P D A College of Engineering, Gulbarga

Autonomous Institute, Affiliated to VTU

Department of
Electronics and Communication Engineering

M.Tech. (Communication Systems)

Scheme of Teaching and Syllabus
With effect from the Academic Year 2020

M.Tech. Communication Systems

Proposed Scheme of Teaching and Syllabus
First Semester

SubjectCode	Course	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CIE	SEE	Total
20 PCE11	Advanced Engineering Mathematics	04	02	00	05	50	50	100
20 PCE12	Advanced Digital Communication	04	02	00	05	50	50	100
20 PCE 13	Research Methodology	04	00	00	04	50	50	100
20PCE 14x	Elective -I	04	00	00	04	50	50	100
20 PCE 15x	Elective -II	04	00	00	03	50	50	100
20 PCE 16x	Elective -III	04	00	00	03	50	50	100
20 PCE 17L	Advanced Communication Laboratory			03	02	50	50	100
Total		**24**	**04**	**03**	**26**	**350**	**350**	**700**

Note: Two electives to be chosen from the list below: Elective will be offered for a minimum strength of six candidates (out of 18) / eight candidates (out of 24).

20 PCE14x: Elective - I		**20 PCE15x: Elective-II**		**20 PCE16x: Elective - III**	
20 PCE141	Advanced Wireless Communication	20PCE151	Wireless Adhoc and Sensor Networks	20PCE161	RF and Microwave circuit Design
20 PCE142	Advanced Data Networks	20PCE152	Statistical Signal Processing	20PCE162	Multimedia Communications
20 PCE143	Optical Communication and Networking	20PCE153	Cryptography and Network Security	20PCE163	Engineering Optimization

Second Semester

Subject Code	Course	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CIE	SEE	Total
20 PCE21	Antenna Theory and Design	04	00	00	04	50	50	100
20 PCE22	Error Control Coding	04	02	00	05	50	50	100
20 PCE23	Detection and Estimation	04	00	00	04	50	50	100
20 PCE24x	Elective- IV	04	00	00	04	50	50	100
20 PCE25x	Elective-V	04	00	00	03	50	50	100
20 OPE261	Open Elective	04	00	00	04	50	50	100
20 PCE27	Mini Project			03	02	50	50	100
Total		**24**	**02**	**03**	**26**	**350**	**350**	**700**

Note: Two electives to be chosen from the list below: Elective will be offered for a minimum strength of six candidates (out of 18) / eight candidates (out of 24).

20 PCE24x: Elective – IV		**20 PCE25x: Elective – V**		**20 OPE261:Open Elective**
20PCE241	Advances in Image Processing	20 PCE251	High Performance Computing	Machine Learning
20PCE242	MultirateSystems and Filter Banks	20 PCE252	Real Time Embedded Systems	----------

20PCE24 3	Millimeter Wave Technology	20 PCE253	Speech & Audio Processing	
20PCE24 4	Big Data Analytics	20PCE254	Soft Computing	

Third Semester

Code No.	Course	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CIE	SEE	Total
20 PCE31	Industrial Internship	00	00	06 weeks	05	50	50	100
20 PCE32	Project Phase-I	00	00	00	08	50	50	100
20 PCE33	Technical Seminar	00	00	03	01	100	--	100
20 PCE34	Certificate Course	00	00	00	02			
	Total	**00**	**00**	**00**	**16**	**200**	**100**	**300**

Expert Committee: Consists of minimum of 3 and maximum of 5 faculty members in the relevant field.

Project Phase I: Work will be for a period of 8 months out of which 3 months will be during III semester. During this semester, student has to carry out literature survey and finalize the objectives of the project work. CIE will be evaluated by concerned guide along with the expert committee on the basis of the literature collection (10 to 15 journal papers), Seminar delivered by the candidate. SEE will be evaluated by external and internal (Guide) examiners.

Industrial Visit/ Industrial Internship: During the vacation period or one month from the re-opening day of that semester, student has to visit at least one industry for stipulated period of four month and submit a report of their exposure in respective field and present a seminar before the expert committee for evaluation of the CIE marks.

SEE will be evaluated by external and internal examiners.

Fourth Semester

Code No.	Course	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CIE	SEE	Total
20 PCE41	Project Phase -II Internal Assessment	00	00	00	20	50	--	50
20 PCE42	Project Phase –II External Assessment					--	50	50
Total					**20**	**50**	**50**	**100**

*** MANDATORY:**The said NPTEL/MOOCs/SWAYAM courses of **Three Credit** is compulsary and every student must complete this professional certification course, anywhere from 1st to 4th sem and submit the copy of the certificate of course completion to COE for reflection of the same in the Grade card through proper channel. This completion of Certification course is made reflected only in 4^{th}Sem grade card.

The above said NPTEL/MOOCs/SWAYAM certification course is to be selected from the web portal. The subject which is not in the curriculum shall be selected and finalised with the consent of the respective HOD's/course coordinator.

CIE :Continuous Internal Evaluation; **SEE**– Semester End Examination
Expert Committee: Consists of minimum of 4 and maximum of 5 faculty members in the relevant field.

CIE: During fourth semester student has to present two seminars (one at the mid sem, another at the end of sem) on **PHASE-II**Before the expert committee for evaluation.
SEE: * Evaluation of project thesis by internal and external examiners.
** Candidate has to appear viva- voce examination in the presence of internal and external examiner.

Dean Academic **Principal**

ADVANCED ENGINEERING MATHEMATICS
(MATHEMATICAL FOUNDATIONS FOR COMMUNICATION ENGINEERS)

<table>
<tr><td colspan="2">Subject Code : 20PCE11</td><td colspan="2">Credits : 4:2:0</td></tr>
<tr><td>CIE : 50 Marks</td><td colspan="2">SEE : 50 Marks</td><td>SEE: 03 Hrs.</td></tr>
<tr><td colspan="2">Hours/Week: 4 hrs. (Theory) + 2 hrs tutorial</td><td colspan="2">Total Hours : 52</td></tr>
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Module-1

Introduction to Probability Theory: Experiments, Probability Space, Events, Axioms, Conditional probability, Baye's Theorem, Independence, Bernoulli Trials, Bernoulli's Theorem.
Random Variables, Distributions, Density Functions: CDF, PDF, Gaussian random variable, Other important random variables. **11Hrs**

Module-2

Operations on a single RV: Expected value, EV of random variables, EV of functions of random variables, Central Moments, Conditional expected values.
Characteristic functions: Probability generating functions, Moment generating functions, Engineering applications. **10Hrs**

Module-3

Random Process: Definition and classification, Mathematical tools for studying Random Processes, Stationary and Ergodic Random processes, Properties of Autocorrelation Function.
Example processes: Markov processes, Gaussian processes, Poisson processes, Engineering applications. **10Hrs**

Module-4

Matrices and Vector spaces: Geometry of system of linear equations, vector spaces and subspaces, linear independence, basis and dimension, four fundamental subspaces, Rank-Nullity theorem (without proof), linear transformations. **11Hrs**

Module-5

Orthogonality and Projections of vectors: Orthogonal Vectors and subspaces, projections and least squares, orthogonal bases and Gram- Schmidt orthogonalization, Computation of Eigen values and Eigen vectors, diagonalization of the matrix, Singular Value Decomposition. **10Hrs**

Course Objectives (COs)

CO 1: Demonstrate the understanding of fundamentals of matrix theory, probability theory andrandom process.
CO 2: Formulate and solve communication problems involving random variables.
CO 3: Analyze and solve problems on matrix analysis, probability distributions and multiple random variables.
CO 4: Understand the fundamental concepts in vector spaces, linear operators, matrices
CO 5: Estimate Orthogonality of vector spaces, Cumulative distribution function and Characteristic function.
Recognize problems that involve these concepts in engineering applications.

