networks.
3. Understand and recognize the architectures, designing MAC,TCP,IP and security protocols
4. Analyze the solutions for covering the security principles of wireless networks.
5. Apply in-depth knowledge of wireless communications principles, systems, and networks to the solution of wireless engineering problems.

Unit I

Wireless LAN, PAN, WAN and MAN

Characteristics of wireless channel - Fundamentals of WLANs - IEEE 802.11 standard - HIPERLAN – WLL - Wireless ATM - IEEE 802.16 standard – HIPERACCESS- AdHoc Wireless Internet.

9 Hours

Unit II

MAC and Routing Protocols

MAC: Design issues - Goals and classification - Contention–based MAC protocols: MACAW,DPRMA, DPSMA.MAC protocols using directional antenna- Routing protocols: AODV,DSR,ZRP,LAR,CHGSR,FSR and power-aware routing protocols.

9 Hours

Unit III

Transport Layer and Security Protocols

Transport layer Protocol: Design issues - Goals and classification - TCP over AdHoc wireless Networks – Security - Security requirements - Issues and challenges in security provisioning - Network security attacks - Security routing.

9 Hours

Unit IV

Energy Management

Need - Classification of battery management schemes - Transmission power management schemes - System power management schemes. Wireless Sensor Networks: Architecture - Data dissemination - Date gathering - MAC protocols - Location discovery - Quality of a sensor network.

9 Hours

Unit V

Performance Analysis

ABR beaconing - Performance parameters - Route-discovery time - End-to-end delay performance - Communication throughput performance - Packet loss performance - Route reconfiguration/repair time - TCP/IP based applications.

9 Hours

Unit VI[$]

VANET-architecture, challenges-wireless technologies for VANET-wireless body area network-communication domains-Energy-efficient multicasting- wireless recharging techniques- QoS frame works in MANET- Network layer solutions.

Total: 45 Hours

Reference(s)

1. C.Siva Ram Murthy and B.S.Manoj, *AdHoc Wireless Networks: Architectures and protocols*, Prentice Hall PTR, 2007
2. C.K.Toh. , *AdHoc Mobile Wireless Networks: Protocols and Systems*, Prentice Hall PTR, 2008
3. Mohammad Ilyas, *The Handbook of AdHoc Wireless Networks*, CRC press, 2002
4. Charles E. Perkins, *AdHoc Networking*, Addison – Wesley, 2008
5. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan Stojmenovic, *Mobile AdHoc Networking*, Wiley – IEEE press, 2004
6. www.ietf.org/internet-drafts/draft-ietf-manet-dsr-07.txt 21
7. www.ietf.org/internet-drafts/draft-ietf-manet-aodv-11.txt 19

15CO61 BROAD BAND ACCESS TECHNOLOGIES AND DISTRIBUTION SYSTEMS

3 0 0 3

Course Objective

- To gain insight and understand current and emerging wired and wireless Internet access technologies.
- To learn the current technology trends and system standards as well as emerging technologies for next generation broadband access networks.
- To review emerging optical and wireless access systems including very high throughput radio over fiber wireless technologies for in-building applications

Course Outcomes (COs)

1. able to gain insight and understand about the wired access technologies include :ADSL, Gigabit Ethernet, and optical access networks (PONs) which include APON,BPON, GPON, GE-PON, WDM-PON.
2. able to gain and understand about fundamental device technology, operation system requirements, physical layer interface, link protocols and network architectures.
3. able to compare recent international standards efforts on Optical PON architecture and performance and requirement of Fiber-Optic Services (FiOS) or U-Verse based on Fiber-to-the-home (FT TH) architecture with cable-TV technology based on Hybrid Fiber-Coax (HFC) technology.

Unit I

Introduction to Broadband Access Technologies

History, Overview, Applications requirements ,Introductory comparisons of access technologies :Legacy systems, Limitations of Twisted Pair wires, XDSL systems, HFC systems, Wireless Access, Fiber Access/FTTP/FTTH, Gigabit, 10 Gigabit Ethernet, and 100Gbit Ethernet, Economic considerations ,Layered view of the system

9 Hours

Unit II

Fundamentals of Broadband Distribution Systems

Coaxial Cable- Types, Impedance, Attenuation, Return Loss, and Shielding, Amplifiers, Passive Coaxial Components, Power Supplies, System Design: CNR, BER vs. System Design ,Distortion ,Signal level stability and management.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Linear Fiber Optic Signal Transport-Optical basics ,Multimode and Single Mode Fibers ,Network Passive Components ,Linear Optical Transmitters, Optical Amps and Receivers, Subcarrier Multiplexing Techniques ,Interactions and End to End Link Performance.

