

4. Kalyanmoy Deb, "Optimization for Engineering Design, Algorithms and Examples", PHI Learning Pvt Ltd, New Delhi, 2016.
5. Singiresu S Rao, "Engineering Optimization Theory and Practice", New Age International, New Delhi, 2016.

COURSE OUTCOMES:

- CO1 Apply the concepts of linear independence, basis, dimension, and Gram-Schmidt orthogonalization to transform vector spaces and perform linear transformations.
- CO2 Analyze the diagonalization of matrices and perform eigenvalue decomposition including SVD and QR to interpret dynamic systems and matrix behavior.
- CO3 Evaluate and solve linear optimization problems using simplex, duality, and transportation models, and select optimal solutions based on cost-effectiveness.
- CO4 Apply methods like exhaustive search, Fibonacci, and interval halving to identify optimal values in single-variable nonlinear optimization problems.
- CO5 Create and implement appropriate optimization algorithms (e.g., Hooke-Jeeves, conjugate gradient) for solving multivariate optimization problems.

CO-PO MAPPING

CO	PO 1	PO 2	PO3
1	3	-	2
2	3	-	2
3	3	-	2
4	3	-	2
5	3	-	2

125COT02

ADAPTIVE SIGNAL PROCESSING

L T P C
3 0 0 3

COURSE OBJECTIVES:

- Understand the concept of signals in frequency domain.
- Estimate the signal spectrum by parametric and Non-Parametric approach.
- Design and analysis of filtering functions.
- Understand the concept of Adaptive filters.
- Apply multirate signal processing in various applications.

UNIT I DISCRETE RANDOM SIGNAL PROCESSING

9

Discrete Random Processes- Ensemble averages, stationary processes, Autocorrelation and Auto covariance matrices. Parseval's Theorem, Wiener-Khintchine Relation- Power Spectral Density-Periodogram, Spectral Factorization, Filtering random processes. Low Pass Filtering of White Noise. Parameter estimation: Bias and consistency.

UNIT II SPECTRUM ESTIMATION

9

Estimation of spectra from finite duration signals, Non-Parametric Methods-Correlation Method, Periodogram Estimator, Performance Analysis of Estimators -Unbiased, Consistent Estimators-Modified periodogram, Bartlett and Welch methods, Blackman –Tukey method. Parametric Methods - AR, MA, ARMA model based spectral estimation. Parameter Estimation -Yule-Walker equations, solutions using Durbin's algorithm.

COURSE OBJECTIVES

- To extend the theory of Constant envelope modulation to M-ary schemes and to familiarize the concept of Spread Spectrum.
- To develop the mathematical and algorithmic foundations of the error detecting and error correcting codes used in modern communications systems.

UNIT I DETECTION AND ESTIMATION 9

Pass band Transmission model - Gram Schmidt orthogonalization procedure, Geometric Interpretation of signals, Response of bank of correlators to a noisy input-Coherent detection of signals in noise, Probability of error - Correlation Receiver - Matched Filter - Detection of signals with unknown phase.

UNIT II EQUALIZATION TECHNIQUES 9

Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals Equalization algorithms– Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

UNIT III CONVOLUTIONAL CODING 9

Representation of codes using Polynomial - State diagram - Tree diagram - and Trellis diagram, Decoding techniques: Maximum likelihood decoding - Viterbi algorithm- Sequential decoding Coded modulation for bandwidth constrained channels.

Trellis coded modulation : Set Partitioning - Four state trellis - coded modulation with 8-PSK signal constellation - Eight state trellis code for coded 8-PSK modulation - Eight state trellis for rectangular QAM signal constellations.

UNIT IV TURBO CODING 9

Introduction - Turbo Encoder -Turbo Decoder-Iterative Turbo Decoding Principles-Modifications of the MAP Algorithm - The Soft-Output Viterbi Algorithm (SOVA) -Turbo Coded BPSK Performance over Gaussian channels -Turbo Coding Performance over Rayleigh Channels.

UNIT V MULTICARRIER AND MULTIUSER COMMUNICATIONS 9

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), Modulation and demodulation in an OFDM system, An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation. Introduction to CDMA systems, multiuser detection in CDMA systems–optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

Upon Completion of this course, students will be able to :

CO1: Apply Digital communication technologies in a variety of engineering applications

CO2: Gain knowledge in equalization techniques

CO3: Implement Error control coding and Digital modulation techniques in MATLAB

CO4: Learn turbo coding and its comparison with Rayleigh channels

CO5: Learn about multicarrier and multiuser communication.

REFERENCE BOOKS

1. Simon Haykin, "Digital Communications", John Wiley and sons, Reprint 2009

2. L. Hanzo, T.H. Liew & B.L. Yeap, "Turbo Coding, Turbo Equalization & Space-Time Coding", Wiley, First Edition, 2002
3. Theodore S.Rappaport, "Wireless Communications", Pearson Education, Second Edition 2002.
4. Stephen G. Wilson, "Digital Modulation and Coding", Pearson Education, First Indian Reprint, 2003.
5. Rodger E. Ziemer, Roger L. Peterson, David E. Borth, "Introduction to Spread Spectrum Communications", Prentice Hall, First Edition, 1995.
6. Lathi B P and Zhi Ding, "Modern Digital and Analog communication Systems", Oxford University Press, 2011.
7. Richard Van Nee & Ramjee Prasad, "OFDM for Multimedia Communications" Artech House Publication, 2001.
8. Nptel Lecture: <http://aicte-stream/>

CO-PO MAPPING

CO	PO 1	PO 2	PO3
1	3	3	2
2	3	3	2
3	3	3	2
4	2	3	3
5	3	2	2

125COT04

ADVANCED WIRELESS COMMUNICATION

LT P C

3 0 0 3

Course Objectives

- To learn the concepts of wireless communication.
- To know about the various propagation methods, Channel models, capacity calculations, multiple antennas and multiple user techniques used in the mobile communication.