References:

1. Probability and Random Processes with Applications to Signal Processing and Communications,Scott. L. Miller and Donald. G. Childers, 2 nd Edition, Elsevier Academic.
2. Probability, Statistics and Random Processes, T. Veerarajan, 3rd Edition, Tata McGraw Hill Education Private Limited, 2008, ISBN:978-0-07-066925-3.Press, 2012, ISBN 9780121726515.
3. Linear Algebra and its Applications, Gilbert Strang, 4 th Edition, Cengage Learning, 2006, ISBN 97809802327.
4. Schaum's Outline of Linear Algebra, Seymour Lipschutz and Marc Lipson, 5 th Edition, McGraw Hill Education, 2012, ISBN-9780071794565.

ADVANCED DIGITAL COMMUNICATION

Subject Code : 20PCE12		**Credits : 4:2:0**
CIE : 50 Marks	**SEE : 50 Marks**	**SEE: 03 Hrs.**
Hours/Week: 3 hrs. (Theory) + 2 hrs tutorial		**Total Hours : 52**

Module 1

Optimum Receiver for signals corrupted by AWGN: Correlation demodulator, matched filter demodulator, optimum detector, maximum likelihood sequence detector, symbol by symbol MAP detector for signals with memory.Performance of the optimum receiver for memory less modulation: Probability of error for binary modulation, M – ary orthogonal signals, M-ary PAM, M-ary PSK, DPSK, QAM. Comparison of digital modulation methods.Optimum receiver for signals with random phase in AWGN:Optimum receiver for binary signals and M-ary orthogonal signals, probability of error for envelope detection of M-ary orthogonal signals. **10 Hrs**

Module 2

Communication through band limited linear filter Channels: Optimum receiver for channels with ISI and AWGN: Optimum maximum Likelihood Receiver, A discrete time model for a channel with ISI, Performance of MLSE for channels with ISI.Linear Equalization: Peak distortion criterion, Minimum-square error (MSE) criterion, Performance characteristics of the MSE equalizer.Decision Feedback Equalization: Coefficient optimization, performance characteristics ofDFE. Reduced complexity ML decoders, Iterative equalization and decoding.**11 Hrs**

Module 3

Adaptive Equalization: Adaptive linear equalization: the zero forcing equalization, the LMS algorithm. Adaptive Decision – Feedback Equalizer. Recursive least square algorithm for adaptive equalization: Recursive least-square (Kalman) algorithm. Self – Recovering (Blind) equalization: Blind equalization based on ML criterion. **09 Hrs**

Module 4

Spread spectrum signals for Digital Communication: Model of spread spectrum digital communication system. Direct sequence spread spectrum signals: Error rate performance of decoder, applications of DS spread spectrum, Generation of PN sequence. Frequency – hopped spread spectrum signals: Performance of FH spread spectrum signals in AWGN channel, A CDMA based on FH spread spectrum signals. Time hopping (TH) spread spectrum system.**10 Hrs**

Module 5

Digital Communication through fading multi-path channels: Characterization of fading multipath channels: Channel correlation functions and power spectra. Statistical models for fading channels. Effect of signal characteristics on the choice of a channel model.Frequency – nonselective, slowly fading channel. Diversity techniques' for fading multipath channels: for binary, multiphase and M-ary orthogonal signals. Digital signalling over a frequency-selective, slowly fading channel: A tapped delay line channel model, the RAKE demodulator and its performance. Multiple antenna systems. **12 Hrs**

Course Outcomes: - The students will be able to

CO1: Apply the knowledge of statistical theory of communication and explain the conventional digital communication system.

CO2: Apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise.

CO3: Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code.

CO4: Describe and analyse the digital communication system with spread spectrum modulation.

CO5: Design as well as conduct experiments, analyse and interpret the results to provide valid conclusions for digital modulators and demodulator using hardware components and communication systems using CAD tool.

References:

1. J. G Proakis, Digital Communications, 4^{th} edition, MH, 2001.
2. Stephen G. Wilson," Digital Modulation and Coding," Pearson Education (Asia).
3. KamiloFeher, "Wireless Digital Communications: Modulation and Spread Spectrum Applications," Prentice-Hall of India, 2004.
4. Andrew J.Viterbi, "CDMA: Principles of Spread Spectrum Communications," Prentice Hall, USA,1995.

RESEARCH METHODOLOGY

Subject Code : 20PCE13		**Credits : 4:0:0**	
CIE : 50 Marks	**SEE : 50 Marks**		**SEE: 03 Hrs.**
Hours/Week: 4 hrs. (Theory)		**Total Hours : 52**	

Module 1

Meaning, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research - Developing a research plan. **10hrs**

Module 2

Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem - Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - Reviews, treatise, monographs, patents - web as a source - searching the web - Identifying gap areas from literature review - Development of working hypothesis. **10hrs**

Module 3

Research design and methods – Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models - Developing a research plan - Exploration, Description, Diagnosis, and Experimentation - Determining experimental and sample designs. **12hrs**

Module 4

Sampling design - Steps in sampling design - Characteristics of a good sample design - Types of sample designs - Measurement and scaling techniques - Methods of data collection - Collection of primary data - Data collection instruments **10hrs**

Module 5

Testing of hypotheses - Basic concepts - Procedure for hypotheses testing flow diagram for hypotheses testing - Data analysis with Statistical Packages – Correlation and Regression - Important parametric test - Chi-square test - Analysis of variance and Covariance **10hrs**

Course Outcomes: The students will be able to

CO 1: Explain key research concepts issues and identify and discuss the role and importance of research in the social sciences.

CO 2: Identify and discuss the issues and concepts salient to the research process

CO 3: Identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.

CO 4: Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.

CO 5: Read, comprehend, and explain research articles in their academic discipline.

REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.

2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi

4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.

5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.

6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, CambridgeUniversity Press.

7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications

8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

9. Intellectual Property Rights in the Global Economy: Keith Eugene Maskus, Institute for International Economics, Washington, DC, 2000

10. Subbarau NR-Handbook on Intellectual Property Law and Practice-S Viswanathan Printers and Publishing Private Limited.1998

ADVANCED WIRELESSCOMMUNICATION

Subject Code : 20PCE141		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs (Theory)		Total Hours : 52

Module 1

Cellular concept: Frequency reuse, channel assignment strategies, handoff strategies; interference and system capacity, trunking and grade of service, improving coverage and capacity in cellular systems. TDMA, FDMA and CDMA techniques. **12 Hrs**

Module 2

Large scale path loss: Free space propagation model, relating power to electric field, reflection, ground reflection diffraction, scattering, practical link budget design using path loss models, outdoor propagation models, Longley Rice model, Durkin model, Okumura model. Indoor propagation models, Log-distance path loss model, attenuation factor model. **10 Hrs**

Module 3

Small scale multi-path propagation, factors influencing small scale model, impulse response model of a multi-path channel, small scale multi-path measurements, parameters of mobile multi-path channels, types of small scale fading, Rayleigh and Ricean distributions. Clarkes model for flat fading, spectral shape due to Doppler spread, level crossing and fading statistics, two ray fading model.

Module 4

Diversity Schemes: Macroscopic diversity scheme, Microscopic diversity scheme – Space diversity, Field diversity, Polarization diversity, Angle diversity, Frequency diversity and time diversity scheme. Combining techniques for Macroscopic diversity, Combining techniques for Microscopic diversity.

Module 5

Code Division Multiple Access:Introduction to CDMA technology, IS 95 system architecture, Air Interface, Physical and logical channels of IS 95, Forward Link and Reverse link operation, Physical and Logical channels of IS 95 CDMA, IS 95 CDMA Call Processing, soft Handoff, Evolution of IS 95 (CDMA One) to CDMA 2000, CDMA 2000 layering structure and channels.