9 Hours

Unit III

Cable Access Networks

Physical level-Current HFC Cable Networks and Examples, Physical System Design: CNR, BER vs. System Design, Distortion, Signal level stability and management, Downstream Channel: Noise and Distortion Allocations, Upstream Channel: Interference Signals in the Return Path ,Physical Channel Models for Upstream and Downstream Cable

Services Level-Telephony systems on HFC plant: TDM vs IP , Quality of Service ,Program Denial Technologies, Open Cable and other ,Digital Video Standards ,Home Gateway

Network Level-Network Access Technology for HFC Channels, Requirements for voice, video and data, MAC Protocols for centralized shared access media ,Performance characterization

9 Hours

Unit IV

Digital Cable Television Systems

Cable TV frequency plans (HRC, IRC, and STD),Digitization of Video, Digital Compression, Packetized multi program Data stream ,Modulation ,Error Correction ,Signal Quality ,Legacy (analog) Cable TV: Head end Signal Reception and processing ,Program Denial Technologies, Open Cable and other Digital Video Standards ,Cable Digital Data Transport **:**Modulation Methods, Spectrum Sharing and Capacity Issues ,Advanced PHY Specification: FA-TDMA/S-CDMA combination ,Receiver Design Examples ,Performance Evaluation vs. Channel Models, MAC Protocols for centralized shared access media ,Performance characterization and traffic modeling ,System management and adaptation to changes in traffic, physical channel .

9 Hours

Unit V

Alternate Broadband Access Networks

Comparison to Alternate Broadband Access Networks, ADSL/xDSL Access Networks. **Wireless Access Networks-** Fixed wireless media characteristics, Different physical layer options for wireless, WiFi, WiMax, LTE and WiMedia,60GHz wireless over Fiber networks .

Fiber Access Networks-Example architectures : Point-to-point Optical Networks, Passive Optical Networks, Active Optical Networks. Design of the physical channel :CWDM, Optical multiplexers, Overlay channels ,Cost comparisons ,Design of a PON link, Access Protocols (general) ,PON protocols, architectural consideration, Dynamic Bandwidth Allocation, APON, BPON, GPON, EPON and Other architectures ,IPTV ,Wireless over Fiber Technologies and Applications

9 Hours

Unit VI[$]

Optical Metro Networks- Introduction to metro network, overview of traffic grooming in SONET ring, traffic grooming in WDM ring, RINGOSTAR: architecture, proxy stripping, protectoration and network lifetime

Total: 45 Hours

Reference(s)

1. W. Ciccora, J. Farmer, and D. Large. Modern Cable Television Technology, Video, Voice and Data Communications, Elsevier 2nd edition,2004.
2. Glen Kramer, Ethernet Passive Optical Networks, McGraw Hill Professional,2005.
3. HoudaLabiod, HossamAfifi, Costantino de Santis, WiFi, Bluetooth, Zigbee, andWimax,Springer,2010.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

4. Paul E. Green ,Fiber to the Home, John Wiley & sons,2006.
5. Phillip Golden, Implementation and Applications of DSL Technology, Auerbach Publications, Taylor & Francis Group, 2008.

15CO62 RF SYSTEM DESIGN FOR WIRELESS COMMUNICATION

3 0 0 3

Course Objectives

- To understand the basics of system design.
- To understand the concepts of radio architectures.
- To introduce to the students the transmitter and receiver system design techniques and analysis.
- To learn the applications of RF systems in wireless communication.

Course Outcomes (COs)

1. Understanding of application of RF system parameters.
2. Knowledge of various RF architectures and design for wireless systems.
3. Discussion about design and simulation of transmitter and receivers using software
4. Learn the application of RF system design.

Unit I

Fundamentals of System design

Linear systems and transformation- linear system, Fourier series and transformation, frequency response of LTI system, Band-pass to Low-pass equivalent mapping and Hilbert transform- non-linear system representation and analysis approaches- representation of memoryless nonlinear systems, multiple input effects in nonlinear systems, memoryless band-pass nonlinearities and their low-pass equivalents. Noise and Random Process -Noise Power and Spectral Representation, Noise and Random Process Through Linear Systems, Narrow-Band Noise Representation ,Noise Figure and Noise Temperature-Elements of Digital Base-Band System- Jitter Effect of Sampling and Quantizing Noise, Commonly Used Modulation Schemes, Pulse-Shaping Techniques and Intersymbol Interference (ISI), Error Probability of Detection, Signal-to-Noise Ratio (SNR) and Carrier-to-Noise Ratio (CNR)

9 Hours

Unit II

Radio architecture and Design considerations

Superheterodyne Architecture- configuration, frequency planning and design consideration- Direct-conversion (Zero IF) architecture- configuration, technical challenges, design considerations- Low IF architecture- configuration, approaches to achieve high image rejection, design considerations- Band-pass sampling radio architecture- basics of band-pass sampling, configuration and design considerations.

9 Hours

Unit III

Receiver system design

Introduction- sensitivity and noise figure of receiver- inter modulation characteristics- single tone desensitization-adjacent/alternate channel selectivity and blocking characteristics- receiver dynamic range and AGC system- system design and performance evaluation- compression points, minimum detectable signal, dynamic range, spurious components, SFDR, blocking, cross-modulation, reciprocal mixing, IF notch rejection.

9 Hours

Unit IV

Transmitter system design and analysis

Transmitter power and spectrum- modulation accuracy- adjacent and alternate channel power- noise emission calculation- important considerations in system design- transmitter noise, frequency stability

and spurious signals, frequency tuning, output power and efficiency, inter modulation.

9 Hours

Unit V

Applications of System design

Multimode and Multiband Super heterodyne Transceiver -Selection of a Frequency Plan, Receiver System Design, Transmitter System Design- Direct Conversion Transceiver- Receiver System Design, and Transmitter System Design.

9 Hours

Unit VI[$]

Measurement of noise, jitter, SFDR, intermodulation products for RF system

Total: 45 Hours

Reference(s)

1. Bosco Leung,*VLSI for Wireless Communication* ,Springer, 2011.
2. Elmad N Farag and Mohamed I Elmasry, Mixed *Signal VLSI Wireless Design-Circuits and Systems*, Kluwer Academic Publishers, 2002.
3. Zhipei Chi, *High Performance, High Speed VLSI Architectures for Wireless Communication Applications* University of Minnesota, 200

15CO63 SOFTWARE DEFINED RADIO

3 0 0 3

Course Objectives

- To explore the concepts of software based radio and architectures, implementation issues
- To study digital RF, base band and software technology
- To study the protocols and network aspects

Course Outcomes (COs)

1. able to learn the concepts of software based radio and its applications
2. able to understand the bridging concept between RF and baseband processing.
3. able to get an idea over baseband technology on software radio.

Unit I

Software Based Radio

Software defined radio and Software Radio Concepts – Realization of Software Based Radio –Front end Technology: radio frequency Translation and Software Defined Radio: Requirements and Specifications –Receiver Design Considerations – Transmitter Design considerations – Candidate Architectures for SDR – Radio frequency front end Implementations for Multimode SDRS: Superheterodyne Architecture –The AS 2/6 Product Family

9 Hours

Unit II

Data Conversion in Software Defined Radios

The Importance of Data Converters in Software Defined Radios – Converter Architectures – Converter Performance Impact on SDR – Superconductor Microelectronics: A Digital RF Technology for Software Radios: Introduction-Rapid Single Flux Quantum Digital Logic – The Digital Front End: Bridge between RF and Baseband Processing: The digital front end –Digital up and down conversions –Channel Filtering –Sample Rate Conversion.

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit III

Baseband Technology

Baseband Processing for SDR –The Role of Baseband Architectures – Base Band Component Technologies-Design Tools and Methodologies –System design and maintenance –Parameterization – A Technique for SDR Implementation –Definitions –Adaptability – Parameterization of Standards – Signal Processing Issues – Adaptive Computing IC Technology for 3G Software – Software defined Radio – A Solution for Mobile Devices –The Mobile Application Space and the need for Processing Power – SDR Baseband processing -Hardware with Software Programmability.

9 Hours

Unit IV

Software Technology

Software Engineering for Software Radios-Overview of Vanu Systems – The Importance of software in software Radio –Software Portability –Commodity PC hardware-Signal Processing software – Control - Software – Performance –Future Directions –Software Download for Mobile Terminals-Downloading Technologies for SDR – Standards for downloading – Seamless Upgrading 'on the FLY' security of download –software Architectures for Download –Future Applications of SDR Downloading.

9 Hours

Unit V

Protocols and Network Aspects

Protocols and Network Aspects of SDR – Protocol stacks: SAPS vs, Reconfigurability – Approaches to protocol stack reconfiguration- Reconfiguration Management and control -Network support for software radios Conclusion – The Waveform Description Language: The specification problem – WDL overview –FM3TR example – Refinement to an implication- WDL details – A practical WDL support environment.

9 Hours

Unit VI[$]

Superheterodyne Architecture –The AS 2/6 Product Family, SDR Baseband processing -Hardware with Software Programmability, Applications of SDR Downloading, A practical WDL support environment, A Digital RF Technology for Software Radios.

Total: 45 Hours

Reference(s)

1. Walter Tuttlebee, *Software Defined Radio: Enabling Technologies*, Wiley Publications, 2002.
2. Paul Burns, *Software Defined Radio for 3G*, Artech Hose, 2002.
3. Markus Dillinger, *Software Defined Radio: Architectures, Systems and Functions*, 2003.
4. www.citeseerx.ist.psu.edu
5. www.en.wikipedia.org/wiki/Software-defined_radio

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15CO64 ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

3 0 0 3

Course Objectives

- To learn the concepts of OFDM and channel models
- To have a knowledge of the basics of OFDM and Synchronization error
- To study the signal processing and channel estimation aspects of OFDM
- To understand the interleaving and coding techniques in OFDM
- To understand the peak power problem and the methods of reducing it.

Course Outcomes (COs)

1. Understanding of application of OFDM for communication systems.
2. Knowledge of various techniques and aspects of OFDM.
3. Discussion about design and simulation of modulation and coding techniques using software
4. Learn the problems in OFDM and Hybrid OFDM.

Unit I

Fundamentals

History of OFDM, orthogonal signals and vectors, quadrature modulation and demodulation, AWGN channel, detection of signals in noise, SNR, linear modulation schemes-ASK, QAM, PSK and DPSK.