Course Outcomes (COs):

CO 1: Apply frequency-reuse concept in mobile communications, and analyse its effectson interference, system capacity, handoff techniques.
CO 2: Analyse path loss and interference for wireless telephony and their influences on a mobile- communication system's performance.
CO 3: Analyse and design CDMA system functioning with knowledge of forward and reverse channel details, advantages and disadvantages of using the technology.

CO 4: Combine different diversity scheme to enhance system performance
CO 5: Identify the advantages of multicarrier modulation

References:

[1].Theodore S. Rappaport, Wireless Communications Principles and Practice, Third Edition, Pearson Education. (Indian Edition is available).
[2]. Andrea goldsmith, `Wireless Communication`, South Asia Edition 2015, Cambridge University Press
[3]David Tse, PramodViswanath, Fundamentals of WirelessCommunication, Cambridge University Press.
[4]. V.K.Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008.
[5]. V.K.Garg, "IS-95 CDMA and CDMA 2000", Pearson Education, 4th edition, 2009.

ADVANCED DATA NETWORKS

Subject Code : 20PCE142		**Credits : 4:0:0**
CIE : 50 Marks	**SEE : 50 Marks**	**SEE: 03 Hrs.**
Hours/Week: 4 hrs. (Theory)		**Total Hours : 52**

Module 1

Introduction: Message & switching, Layering, A distributed algorithm problem.

Physical Layer: Channels & Modems, Error detection, ARQ, Framing, Standard DLCs, Initialization & disconnect for ARQ protocols, PPP at network layer, the transport Layer, Broadband ISDN & the ATM. **12Hrs**

Module 2

Delay models in networks: Introduction, Queueing Models, M/M/1 Queueing system, M/M/m, M/M/∞, M/M/m/m & other Markov systems, M/G/1 system, Networks of transmission lines, Time reversibility, Networks of Queues.**8Hrs**

Module 3

Multi-access communication: Introduction, Slotted multi-access & aloha system, Splitting algorithms, Carrier sensing, Multi-access reservations, Packet Radio networks.**10Hrs**

Module 4

Routing in Data Networks: Introduction, Network algorithms & shortest path routing, Broadcasting routing information, coding with link failures, Flow models, optimal routing, & topological design, characterization of optimal routing, feasible direction methods for optimal routing, projection routing for optimal routing, routing in the codex networks. **12Hrs**

Module 5

Flow Control: Introduction, window flow control, rate control scheme, overview of flow control in practice, rate adjustment algorithms.**10Hrs**

Course Outcomes (COs):

CO1: To provide a basic understanding to the students, researchers with an expert knowledge to the basic concepts, design issues and also solutions to these issues, architectures, protocols and state of art researcher developments in Advanced data Networks.

CO2: To understand basic concepts of queueing theory and delay networks and utilize the potential of delay models.

CO3: To understand the details of multi-access communication and related protocols.

CO4 : To understand the routing issues and protocols in data networks.

CO5 :To understand the need for flow control and various important flow control strategies.

References:

1. W. Stallings, "Data and Computer Communications", 6th edition (PHI).
2. Alberto Leon Garceia, Communication Networks-Fundamental Concepts and Key Architeture.
3 A.S. Tanenbaum, "Computer Networks",4th edition(PHI).

OPTICAL COMMUNICATION & NETWORKING

Subject Code : 20PCE143		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs. (Theory)		Total Hours : 52

Module 1

Introduction: Propagation of signals in optical fiber, different losses, nonlinear effects, solitons, optical sources, detectors.

Optical Components: Couplers, isolators, circulators, multiplexers, filters, gratings, interferometers, amplifiers **10 Hrs**

Module 2

Modulation — Demodulation: Formats, ideal receivers, Practical detection receivers, Optical preamplifier, Noise considerations, Bit error rates, Coherent detection.

Transmission system engineering: system model, power penalty, Transmitter, Receiver, Different optical amplifiers, Dispersion. **11 Hrs**

Module 3

Optical networks: Client layers of optical layer, SONET/SDH, multiplexing, layers, frame structure, ATM functions, adaptation layers, Quality of service and flow control, ESCON, HIPPI. **10 Hrs**

Module 4

WDM network elements: Optical line terminal optical line amplifiers, optical cross connectors, WDM network design, cost tradeoffs, LTD and RWA problems, Routing and wavelength assignment, wavelength conversion, statistical dimensioning model. **10Hrs**

Module 5

Control and management: network management functions, management frame work, Information model, management protocols, layers within optical layer performance and fault management, impact of transparency, BER measurement, optical trace, Alarm management, configuration management. **11 Hrs**

References:

1. John M. Senior, "Optical Fiber Communications", Pearson edition, 2000.
2. Rajiv Ramswami, N Sivaranjan, "Optical Networks", M. Kauffman Publishers, 2000.
3. Gerd Keiser, "Optical Fiber Communication", MGH, 1 991.
4. G. P. Agarawal, "Fiber Optics Communication Systems", John Wiley NewYork, 1997.
5. P.E. Green, "Optical networks", Prentice Hall, 1994.

WIRELESS AD-HOC AND SENSOR NETWORKS

Subject Code : 20PCE151		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs. (Theory)		Total Hours : 52

Module 1

Ad-hoc MAC: Introduction – Issues in Ad-Hoc Wireless Networks. MAC Protocols – Issues, Classifications of MAC protocols, Multi- channel MAC & Power control MAC protocol. (**10 hrs)**

Module 2

Ad-hoc network routing & TCP issues: Classifications of routing protocols – Hierarchical and Power aware. Multicast routing – Classifications, Tree based, Mesh based. Ad Hoc Transport Layer Issues. TCP Over Ad Hoc – Feedback based, TCP with explicit link, TCP-BuS, Ad Hoc TCP, and Split TCP. **(11 hrs)**

Module 3

WSN-MAC, routing, localization &QoS issues: Introduction – Sensor Network Architecture, Data dissemination, Gathering. MAC Protocols self-organizing, Hybrid TDMA/FDMA and CSMA based MAC.OLSR, AODV. Localization – Indoor and Sensor Network Localization, QoS in WSN. **(11 hrs)**

Module 4

Platforms and Tools: Berkley motes, Sensor network programming challenges, Node level software platforms. Embedded Operating System, Tiny O.S. Nesc, data flow language – tiny GALS.Node level simulators: ns-2 and TOSSIM.**(10 hrs)**

Module 5

Mesh networks: Necessity for Mesh Networks, MAC enhancements, IEEE 802.11s Architecture, Opportunistic routing, Self- configuration and Auto configuration, Capacity Models, Fairness, Heterogeneous Mesh Networks and Vehicular Mesh Networks.**(10 hrs)**

References:

1. C.Siva Ram Murthy and B S.Manoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004.

2. Feng Zhao and Leonidas Guibas, “Wireless Sensor Networks”, Morgan Kaufman Publishers, 2004.

3. C.K.Toh, “Ad Hoc Mobile Wireless Networks”, Pearson Education, 2002.

4. Thomas Krag and SebastinBuettrich, “Wireless Mesh Networking”, O’Reilly Publishers, 2007.

STATISTICAL SIGNAL PROCESSING

Subject Code : 20 PCE152		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs. (Theory)		Total Hours : 52

Module 1

Random processes: Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes. **(10 hrs)**

Module 2

Signal Modeling: Least squares method, Padé approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schur recursion; Levinson recursion. **(10 hrs)**

Module 3

Spectrum Estimation: Nonparametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation. **(11 hrs)**

Module 4

Optimal and Adaptive Filtering: FIR and IIR Wiener filters, Discrete Kalman filter, FIR Adaptive filters: Steepest descent, LMS, LMS-based algorithms, adaptive recursive filters, RLS algorithm. **(10 hrs)**

Module 5

Array Processing: Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beam forming, linearly constrained minimum-variance beam-formers, side-lobe cancellers, space-time adaptive processing. **(11 hrs)**

References:

1. Monson H. Hayes, “Statistical Digital Signal Processing and Modelling," John Wiley & Sons (Asia) Pte. Ltd., 2002.

2. Dimitris G. Manolakis, Vinay K. Ingle, and Stephen M. Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing," McGraw-Hill International Edition, 2000.