Channel model for OFDM systems-Introduction- characterization of mobile radio channel- Frequency Division (FD) channel modeling- FD channel simulation- application to millimeter-wave radio channels.

9 Hours

Unit II

System Modeling

Concept of multicarrier transmission, OFDM as multicarrier transmission, Implementation of OFDM by FFT, OFDM with guard interval. OFDM introduction and block diagram, design of OFDM signal, OFDM system model, synchronization errors, performance of uncoded OFDM system-mathematical modeling, analytical evaluation of the BER and performance results.

9 Hours

Unit III

Synchronization

Synchronization and signal processing aspects of OFDM-spectral shaping, sensitivity of OFDM signal against nonlinearities. Synchronization and channel estimation aspects - time and frequency synchronization, OFDM with pilot symbols for channel estimation- Wiener estimator and Wiener filtering for OFDM.

9 Hours

Unit IV

PAPR and Hybrid concepts

Distribution of PAP ratio, clipping and peak windowing, peak cancellation, PAP reduction codes-generating complementary codes, minimum distance of complementary codes, Maximum-Likelihood decoding of complementary codes, suboptimal decoding of complementary codes, large code lengths-symbol scrambling.

Hybrid OFDM concept- structure of various multiple access schemes, comparison to MC-CDMA – analytical performance of fading channels- with perfect estimation and realistic estimation.

9 Hours

Unit V

LTE Standards

Requirements for mobile radio channel, time and frequency interleavers, diversity spectrum of a wideband multicarrier channel. OFDM systems with convolutional coding and QPSK, convolutional

coding and M^2-QAM, convolutionally coded QAM with real channel estimation and imperfect interleaving, antenna diversity for convolutionally coded QAM multicarrier systems.

9 Hours

Unit VI[$]

MIMO OFDM– MIMO Channel Capacity- Diversity – Alamouti, OSTBC- Cooperative Communications, Relay channel and cooperative protocols-different modulation for cooperative communication.

Total: 45 Hours

Reference(s)

1. Ramjee Prasad, *OFDM for Wireless Communication Systems*, ArtechHouse,Inc, 2004.
2. Henrik Schulze and Christian Luders, *Theory and Applications of OFDM and CDMA-Wideband Wireless Communications*, John Wiley & Sons Ltd, 2005.
3. RichardvanNee, Ramjee Prasad ,*OFDM for wireless multimedia communications,* Artech House, 2000.

15CO65 SPEECH AND AUDIO SIGNAL PROCESSING

3 0 0 3

Course Objectives

- To study the basics of speech signal, speech production mechanisms
- To explore time domain and frequency domain analysis of speech signal
- To focus on the applications of speech signal processing

Course Outcomes (COs)

1. Understanding of continuous-time wavelet transforms.
2. Understanding of discrete-time wavelet transforms.
3. The ability to design wavelet filter banks
4. Knowledge of Compression techniques
5. The ability to apply above knowledge and skills to image processing applications.

Unit I

Mechanics of Speech

Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Representation of Speech signals – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Music production – Auditory perception – Anatomical pathways from the ear to the perception of sound – Peripheral auditory system – Psycho acoustics.

9 Hours

Unit II

Time Domain Methods for Speech Processing

Time domain parameters of Speech signal – Methods for extracting the parameters Energy- Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy – Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function.

9 Hours

Unit III

Frequency Domain Method for Speech Processing

Short Time Fourier analysis – Filter bank analysis – Formant extraction – Pitch Extraction – Analysis by Synthesis-Analysis synthesis systems- Phase vocoder—Channel vocoder. Homomorphic speech analysis: Cepstral analysis of Speech – Formant and Pitch Estimation Speech enhancement

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

techniques in time domain –Homomorphic vocoders.

9 Hours

Unit IV

Linear Predictive Analysis of Speech

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.

9 Hours

Unit V

Application of Speech & Audio Signal Processing

Algorithms: Spectral Estimation, dynamic time warping – Hidden Markov model – Music analysis – Pitch Detection– Feature analysis for recognition – Music synthesis – Automatic Speech Recognition – Feature Extraction for ASR – Deterministic sequence recognition – Statistical Sequence recognition – ASR systems – Speaker identification and verification – Voice response system

9 Hours

Unit VI[$]

Speech Synthesis: Text to speech - voice over IP-Enhancement of speech using spectral subtraction, wiener filter- Voice activity detection for speech coding-simulation of audio coding techniques - Pitch detection using LPC.

9 Hours

Total: 45Hours

Reference(s)

1. L.R.Rabiner and R.W. Schaffer., *Digital Processing of Speech signals* – Prentice Hall –1978.
2. Ben Gold and Nelson Morgan, *Speech and Audio Signal Processing*, John Wiley and Sons Inc., 2004.
3. Quatieri ,*Discrete-time Speech Signal Processing* , Prentice Hall, 2001.
4. J.L.Flanagan ,*Speech analysis: Synthesis and Perception* ,Berlin,1972.
5. I.H. Witten, *Principles of Computer Speech* – Academic Press, 1982.

15CO66 BIOLOGICAL EFFECTS OF MICROWAVES

3 0 0 3

Course Objectives

- To study about the types of Radiations
- To understand how analyzes Characteristics of microwaves and their interaction with living systems
- To learn effects of microwaves on various systems

Course Outcomes(COs)

1. Understanding of various typical equipments generating microwaves.
2. Knowledge of various standards.
3. Discussion RF/Microwave Radiation exposure standards
4. Learn the various effects of microwaves on various systems.

Unit I

Introduction

Types of Radiations- microwave radiation, ionizing radiation, non-ionizing radiation and radio protection. EM spectrum, wavelengths and energy of different waves like radio frequencies,

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

microwave frequencies, visible light, UV rays, X rays and Gamma rays. Typical equipments generating microwaves and their qualitative description with schematic representation.

9 Hours

Unit-II

Characteristics of microwaves and their interaction with living systems

Formation of microwaves- parameters characterizing microwaves- frequency, velocity, wavelength, Electric and Magnetic field vectors, relation between the vectors and characteristic impedance of the microwave. Interaction of Microwaves- penetration of microwave into biological target- primary interaction of microwaves with living matter-secondary effects induced by primary interaction. Three layered semi-infinite slab model of biological target-primary and secondary effects of microwave interaction from molecular level to highly organized living systems.

9 Hours

Unit-III

Effects of microwaves on various systems

General thermal effects, specific thermal effects, Effects on nervous system, cardiovascular effects, effects on endocrine and metabolic effects, effects on genital system, foetal development, chromosome effects, cellular effects, effects on internal organs like abdominal cavity, chest and digestive track, effects on blood and the blood forming system, cataractogenesis- Lymphoblastoid Transformations -Mutagenic Effects-Hematologic Effects-Analeptic effect- synergic effect of drugs with RF/ Microwave radiation. Health status of personnel occupationally exposed to microwaves and the symptoms of microwave overexposure- a survey.

9 Hours

Unit-IV

Safe exposure limits, control and prevention of health hazards

Basic principles, determining safe limits, analysis on safe exposure limit of microwaves. Control methods for RF/ Microwave radiation- Engineering control like shielding- administrative control-personal protection and controlling microwave shocks and burns. Various prevention health hazards-RF/microwave energy depositions and its measurement- Specific Absorption Rate (SAR)- power density, depth of energy penetration- effect of geometry, effect of the resonance frequency, effect of clothing.

9 Hours

Unit-V

RF/Microwave Radiation exposure standards

Need for adopting guidelines for microwave exposure-Development of radiation exposure guidelines-various standards like ANSI Standard C95.1, USAF PEL (AFOSH Standard 161-9), OSHA regulations, ICNIRP recommendations, Federal Communications Commission (FCC). FCC exposure guidelines time averaging of exposure, induced and contact currents, FCC Limits for Maximum Permissible Exposure (MPE), FCC Limits for Localized (Partial-body) Exposure, Microwave equipment safety guidelines.

9 Hours

Unit-VI[$]

Epidemiological studies of Electromagnetic Fields and Health, Mechanisms and Therapeutic Applications of Time-Varying and Static Magnetic Fields, Therapeutic Heating Applications of Radio Frequency Energy, Electroporation, Electrical Shock Trauma

Total: 45 Hours

Reference(s)

1. Baranski and P Czerski, *Biological Effects Of Microwaves*, Dowden, Hutchinson and Ross, Inc.,Stroudsburg, Pennsylvania, U.S.A. (1976).

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

2. John M. Osepchuk, '*Biological Effects of Electromagnetic Radiation'* IEEE Press, 1983.
3. Frank s. Barnes, Ben Greenebaum, *Biological and Medical aspects of Electromagnetic Fields - Handbook of Biological effects of Electromagnetic Fields* – Third Edition, 2008.
4. Elliot Postow, CRC Handbook of Biological effects of Electromagnetic Fields, CRC Press, 'Maximum Exposure levels to RF fields-3KHz to 300GHz, Radiation Protection Series No.3', Published by Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). 1986.

15CO67 BASEBAND ALGORITHMS ON FPGA

3 0 0 3

Course Objectives:

- To learn basic concepts of FPGA, programming languages and technology.
- To study the basic building blocks of FPGA
- To understand baseband communication blocks that can be implemented on FPGA

Course Outcomes (COs):

1. Identification of various construction blocks and operation of FPGA
2. Implementation of arithmetic units and digital filters on FPGA
3. Design and implementation of Fourier transform and various baseband communication blocks

Unit I

FPGA Technology

Basics of FPGA, Gate array, Comparison of ASIC and FPGA, Introduction to FPGA Design flow, Programming languages, programming technology

9 Hours

Unit II

Basic Building Blocks

Number representation, Binary adders, Binary dividers, Floating point arithmetic, MAC &SOP unit .