3. Bernard Widrow and Samuel D. Stearns, "Adaptive Signal Processing," Pearson Education (Asia) Pte. Ltd., 2001.

4. Simon Haykin, "Adaptive Filters," Pearson Education (Asia) Pte. Ltd, 4th edition, 2002.

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

CRYPTOGRAPHY AND NETWORK SECURITY

Subject Code : 20 PCE153		**Credits : 4:0:0**
CIE : 50 Marks	**SEE : 50 Marks**	**SEE: 03 Hrs.**
Hours/Week: 4 hrs. (Theory)		**Total Hours : 52**

Module 1

Overview: Need for information security, Services, Mechanisms and attacks, OSI security architecture, Model for network security, Cryptography, Cryptanalysis and Brute-Force Attack.

Classical Encryption Techniques: Symmetric Cipher Model, , Substitution Techniques, Caesar Cipher, Mon alphabetic Cipher, Playfair Cipher, Hill Cipher, Polyalphabetic Cipher, One Time Pad(Vernam Cipher).

Block Ciphers and the Data Encryption Standard (DES) Algorithm: Traditional block Cipher structure, stream Ciphers and block Ciphers, Motivation for the Feistel Cipher structure, the Feistel Cipher, The Data Encryption Standard (DES) algorithm, Avalanche effect, Strength of DES, Timing attacks, Block cipher design principles, Introduction to Advanced Encryption Standard (AES). **(12Hrs)**

Module 2

Public-Key (Asymmetric Key) Cryptography and RSA Algorithm: Mathematics of Asymmetric Key Cryptography. Principles, Applications, and Requirements of public-key cryptosystems, public-key cryptanalysis.

The RSA algorithm: Description of the algorithm, Computational aspects, and Security of RSA.

Other Public-Key Cryptosystems: Key management, Diffie-Hellman key exchange algorithm, Elliptic curve arithmetic, Elliptic curve cryptography. **(10 Hrs)**

Module 3

Message Authentication and Cryptographic Hash Functions: Authentication Requirements and Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and MACs, Problems.

Digital Signature and Authentication Protocols: Digital Signature Schemes and Authentication Protocols, Digital Signature Standard (DSS), Attacks, Variations and Applications. **(1 0 Hrs)**

Module 4

Authentication Applications Entity/Message Authentication, Kerberos, Kerberos versions 4 and 5, X.509 authentication service, Kerberos Encryption technique, Problems. **(09 Hrs)**

Module 5

Security in Network based Applications

Electronic Mail Security: Pretty Good Privacy (PGP), S/MIME, Data Compression using ZIP, Radix-64 conversion, PGP random number generator.

IP Security: Overview, IP security architecture, Authentication header, Encapsulating Security Pay Load (ESP), Security associations, Key management.

Firewalls: Design principles, Trusted systems. **(11 Hrs)**

Course Outcomes (COs) :

1. Analyse the vulnerabilities, security threats, issues and service mechanisms in networking environments.

2. Understand and implement all classical and a popular symmetric key encryption technique (Data Encryption Standard (DES)).

3. Learn and apply public key cryptographic techniques for data security and key management applications.

4. Apply the knowledge on Hash functions and Digital signature schemes to provide data security, integrity, authentication and confidentiality.

5. Realize the role of security measures such as E-mail, Firewalls, and IP security in network based applications.

Reference

1. William Stallings, “Cryptography and Network Security”, Prentice Hall, 2nd edition.

2. William Stallings, “Cryptography and Network Security”, Pearson 6th edition.

3. BehrouzForouzan and DebdeepMukhopadhyay, “Cryptography and Network Security”, 3rd edition, Mc Graw Hill Education.

RF ANDMICROWAVE CIRCUIT DESIGN

Subject Code : 20 PCE161		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs. (Theory)		Total Hours : 52

Module 1

Wave Propagation in Networks: Introduction to RF/Microwave Concepts and applications, RF Electronics Concepts, Fundamental Concepts in Wave Propagation. **10 Hrs**

Module 2

Passive Circuit Design: The Smith Chart, Application of the Smith Chart in Distributed and lumped element circuit applications. Circuit Representations of two port RF/MW networks. **11 Hrs**

Module 3

Basic Considerations in Active Networks: Stability Consideration in Active networks, Gain Considerations in Amplifiers.Circuit Representations of two port RF/MW networks. **10 Hrs**

Module 4

Active Networks: Linear and Nonlinear Design: RF/MW Amplifiers Small Signal Design, Large Signal Design, RF/MW Oscillator Design, Noise Considerations in Active Networks.

11 Hrs

Module 5

RF/MW Frequency Conversion Rectifier and Detector Design, Mixer Design, RF/MW Control Circuit Design, RF/MW Integrated circuit design. **10 Hrs**

Reference Books:

1. Matthew M. Radmanesh, Radio Frequency and Microwave Electronics Illustrated, Pearson Education (Asia) Pte. Ltd., 2004.
2. Reinhold Ludwig and Pavel Bretchko, RF Circuit Design:Theory and Applications, Pearson Education (Asia) Pte. Ltd.,2004.
3. D K Mishra,RF Circuit Design, John Wiley, Intl.

ENGINEERING OPTIMIZATION

<table>
<tr><td colspan="2">Subject Code : 20 PCE162</td><td colspan="2">Credits : 4:0:0</td></tr>
<tr><td>CIE : 50 Marks</td><td colspan="2">SEE : 50 Marks</td><td>SEE: 03 Hrs.</td></tr>
<tr><td colspan="2">Hours/Week: 4 hrs. (Theory)</td><td colspan="2">Total Hours : 52</td></tr>
</table>

Module 1

Motivation, mathematical review, matrix factorizations, sets and sequences, convex sets and functions, Linear programming and simplex method. **11 Hrs**

Module 2

Weierstras's theorem, Karush Kuhn Tuker optimality conditions, algorithms, convergence, unconstrained optimization. **10 Hrs**

Module 3

Line search methods, method of multidimensional search, steepest descent methods, Newton's method, modifications to Newton's method. **11 Hrs**

Module 4

Trust region methods conjugate gradient methods, quasi-Newton's methods. Constrained optimization, penalty and barrier function methods augmented Lagrangian methods. **10 Hrs**

Module 5

Polynomial time algorithm for linear programming, successive linear programming, and successive quadratic programming. **10 Hrs**

References:

1) R. Fletcher, Practical Optimization (2nd Edition) John Wiley & Sons, New York, 1987.

2) M.S.Bazara, H.D.Sherali and C.Shetty, Nonlinear Programming, Theory and Algorithms, John Wiley and Sons, New York, 1993.

MULTIMEDIA COMMUNICATIONS

Subject Code : 20PCE163		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs. (Theory)		Total Hours : 52

Module 1

Multimedia communications: multimedia information representation, multimedia networks, multimedia applications, network QoS and application QoS. Information representation: text, images, audio and video, Text and image compression, compression principles, text compression, image compression. (10 Hrs)

Module 2

Audio and video compression, audio compression, video compression, video compression principles, video compression standards: H.261, H.263, P1.323, MPEG 1, MPEG 2. Other coding formats for text, speech, image and video. (10 Hrs)

Module 3

Detailed study of MPEG 4: coding of audiovisual objects, MPEG 4 systems, MPEG 4 audio and video, profiles and levels. MPEG 7 standardization process of multimedia content description, MPEG 21 multimedia framework, significant features of JPEG 2000, MPEG 4 transport across the Internet. (11 Hrs)

Module 4

Synchronization: Notion of synchronization, presentation requirements, reference model for synchronization, Introduction to SMIL, Multimedia operating systems, Resource management, and process management techniques. (10 Hrs)

Module 5

Multimedia communication across networks: Layered video coding, error resilient video coding techniques, multimedia transport across IP networks and relevant protocols such as RSVP, RTP, RTCP, DVMRP, multimedia in mobile networks, multimedia in broadcast networks, Content based retrieval in digital libraries. (11 Hrs)

References
1. Ze-Nian Li & Mark S.Drew, “Fundamentals of Multimedia”, Pearson Edition, 200
2. J-R. Ohm, “Multimedia Communication Technology”, Springer International Edition.
3. V.Bhaskaran and K.Konstantinedes, “Image and Video Compression Standards,
4. Algorithms and Architecture”, 2 nded, Kluwer publications, 1997
5. Fred Halsall, “Multimedia communications”, Pearson education, 2001

ANTENNA THEORY & DESIGN

Subject Code : 20PCE21		Credits : 4:0:0
CIE : 50 Marks	**SEE : 50 Marks**	**SEE: 03 Hrs.**
Hours/Week: 4 hrs. (Theory)		**Total Hours : 52**

Module 1

Antenna Fundamentals and Definitions: Radiation mechanism - over view, Electromagnetic Fundamentals, Solution of Maxwell’s Equations for Radiation Problems, Ideal Dipole, Radiation Patterns, Directivity and Gain, Antenna Impedance, Radiation Efficiency. Antenna Polarization. **(10 Hrs)**

Module 2

Resonant Antennas: Wires and Patches, Dipole antennas, Yagi - Uda Antennas, Micro strip Antenna.

Broad band Antennas: Travelling - wave antennas, helical antennas, Biconical antennas, sleave antennas, and Principles of frequency - independent Antennas, spiral antennas, and Log - Periodic Antennas.

Aperture Antennas: Reflector antennas - Parabolic reflector antenna principles, Axi -symmetric parabolic reflector antenna, offset parabolic reflectors, dual reflector antennas. **(12 Hrs)**

Module 3

Arrays: Array factor for linear arrays, uniformly excited, equally spaced Linear arrays, pattern multiplication, directivity of linear arrays, non- uniformly excited -equally spaced linear arrays, Mutual coupling, multidimensional arrays, phased arrays, feeding techniques, perspective on arrays. **(10 Hrs)**

Module 4

Antenna Synthesis: Formulation of the synthesis problem, synthesis principles, line sources shaped beam synthesis, linear array shaped beam synthesis — Fourier Series, Woodward — Lawson sampling method, comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods DolphChebyshev linear array, Taylor line source method. **(10 Hrs)**

Module 5

Method of Moments: Introduction to method of Moments, Pocklington's integral equation, integral equations and Kirchoff's Networking Equations, Source Modelling, Weighted residuals formulations and computational consideration, calculation of antenna and scatter characteristics. **(10 Hrs)**

Course Outcomes (CO s)

1.Describe fundamental concepts of antenna radiation and standard antenna parameters.

2.Comprehend the concepts of design and analysis of simple antennas.

3.Design and analyze antenna arrays with required radiation pattern characterization.

4. Realize mutual impedance effects in the context of antenna arrays.

5. Explain the role of computational electromagnetic methods in the design of antennas and evaluate the requirements, potential design options for antenna applications.

References:

1.Stutzman& Thiele, "Antenna theory &Desugn", 2nd Ed,Johnwiley& Sons Inc.

2.C.A.Balanis;Antenna Theory Analysis &Design,John Wiley. 2nd ed, 1997.

3.Kraus:Antennas,McGraw Hill,TMH,3rd Ed,2003.

4.Kraus&R.J.Marhefka:Antennas,McGeaw Hill,2nd Edition,1998.

ERROR CONTROL CODING

Subject Code : 20PCE22		**Credits : 4:1:0**
CIE : 50 Marks	**SEE : 50 Marks**	**SEE: 03 Hrs.**
Hours/Week: 4 hrs. (Theory) + 2 hrs (Tutorial)		**Total Hours : 52**

Module 1

Introduction to Algebra: Groups, Fields, Binary Field Arithmetic, Construction of Galois Field and its basic properties, Computation using Galois Field Arithmetic, Vector spaces and Matrices. **(10Hrs)**

Module 2

Linear Block Codes: Generator and Parity check Matrices, Encoding circuits, Syndrome and Error Detection, Minimum Distance Considerations, Error detecting and Error correcting capabilities, Standard array and Syndrome decoding, Decoding circuits, Hamming Codes, Reed Muller codes, The (24, 12) Golay code, Product codes and Interleaved codes. **(10 Hrs)**

Module 3

Cyclic Codes: Introduction, Generator and Parity check Polynomials, Encoding using Multiplication circuits, Systematic Cyclic codes – Encoding using Feedback shift register circuits, Generator matrix for Cyclic codes, Syndrome computation and Error detection, Meggitt decoder, Error trapping decoding, Cyclic Hamming codes, The (23, 12) Golay code, Shortened cyclic codes. **(10 Hrs)**

Module 4

BCH Codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field Arithmetic, Non – binary BCH codes: q – ary Linear Block Codes, Primitive BCH codes over GF (q), Reed – Solomon Codes, Decoding of Non – Binary BCH and RS codes: The Berlekamp - Massey Algorithm. **(10 Hrs)**

Module 5

Convolutional Codes: Encoding of Convolutional codes, Structural properties, Distance properties, Viterbi Decoding Algorithm for decoding, Soft – output Viterbi Algorithm, Stack and Fano sequential decoding Algorithms, Majority logic decoding.

Concatenated Codes & Turbo Codes: Single level Concatenated codes, Multilevel Concatenated codes, Soft decision Multistage decoding, Concatenated coding schemes Introduction to Turbo codes, LDPC codes**. (12Hrs)**

Course Outcomes: Students will be able to

CO 1: Understand the concepts of groups, fields, galois fields, vector spaces and matrices.

CO 2: Design encoder and decoder circuits of linear block codes and apply these designs to realise different linear block codes.

CO 3: Analyse different encoding and decoding techniques of cyclic codes and apply these techniques to realise different cyclic codes.

CO 4: Analyse different decoding techniques in BCH and non-binary BCH codes.

CO 5: Design encoder, decoder using Viterbi algorithm and Soft-Viterbi algorithm for convolution codes, Understand majority-logic decoding and concatenated codes, turbo codes and LDPC codes.

References:

1. Shu Lin & Daniel J. Costello, Jr., "Error Control Coding" Pearson /PHI 2nd Edition, 2004.

2. Blahut, R.E. "Theory and Practice of Error Control Codes" Addison Wesley, 1984.

3. F.J.Mac Williams &N.J.A.Slone, "The theory of error correcting codes" North Holland, 1977.

4. Peterson,W.W. & Weldon, E.J. "Error-Correcting Codes" MIT Press, Cambridge, 1972.

5. Das J, Mullick, S.K. &Chaterjee.P.K, "Principles of Digital Communications" Wiley, 1986.

6. Satyanarayana P.S., "Concepts of Information Theory & coding", Dynaram Publications.

DETECTION AND ESTIMATION

Subject Code : 20 PCE23		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs. (Theory)		Total Hours : 52

Module 1

Classical Detection and Estimation Theory: Introduction, simple binary hypothesis tests, M Hypotheses, estimation theory, composite hypotheses. (11 hrs)

Module 2

Representations of Random Processes: Introduction, orthogonal representations, random process characterization, homogenous integral equations and eigen-functions, periodic processes, spectral decomposition, vector random processes. (11 hrs)

Module 3

Detection of Signals-Estimation of Signal Parameters: Introduction, detection and estimation in white Gaussian noise, detection and estimation in nonwhite Gaussian noise, signals with unwanted parameters, multiple channels and multiple parameter estimation. (10 hrs)

Module 4

Estimation of Continuous Waveforms: Introduction, derivation of estimator equations, a lower bound on the mean-square estimation error, multidimensional waveform estimation, nonrandom waveform estimation. (10 hrs)

Module 5

Linear Estimation: Properties of optimum processors, realizable linear filters, Kalman-Bucy filters, fundamental role of optimum linear filters. (10 hrs)

Course Outcomes

CO 1: Learn about basic Estimation Methods: Maximum Likelihood Estimation, Maximum A Posterior i Estimation, Minimum VarianceUnbiased Estimation, Minimum Mean Square Error Estimation, Linear Minimum Mean Square Error Estimation and Kalman Filtering.
CO 2: Learn about basic estimator properties such as Bias, Efficiency, Linearity
CO 3: Learn Classical and Bayesian Estimation Approaches
CO 4: Learn Basic Estimation Performance Bounds such as Cramer-Rao Bound
CO 5: Gain ability to apply estimation methods to real engineering problems.