9 Hours

Unit III

Digital filter implementation

FIR filter, Theory and Structure, Filter design, Constant coefficient, FIR Design IIR filter, IIR theory, Coefficient computation and Implementation details, Fast IIR filter

9 Hours

Unit IV

Fourier Transform

DFT algorithms, Goertzel algorithm, Hartley transform, Winograd DFT, blustein chirp-z transform, Rader algorithm, FFT algorithms, Cooley-tukey, Good Thomas, Winograd FFT

9 Hours

Unit V

Communication Blocks

Computation of Special Functions Using CORDIC, Error codes, Linear block code, Convolution codes, Modulation and Demodulation, Adaptive filters, LMS, RLS, Decimator and Interpolator, High Decimation Rate Filters.

9 Hours

Unit VI[$]

Error Control and Cryptography, VHDL and Verilog Coding, Rectangular and Number Theoretic Transforms

Total: 45 Hours

Reference(s)

1. Uwe.Meyer-Basese, "*Digital Signal processing with Field Programmable Gate Arrays*", Springer,Third 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*", Fourth Ed. McGraw Hill International Edition,2000
4. Michael John Sebastian Smith, "*Applications Specific Integrated Circuits*", Pearson Education,2000

15CO68 SATELLITE REMOTE SENSING AND DATA ANALYSIS

3 0 0 3

Course Objectives

- To study about the acquisition of satellite images
- To understand about the processing methodologies of satellite images
- To analyze and extract information from them, using signal and image processing

Course Outcomes (COs)

1. Understanding of remote sensing process and spectral reflectance curve
2. Knowledge of preprocessing techniques
3. Discussion of satellite image enhancement techniques
4. Learn the various data fusion and data compression techniques

Unit I

Satellite Data and Remote Sensing

Remote sensing process, Radiation principles, Spectral reflectance curve, EMR interactions with-atmosphere-earth surface features. satellite Image Characteristics, Resolution types, Pre-processing - Geometric Correction, Radiometric Correction.

9 Hours

Unit II

Satellite Image Enhancement

Radiometric Enhancement- Histogram Based Enhancements, Density Slicing, Stretching, Geometric Enhancement- Neighborhood Operations, Template Operation

9 Hours

Unit III

Data Transformation

Spectral Transforms-Multispectral Ratios- Vegetation Indexes, Principal Components, Tasseled-Cap Component, Color-Space Transforms, Spatial Transforms-Convolutions, Fourier Transform, Scale space Transforms

9 Hours

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

Unit IV

Image Analysis and Data Fusion

Feature Extraction-Statistical, Structural, Traning- Supervised, Unsupervised, Hybrid Training, Feature Space fusion, Spatial domain fusion, Scale space fusion

9 Hours

Unit V

Data Compression

Compression by coding, Fractal Compression, Wavelet Compression.

9 Hours

Unit VI[$]

Object recognition in satellite and aerial images, satellite image processing on computational grids and Image Based computation of Vegetation Indices in Medio GRID Architecture.

Total: 45 Hours

Reference(s)

1. Thomas M.Lillesand,Ralph W.Kiefer, "*Remote Sensing And Image Interpretation*", Fifth Edition,2004.
2. Robert A.Schowengerdt, '*Remote Sensing Models & Methods For Image Processing'***,** III Edition, 2004.
3. J.A.Richards *"Remote Sensing Digital Image Analysis: An Introduction",* Second Revised Edition, 1993.
4. John R.Jensen*,"Remote Sensing Of The Environment-An Earth Resource Perspective*", Pearson Education Series,2003.
5. Rafael C.Gonzalez,Richard E.Woods,"*Digital Image* Processing" Third edition, Prentice Hall, 2007

15CO69 MICROWAVE REMOTE SENSING

3 0 0 3

Course Objectives

- To learn the concepts of Radio telemetry
- To have a knowledge of the basics of radar remote sensing
- To study the airborne and space borne radar systems
- To impart the knowledge of Microwave Remote sensing and its applications.

Course Outcomes (COs)

1. Understanding of applications Radar systems
2. Knowledge of various techniques and aspects of Radar for remote sensing.
3. Learn the problems in remote sensing

Unit I

Fundamentals and Radiometry

Introduction and early history, Basic concepts, plane waves, antenna systems, radiometry, microwave interactions with atmospheric constituents, Earth's surface and vegetation, Radiometric systems, Sensors, Data products and its applications.

9 Hours

Unit II

Radar Remote Sensing

Radar Basics, Radar interaction with Earth surface and vegetation, Surface scattering theory. Radar

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

equation , fading concept, Measurement and discrimination, Physical mechanisms and empirical models for scattering and emission, Geometry of Radar images, Radar return and image signature,Resolution concepts, SAR, Speckle in radar imagery, concept of roughness, geometry of targets, resonance, dielectric constant, surface and volume scattering, signal penetration and enhancement.

9 Hours

Unit III

Airborne and Space borne Radar Systems

Airborne, Spaceborne, different platforms and sensors, Data products and selection procedure, SEASAT,SIRA,SIRB,ERS,JERS,RADARSAT missions, Doppler radar, JASON,TOPEX/POSEIDON, Aircraft: AirSAR, C/X SAR, E-SAR, STAR-1.