References

1. Harry L. Van Trees, "Detection, Estimation, and Modulation Theory," Part I, John Wiley & Sons, USA, 2001.

2. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan, "Introduction to Statistical Signal Processing with Applications," Pearson Education (Asia) Pte. Ltd. /Prentice Hall of India, 2003

3. Steven M. Kay, "Fundamentals of Statistical Signal Processing," Volume I: "Estimation Theory", Prentice Hall, USA, 1998;

4. Steven M. Kay, "Fundamentals of Statistical Signal Processing, "Volume II: "Detection Theory," Prentice Hall, USA, 1998.

5. Louis L Scharf, "Statistical Signal Processing: Detection, Estimation and Time series Analysis", Addison Wesley, 1991

6. K Sam Shanmugam, Arthur M Breipohl, "Random Signals: Detection, Estimation and Data Analysis", John Wiley & Sons, 1998.

Advanced Image Processing

Subject Code : 20 PCE241		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs. (Theory)		Total Hours : 52

Module 1

Digital Image Fundamentals: Introduction, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations. **10Hrs**

Module 2

Image Transforms: Discrete Fourier Transform,Discrete Cosine Transform,Haar Transform, Hadamard Transform.

Image Enhancement: Enhancement by point processing, Spatial Operations, Enhancement in the frequency domain. **8 Hrs**

Module 3

Image Filtering and Restoration: Image observation models,Inverse and Weiner Filtering, Least squares Filters.

Fundamental Concepts of: Edgedetection, Boundary extraction,Boundary and Region representation.**10 Hrs**

Module 4

Image Segmentation: Discontinuity detection, Thresholding, Region Oriented Segmentation. **7Hrs**

Module 5

Color Image Processing: Color Fundamentals, Color Models, Pseudo color Processing.

Morphological Image Processing: Dilation and Erosion, Opening and Closing, Some basic morphological algorithms, Extensions to gray level images. **7Hrs**

Reference Books

1. Fundamentals of Digital Image Processing, Anil K. Jain, Pearson Education, 2001.

2. Digital Image Processing, Rafael C.Gonzalez, Richard E. Woods, etl , TMH , 2nd Edition 2010.

3. Digital Image Processing and Analysis, B. Chanda and D. Dutta Majumdar, PHI, 2003.

Course Objectives

1. Give exposure to the basics of formation and representation of images.

2. Explain various image transforms and basics of image enhancement techniques.

3. Provide concepts to know the effect of image filtering, restoration and learn the fundamentals of: Edge detection, Boundary extraction, Boundary and Region representation.

4. Give exposure Learn the basics of Image Segmentation and its importance in image processing.

5. Learn basics of colour images and their processing and uunderstand morphological operators and basics of morphological image processing.

Course outcomes (COs)

Upon successfully completing the course, the student should be able to:

CO 1: Understand the basics of formation and representation of images.

CO 2: Understand various image transforms and basics of image enhancement techniques.

CO 3: Know the effect of image filtering, restoration and learn the fundamentals of :Edge detection, Boundary extraction, Boundary and Region representation.

CO 4: Learn the basics of Image Segmentation and its importance in image processing.

CO 5: Learn basics of colour images and their processing and uunderstand morphological operators and basics of morphological image processing.

MULTIRATE SYSTEMS AND FILTER BANKS

<table>
<tr><td colspan="2">Subject Code : 20 PCE242</td><td colspan="2">Credits : 4:0:0</td></tr>
<tr><td>CIE : 50 Marks</td><td colspan="2">SEE : 50 Marks</td><td>SEE: 03 Hrs.</td></tr>
<tr><td colspan="2">Hours/Week: 4 hrs. (Theory)</td><td colspan="2">Total Hours : 52</td></tr>
</table>

Module 1

Fundamentals of Multirate systems: Basic Multirate operations, Interconnection of building blocks,Polyphase representation, multistage implementation, Applications of multirate systems. Special filters & filter banks. **(10Hrs)**

Module 2

Maximally decimated filter banks: Errors created in the QMF bank, alis-free QMF system, power symmetric QMF banks,M-channel filter,banks,polyphase representation, perfect reconstruction systems,alisfree filter banks, tree structured filter banks, trans-multiplexers. **(11Hrs)**

Module 3

Li**near phase perfect Reconstruction QMF banks:** Necessary conditions, lattice structures for linear phase FIR PR QMF lattice.

Para-unitary perfect reconstruction filters banks: Lossless transfer matrices, Filter banks properties induced by paraunitariness, two channel Para-Unitary Lattices, M-Channel FIR Para-Unitary QMF banks. **(11Hrs)**

Module 4

Cosine Modulated Filter Banks: Pseudo-QMF bank and its design, efficient poly-phase structures, properties of cosine matrices, cosine modulated perfect reconstruction system. (1**0Hrs)**

Module 5

Wavelet Transform: Short-Term Fourier Transform, Wavelet Transform, discrete-time ortho-normal wavelets, continuous time ortho-normal wavelets. (1**0Hrs)**

References

1) P.P Vaidyanathan,"Multirate Systems amd Filter Banks," Pearson Education(Asia) Pte.Ltd, 2004.

2) Gilbert Strang and Truong Nguyen,"Wavelets and Filter Banks," Wellesley-Cambridge Press, 1996.

3) N.J Fliege,"Multirate Digital Signal Processing," John Wiley & Sons, USA, 2000.

MILLIMETER WAVE TECHNOLOGY

Subject Code : 20 PCE243		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs. (Theory)		Total Hours : 52

Module-1

Introduction: A Preview of MmWave Implementation Challenges, Emerging Applications of MmWave Communications, MmWave Standardization. **(9 Hrs)**

Module-2

Radio Wave Propagation for MmWave: Large-Scale Propagation Channel Effects, SmallScale Channel Effects, Spatial Characterization of Multipath and Beam Combining, Angle Spread and Multipath Angle of Arrival, Antenna Polarization, Outdoor and Indoor Channel Models. **(10 Hrs)**

Module-3

Antennas and Array for MmWave Applications: Fundamentals of On-Chip and In-Package MmWave Antennas, Fundamentals of On-Chip and In-Package MmWave Antennas, InPackage Antennas, Antenna Topologies for MmWave Communications, Techniques to Improve Gain of On-Chip Antennas, Adaptive Antenna Arrays — Implementations for MmWave Communications, Characterization of On-Chip Antenna Performance. **(11 Hrs)**

Module-4

Multi-Gbps Digital Baseband Circuits: Review of Sampling and Conversion for ADCs and DACs, Device Mismatches: An Inhibitor to ADCs and DACs, Goals and Challenges in ADC Design, Encoders, Trends and Architectures for MmWave Wireless ADCs, Digital to Analog Converters. **(11 Hrs)**

Module-5

MmWave Physical Layer Design and Algorithms: Practical Transceivers, High-Throughput PHYs, PHYs for Low Complexity, High Efficiency, Future PHY Considerations, Challenges when Networking mmWave Devices. **(11 Hrs)**

Course Outcomes – The students will be able to

CO1: Be able to explain the fundamental concepts of Mm Wave Wireless Communication.

CO2: Be able to analyze various channel effects in Mm Wave communication scenario and understand various design considerations.

CO3: To get exposed to the goals and challenges of new emerging applications of Mm Wave in Wireless Communications.

CO4: Be able to analyze challenges and various emerging applications of Mm Waves in Wireless Communications research field.

CO5: Be able to review the literature related to Mm wave for Wireless Communication and to report it ethically.

References:

1. Theodore S. Rappaport, Robert W. Heath Jr., Robert C. Daniels, James N. Murdock, Millimeter Wave Wireless Communications, Prentice Hall, 2014.

2. Prakash Bhartia, and Inder Bahl, MmWave Engineering and Applications, WileyInterscience

BIG DATA ANALYTICS

Subject Code : 20 PCE244		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs. (Theory)		Total Hours : 52

Module-1

INTRODUCTION TO NoSQL and BIG DATA

Classification of Digital Data: Structured, Semi-Structured and Unstructured data. NoSQL: Where is it used?, What is it?, Types of NoSQL Databases, Why NoSQL?, Advantages of NoSQL, SQL versus NoSQL, NewSQL, Comparison of SQL, NoSQL and NewSQL.

Elasticsearch: Talking to Elastic Search: Document Oriented, Finding your feet, Life inside Cluster: Scale Horizontally, Coping with Failure, Data-in Data-out: Document Metadata, Indexing a document, Retrieving a document.

Introduction to Big Data: Distributed file system – Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. **11Hrs**

Module-2

HADOOP ARCHITECTURE

Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read, NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration – HDFS Administering –Monitoring & Maintenance. **10Hrs**

Module-3

HADOOP ECOSYSTEM AND YARN

Hadoop ecosystem components - SPARK, FLUME, Hadoop 2.0 New Features- NameNode High Availability, HDFS Federation, MRv2, YARN. **10Hrs**

Module-4

Real-Time Applications in the Real World

Using HBase for Implementing Real-Time Applications- Using HBase as a Picture Management System Using Specialized Real-Time Hadoop Query Systems Apache Drill, Using Hadoop-Based EventProcessing Systems HFlame, Storm. **11Hrs**

Module-5

HIVE AND HIVEQL, HBASE

Hive Architecture and Installation, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating. HBase concepts- Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.

10Hrs

Reference Books:

1. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilly, 2012, ISBN -13: 978 1449311520, ISBN-10: 1449311520.

2. Eric Sammer, "Hadoop Operations", O'Reilly, 2012, ISBN -13 978-1449327057, ISBN-10: 1449327052

3. Vignesh Prajapati, Big data analytics with R and Hadoop, 2013, ISBN -13: 978- 1782163282

4. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilly, 2012, ISBN - 13: 978-1449319335

HIGH PERFORMANCECOMPUTING

Subject Code : 20 PCE251		**Credits : 4:0:0**
CIE : 50 Marks	**SEE : 50 Marks**	**SEE: 03 Hrs.**
Hours/Week: 4 hrs. (Theory)		**Total Hours : 52**

Module 1

Review of few important C concepts: C Programming basics, Linux basics, Compiling, Running a Program, Data Types – Array, Pointer, Dynamic Memory Allocation. (10 Hrs)

Module 2

An introduction to Multi-core/ GPU Computing: Why GPU/Parallel Computing? Differences between GPUs and CPUs, Accelerated Processing Unit (APU), Parallel Computing and Alternatives to Parallel Computing. (10 Hrs)

Module 3

Architecture of some recent CPUs and GPUs: Intel Dual Core Processors, Nvidia Fermi, AMD Fusion, Broadband Engine, PCI-Express Vs PCI.

Introduction to parallel programming: Parallel Algorithms, Task and data decomposition, Parallel computing, Software models, Hardware architectures, Parallel Programming Challenges. (11Hrs)

Module 4

OpenCL Architecture: Comparison with other programming models - Platform Model Execution Model, Memory Model, Programming Model, Open CL Buffers with examples in Image processing. (11Hrs)

Module 5

GPU memories: Bank Conflicts, Memory Coalescing, Threading and Scheduling, Programming Multi Device, Event Timing and Profiling, Performance Optimization. (10 Hrs)

References

1. J. Dongara, I. Foster, G. Fox, W. Cropp et al, "Sourcebook of Parallel Programming", Morgan Kaufmann.
2. Barbara Chapman, Gabriele Jost et.al, "Using OpenMP: Portable Shared Memory Parallel Programming", Scientific and Engineering Computation, MIT 2008.
3. B. Wilkinson and M. Allen, "Parallel Programming: Techniques and Applications", Prentice Hall.
4. S. Akhter and J. Roberts, "Multi-Core Programming–Performance through Multi-threading", Intel Press, 2006
5. David B. Kirk and Wen-mei W. Hwu, "Programming Massively Parallel Processors: A Hands-on Approach (Applications of GPU Computing Series)", Elsevier Press, 2010
6. D. Kirk and W. Hwu, "Programming Massively Parallel Processors", Morgan Kaufmann, ISBN: 978-0-12-381472-2, Guide, May 2011.

REAL TIME EMBEDDED SYSTEMS

Subject Code : 20PCE252		**Credits : 4:0:0**
CIE : 50 Marks	**SEE : 50 Marks**	**SEE: 03 Hrs.**
Hours/Week: 4 hrs. (Theory)		**Total Hours : 52**

Module 1

Introduction: Real Time System, Types, Real Time Computing, Design Issue, Sample Systems, Hardware System Memories, System I/O, Other Hardware Devices (A/D, D/A, USART, Timers, Watchdog Timers) .Interrupt Servicing Mechanism and Interrupt Latency. **(09 Hrs)**

Module 2

Embedded Systems: Introduction, Embedded Hardware units and devices in a system, Embedded Software in a system, Overview of Programming languages, Classifications and examples of embedded systems, Design process and challenges in embedded systems, System Architecture for Embedded System, High Performance Processors - Strong ARM processors. **(11 Hrs)**

Module 3

RTOS-1: Fundamental Requirements of RTOS, Multiple processes and multiple threads in an applications, Tasks and thread states, Task and data, Interprocess Communication and Synchronization, Signals, Concept of Semaphores, Uses of single and multiple semaphores, Semaphore types, Shared data problems, Scheduler, Scheduling modules. **(12 Hrs)**

Module 4

RTOS-II: Device and I/O Subsystem Management, Memory and File management- Pipelining and Cache memories, Paging and Segmentation, Fragmentation, Address Translation.RTOS interrupt latency and response times of tasks as performance matrices, OS Performance guidelines. **(10 Hrs)**

Module 5

Embedded System Testing, Simulation, Debugging Techniques and Tools: Integration and testing for Embedded Hardware, Testing methods, Debugging Techniques.

Simulation tool softwares: Introduction to VX Works/Mucos/pSOS: Example systems. **(10 Hrs)**

References:

1. David E. Simon, "An Embedded software primer", Pearson Education, 1999.
2. Philip. A. Laplante, "Real-Time Systems Design and Analysis- an Engineer's Handbook"- Second Edition, PHI Publications.
3. Jane W.S. Liu, "Real-Time Systems", Pearson Education Inc., 2000.
4. Rajkamal, "Embedded Systems: Architecture, Programming and Design", Tata McGraw Hill, New Delhi, 2003.
5. Dr. K.V.K K Prasad, "Embedded Real Time Systems: Concepts Design and Programming", Dreamtech Press New Delhi, 2003.
6. David A. Evesham, "Developing real time systems – A practical introduction", Galgotia Publications, 1990
7. C. M. Krishna, "Real Time Systems" MGH, 1997

SPEECH AND AUDIO PROCESSING

Subject Code : 20 PCE253		**Credits : 4:0:0**
CIE : 50 Marks	**SEE : 50 Marks**	**SEE: 03 Hrs.**
Hours/Week: 4 hrs. (Theory)		**Total Hours : 52**

Module 1

Digital models for the speech signal: Process of speech production, Acoustic theory of speech production, Lossless tubes models, and Digital models for speech signals.