9 Hours

Unit IV

Application of Radar Remote Sensing

Applications in Agriculture, Forestry, Geology, Hydrology, ice studies, land use mapping and ocean related studies, military and surveillance applications, search and rescue operations, ground and air target detection and tracking.

9 Hours

Unit V

Special Topics in Radar Remote Sensing

SAR interferometry-Basics- differential SAR interferometry, Radar polarimetry-Radargrammetry and applications-Altimeter and its applications, scatter meter and its applications.

9 Hours

Unit VI[$]

RADAR Antennas, Transmitter, Receiver, Synthetic Aperture Radar; Aircraft, AirSAR, C/X SAR, E-SAR, STAR-1, Radargrammetry applications, Microstrip based broadband matching networks, Applications of Hydrology, Oceanography.

Total: 45 Hours

Reference(s):

1. Ulaby,F.T.,Moore,K.R. and Fung, *Microwave remote sensing vol-1*,vol-2 and vol- Addison-Wesley Publishing Company,London,1986.
2. Floyd.M.Handerson and Anthony, J.Lewis ,*Principles and applications of Imaging RADAR*, Manual of Remote sensing, Third edition, vol.2, ASPRS, Jhumurley and sons, Inc,1998.
3. Philippe Lacomme, Jeancl and eMarchais, Jean-Philippe Hardarge and Eric Normant, *Air and spaceborneradar systems-An introduction*, Elsevier publications 2001.
4. Iain H.woodhouse, *Introduction to microwave remote sensing*, 2004.
5. Roger J Sullivan, Knovel, *Radar foundations for Imaging and Advanced Concepts*, SciTech Pub, 2004.Ian Faulcon bridge, Radar Fundamentals, Published by Argos Press, 2002.
6. Eugene A. Sharkov, *Passive Microwave Remote Sensing of the Earth*: Physical Foundations, Published by Springer, 2003

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

15CO70 SIGNAL PROCESSING TECHNIQUES FOR BIOLOGICAL SYSTEMS

3 0 0 3

Course Objectives

- To explore the concepts of signals and systems
- To study the e filters and its applications.
- To learn fundamental concepts on Image processing and its applications

Course Outcomes (COs)

1. Acquiring knowledge of Signals and systems
2. Ability to compute FFT
3. Ability to design and implement filter
4. Understanding basics of image processing
5. Apply above knowledge and skills to analysis of biological systems.

Unit I

Signals and Systems

Introduction to signals and its classification-Sinusoids, complex exponentials, impulse and step signals, -LTI Systems and properties: impulse response, convolution, Eigen functions of LTI systems , Biological time series signals from gene expression microarrays

9 Hours

Unit II

Transforms

Discrete time Fourier transform Fast Fourier transform -sampling theorems-Biological example: Fourier transform of DNA sequences reveal inherent periodicities.

9 Hours

Unit III

Bayesian Detection and Estimation

Bayesian Detection and Estimation-Bayesian statistics: Incorporating prior knowledge-Minimum mean square error -Linear MMSE estimator-Maximum Aposteriori Probability detection.

9 Hours

Unit IV

Image Fundamentals

Fundamental studies related to visual perception, sampling and quantization of visual data, Image restoration and enhancement, Image compression, watermarking, authentication. Image preprocessing –Image enhancement, Image restoration, Image compression.

9 Hours

Unit V

Image Analysis and other Applications

Image segmentation, Image representation and analysis, Neural Network approaches. Image visualization, virtual reality based Interactive visualization. Applications – Spectral Imaging- Tele radiology.

9 Hours

Unit VI[$]

Abnormality detection in medical images, Medial Image formats [DICOM] and PACS, cell classification using supervised learning methods.

Total: 45 Hours

Reference(s)

1. SterenM.Kay , *Fundamentals of Statistical signal processing : Estimation theory upper*

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

saddle river , New Jersy , USA : Prentics Hall , 1993
2. Monson .H.Hayes, *Statistical Digital Signal Processing and Modeling* , New York , USA , Wiley ,1996.
3. Oppenheim Schafer and Buck, Discrete – Time signal Processing.
4. Rafael C. Gonzalez, Richard E .Woods, stevenL. Eddins, *Digital Image Processing using Matlab*, TMH, India Second Edition ,2010.
5. Anil K. Jain ,*Fundamentals of Digital Image Processing:* PHI, India 1995

15CO71 EVOLUTIONARY COMPUTING

3 0 0 3

Course Objectives

- To study different types of optimization techniques.
- To understand the concepts of genetic algorithms.
- To attain sound knowledge applications of soft computing.

Course Outcomes (COs)

1. Analysis the procedure for various principles of Evolutionary computing in real world problem.
2. Analysis feature enhancement and optimization methods using soft computing techniques.
3. Analysis the windowing of better solution in rough surface searching algorithms both using association and non association rules.
4. Identification of new developments in object recognition systems.