Time domain models for speech processing: Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech vs silence discrimination using energy & zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, Median smoothing. **(10 Hrs)**

Module 2

Digital representations of the speech waveform: Sampling speech signals, Instantaneous quantization, Adaptive quantization, Differential quantization, Delta Modulation, Differential PCM, Comparison of systems, direct digital code conversion. **(06 Hrs)**

Short time Fourier analysis: Linear Filtering interpretation, Filter bank summation method, Overlap addition method, Design of digital filter banks, Implementation using FFT, Spectrographic displays, Pitch detection, Analysis by synthesis, Analysis synthesis system. **(06 Hrs)**

Module 3

Homomorphic speech processing: Homomorphic systems for convolution, Complex cepstrum, Pitch detection, Formant estimation, Homomorphicvocoder. **(04 Hrs)**

Linear predictive coding of speech: Basic principles of linear predictive analysis, Solution of LPC equations, and Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Synthesis of speech from linear predictive parameters, Applications. **(06 Hrs)**

Module 4

Speech Enhancement: Spectral subtraction & filtering, Harmonic filtering, parametric re-synthesis, Adaptive noise cancellation. **(02 Hrs)**

Speech Synthesis: Principles of speech synthesis, Synthesizer methods, Synthesis of intonation, Speech synthesis for different speakers, Speech synthesis in other languages, Evaluation, Practical speech synthesis. **(04 Hrs)**

Automatic Speech Recognition: Introduction, Speech recognition vs. Speaker recognition, Signal processing and analysis methods, Pattern comparison techniques, Hidden Markov Models, Artificial Neural Networks. **(06 Hrs)**

Module 5

Audio Processing: Auditory perception and psychoacoustics - Masking, frequency and loudness perception, spatial perception, Digital Audio, Audio Coding - High quality, low-bit-rate audio coding standards, MPEG, AC-3, Multichannel audio - Stereo, 3D binaural and Multichannel surround sound. **(08 Hrs**

References:

1. L. R. Rabiner and R. W. Schafer**,** "Digital Processing of Speech Signals," Pearson Education (Asia) Pte. Ltd., 2004.
2. D. O'Shaughnessy, "Speech Communications: Human and Machine," Universities Press, 2001.
3. L. R. Rabiner and B. Juang, "Fundamentals of Speech Recognition," Pearson Education (Asia) Pte. Ltd., 2004.
4. Z. Li and M.S. Drew**,** "Fundamentals of Multimedia," Pearson Educatio n (Asia) Pte. Ltd., 2004.
5. Jayant and Noll., Principles and applications to speech and video.

SOFT COMPUTING

Subject Code : 20PCE254		**Credits : 4:0:0**
CIE : 50 Marks	**SEE : 50 Marks**	**SEE: 03 Hrs.**
Hours/Week: 4 hrs. (Theory)		**Total Hours : 52**

Module 1

Evolution of Computing, Soft Computing constituents, From conventional AI to computational intelligence, Machine learning basics, Probabilistic reasoning and Bayesian networks.**(10Hrs)**

Module 2

Fuzzy Sets, Fuzzy Logic, Operations on Fuzzy Sets, Fuzzy Relations, Fuzzy Numbers, Linguistic variables, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems. **(10 Hrs)**

Module 3

AdaptiveNeuro- Fuzzy Inference Systems,Coactive Neuro-Fuzzy Modeling, Advanced Neuro-Fuzzy Modelling:Classification and Regression Trees, Data Clustering Algorithms. **(10 Hrs)**

Module 4

Adaptive Networks: Introduction, Architecture, Backpropagation for Feedforward networks, Extended backpropagation for Recurrent networks, Hybrid learning rule. Supervised Learning Neural Networks: Introduction, Perceptrons, Adaline, Backpropagation Multilayer Perceptrons, RBF Networks, Modular Networks, andXOR Problem. **(11 Hrs)**

Module 5

Fuzzy Decision Making: General discussion, Individual decision making, Multiperson decision making, Multicriteria decision making, Multistage decision making, Fuzzy ranking methods.

Engineering Applications: Introduction, Computer engineering, Reliability theory and Robotics.

Miscellaneous Applications: Introduction, Fuzzy systems and Genetic algorithms, Fuzzy regression and Interpersonal communication.**(12 Hrs)**

References

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, “Neuro-Fuzzy and Soft Computing”, A computational approach to learning and machine intelligence, Pearson, 2016.

2. Kwang H.Lee, “First course on Fuzzy Theory and Applications”, Springer, 2005.

3. George J. Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic-Theory and Applications”, Pearson 2018.

4. James A. Freeman and David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques”,

Addison Wesley, 2003.

5. Neural Networks, S. Haykin, Pearson Education, 2ed, 2001.

6. Learning and Soft Computing, V. Kecman, MIT Press, 2001.

MACHINE LEARNING

Subject Code : 20 OPE261		Credits : 4:0:0
CIE : 50 Marks	SEE : 50 Marks	SEE: 03 Hrs.
Hours/Week: 4 hrs. (Theory)		Total Hours : 52

Module 1

Introduction to Machine Learning, ML vs DL vs AI — What's the Difference? Why Machine Learning is the Future, Data Preprocessing.

REGRESSION: Simple Linear Regression, Multiple Linear Regression, Polynomial Regression, Support Vector Regression, Decision Tree Regression, Random Forest Regression, Evaluating Regression Models Performance. **11Hrs**

Module 2

Classification: Logistic Regression, K- Nearest Neighbors, Support Vector Machine(SVM), Kernel SVM, Naive Bayes, decision Tree Classification, Random Forest Classification, Evaluating Classification Models Performance. **11Hrs**

Module 3

Clustering: K-means clustering, K-mean Random Initialisation Trap, K-mean Selecting the Number of Clusters, **Hierarchical Clustering:** Dendrograms, Hierarchical Clustering using Dendrograms. **10Hrs**

Module 4

Deep Learning: Artificial Neural Network: Plan of attack The Neuron, The Activation Function,How do Neural Networks work?, How do Neural Networks learn?,Gradient Descent, Stochastic Gradient Descent,Backpropagation, Business Problem Description.

Convolution Neural Network: Plan of attack, What are convolutional neural networks?, Convolution Operation, ReLU Layer, Pooling, Flattening, Full Connection, Softmax & Cross-Entropy. **10Hrs**

Module 5

Dimensionality Reduction: Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA). Kernel PCA.

Model Selection & Boosting: K-Fold Cross Validation in Python, Grid Search in Python, k-Fold Cross Validation, Grid Search. **10Hrs**

Course Outcomes: The students will be able to -

CO 1: Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.

CO 2: Have an understanding of the strengths and weaknesses of many popular machine learning approaches.

CO 3: Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.

CO 4: Understand the concept behind neural networks for learning non-linear functions.

CO 5: Be able to design and implement various machine learning algorithms in a range of real-world applications.

References:

1. Pattern Recognition and Machine Learning, Christopher Bishop, Springer 2006

2. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Education (INDIAN EDITION), 2013

3. EthemAlpaydin, “Introduction to Machine Learning”, 2nd Ed., PHI Learning Pvt. Ltd., 2013.

4. T. Hastie, R. Tibshirani, J. H. Friedman, “The Elements of Statistical Learning”, Springer; 1st edition, 2001.

5. Introduction to Statistical Learning, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 2013.

6. Pattern Classification, 2nd Ed., Richard Duda, Peter Hart, David Stork, John Wiley & Sons, 2001.