Unit I

Fuzzy Systems

Fuzzy set theory-fuzzy rules and fuzzy reasoning-fuzzy inference systems-decomposition-fuzzy automata and languages-fuzzy control methods.

9 Hours

Unit II

Neural Networks

Basic concepts-knowledge based processing-single layer perceptron-multilayer perceptron-supervised and unsupervised learning-feed forward and back propagation and counter propagation networks-kohensself organizing networks-Hopfield networks.

9 Hours

Unit III

Neuro Fuzzy Modeling

Adaptive neuro fuzzy inference systems-classification and regression trees- data clustering-rule base structure identification-neuro fuzzy controls.

9 Hours

Unit IV

Genetic Algorithms

Basics of GA- choice of encoding-selection probability-mutation and crossover-fitness evaluation–improving convergence rate-a simplex GA- Hybrid approach.

9 Hours

Unit V

Applications of Soft Computing

Fuzzy techniques for inverted pendulum case-SIRM fuzzy systems-MCDM for weather forecasting and financial marketing-Neural networks for pattern recognition-TS problems-Routers.

9 Hours

Unit VI[$]

Fuzzy logic power systems, Neural networks in character recognition applications of neuro-fuzzy systems in speech recognition -GA application to metabolic modeling.

Total : 45 Hours

Reference(s)

1. Jang J.S.R.,Sun C.T and Mizutani E**,***Neuro Fuzzy and Soft computing***",** Pearson Education (Singapore), 2006.
2. David E.Goldberg, *Genetic Algorithms in Search, Optimization, and Machine Learning***,** Pearson Education, Asia, 2001**.**
3. Timothy J.Ross**,***Fuzzy Logic Engineering Applications***,** McGrawHill, New York, 2002.
4. S.Rajasekaran and G.A.VijayalakshmiPai, *Neural networks, Fuzzy logics and Genetic algorithms***,** Prentice Hall of India, 2003.
5. George J.Klir and Bo Yuan, *Fuzzy Sets and Fuzzy Logic***,** Prentice Hall Inc., New Jersey, 2002.

[$] Includes Self Study topics of all 5 units and considered for Continuous Assessment only.

ONE CREDIT COURSES

15COXA ANALOG COMMUNICATION SYSTEM DESIGN

1 0 0 1

Course Objectives

- To introduce the fundamentals of communication systems andtechniques of transmitting and receiving information signals using analog carrier modulation techniques (AM, FM, PM)
- To study the Performance of the above systems in the presence of channel noise
- To study the Methods of digital transmission of analog signals (Binary and M-ary PCM)

Course Outcomes (COs)

The students are expected to demonstrate the ability to:

1. Determine the spectral content of periodic and non-periodic signals by applying Fourier analysis
2. Describe and analyze the mathematical techniques of generation, transmission and reception of amplitude modulation (AM), frequency modulation (FM) and phase modulation (PM) signals
3. Evaluate the performance of AM, FM and PM systems

Introduction to Analog communication system, Signals and Systems, Role of Analog Signal Processing in communication Products. Design of AGC/AVC for Communication receiver, Design of AM Generator & FM Generator, Design of VCO & DCO, Design of Frequency generator & FSK Universal Active Filter – Effect of Active Device GB,State-Space Filters (Tuning of Filters),Automatic Tuning of Filters (PLL) and Review of Filter Design for communication system,PLL and FLL Phase and Frequency Followers, Frequency Locked Loop ,Design of PLL and FLL,Application of PLL in Communication System

Total: 20 hours

15COXB EMBEDDED SYSTEMS DESIGN USING MSP430

1 0 0 1

Course Objectives

1. To understand the fundamental need of Low power embedded system
2. To know how to design low power embedded system Design.

Course Outcomes (COs)

1. Able to understand the need of Low power embedded system and CCS
2. Able to design low power embedded system for communication

UNIT 1

Motivation for MSP430 microcontrollers – Low Power embedded systems, On-chip peripherals (analog and digital), low-power RF capabilities. Target applications (Single-chip, low cost, low power, high performance system design).MSP430 RISC CPU architecture, Compiler-friendly features, Instruction set, Clock system, Memory subsystem. Key differentiating factors between different MSP430 families.

Introduction to Code Composer Studio (CCS v4). Understanding how to use CCS for Assembly, C, Assembly +C projects for MSP430 microcontrollers- Interrupt programming-Digital I/O – I/O ports programming using C and assembly, Understanding the muxing scheme of the MSP430 pins.

10 Hours

UNIT 2:

On-chip peripherals. Watchdog Timer, Comparator, Op-Amp, Basic Timer, Real Time Clock (RTC), ADC, DAC, SD16, LCD, DMA-Using the Low-power features of MSP430. Clock system, low-power modes, Clock request feature, Low-power programming and Interrupt-Interfacing LED, LCD, External memory. Seven segment LED modules interfacing. Example – Real-time clock.

Case Studies of applications of MSP430 - Data acquisition system, Wired Sensor network, Wireless sensor network with Chipcon RF interfaces.

10 Hours
Total: 20 hours