UNIT I WIRELESS CHANNEL PROPAGATION AND MODEL 9

Propagation of EM signals in wireless channel – Reflection, diffraction and Scattering-free space, two ray. Small scale fading- channel classification- channel models – COST -231 Hata model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, 5G Channel model requirements and Measurements, propagation scenarios, METIS channel models, Map-based model, stochastic model.

UNIT II CAPACITY OF WIRELESS CHANNELS 9

Capacity in AWGN, capacity of flat fading channel, capacity of frequency selective fading channels. Capacity of MISO, SIMO systems.

UNIT III DIVERSITY 9

Realization of independent fading paths, Receiver Diversity: Selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain Combining. Transmitter Diversity: Channel known at transmitter, Channel unknown at the transmitter.

UNIT IV MIMO COMMUNICATIONS 9

Narrowband MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain: Beam forming, Diversity-Multiplexing trade-offs, Space time Modulation and coding: STBC,STTC, Spatial Multiplexing and BLAST Architectures.

UNIT V MULTI USER SYSTEMS**9**

Introduction to MUD, Linear decorrelator, MMSE MUD, Adaptive MUD, MIMO-MUD Application of convex optimization to wireless design

TOTAL: 45 PERIODS**Course Outcomes**

On the successful completion of the course, students will be able to

CO1: Analyze the wireless channel characteristics and identify appropriate channel models

CO2: Understand the mathematics behind the capacity calculation under different channel conditions

CO3: Understand the implication of diversity combining methods and the knowledge of channel

CO4: Understand the concepts in MIMO Communications

CO5: Understand multiple access techniques and their use in different multi-user scenarios.

Reference Books

1. David Tse and Pramod Viswanath, *Fundamentals of wireless communications*, Cambridge University Press, First Edition, 2012
2. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press, 2007.
3. Harry R. Anderson, "Fixed Broadband Wireless System Design", John Wiley, India, 2003.
4. Andreas.F. Molisch, "Wireless Communications", John Wiley, India, 2006
5. Simon Haykin & Michael Moher, "Modern Wireless Communications", Pearson Education, 2007.
6. Rappaport. T.S., "Wireless communications", Pearson Education, 2003.
7. Gordon L. Stuber, "Principles of Mobile Communication", Springer International Ltd., 2001.
8. Upena Dalal, "Wireless Communication", Oxford Higher Education, 2009.

CO-PO MAPPING

CO	PO 1	PO 2	PO3
1	3	3	3
2	3	3	3
3	3	3	3
4	3	3	3
5	3	3	3

125COT05**ADVANCED RADIATION SYSTEMS****L T P C****3 0 0 3****COURSE OBJECTIVES:**

- Understand the concept of Retarded vector potential with Heuristic and Maxwell's equation approach.
- Describe the concept of Antenna Arrays with different types and their pattern multiplication
- Examine the different Antenna synthesis method
- Design different types of Antennas with their characteristic
- Compare all the special antennas with their applications.

UNIT I ANTENNA FUNDAMENTALS**9**

Antenna fundamental parameters, Radiation integrals, Radiation from surface and line current distributions -Introduction to numerical techniques- FEM, FDTD, MoM. Linear array -uniform array, end fire and broad side array, gain, beam width, side lobe level- Two dimensional uniform array- Phased array, beam scanning, grating lobe, feed network

COURSE OBJECTIVES:

- To enable students to analyze various research methodologies and designs, including qualitative and quantitative approaches, to effectively frame and investigate research questions.
- To help students apply appropriate measurement techniques, sampling strategies, and data preparation methods for effective collection and presentation of research data.
- To develop the ability to evaluate research hypotheses, interpret multivariate data, and communicate findings through coherent written and oral presentations.
- To provide students with an understanding of the evolution, principles, types, and international frameworks governing Intellectual Property Rights and their role in research and innovation.
- To enable students to apply the procedures and legal requirements involved in patent filing, examination, and licensing within the broader context of innovation protection.

UNIT I	RESEARCH DESIGN	9
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.		
UNIT II	DATA COLLECTION AND SOURCES	9
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.		
UNIT III	DATA ANALYSIS AND REPORTING	9
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.		
UNIT IV	INTELLECTUAL PROPERTY RIGHTS	9
Intellectual Property — The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.		
UNIT V	PATENTS	9
Patents — objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.		

TOTAL: 45 PERIODS**REFERENCES:**

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.

4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013

COURSE OUTCOMES:

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem

CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data

CO3: Explain the process of data analysis; interpret and present the result in suitable form

CO4: Explain about Intellectual property rights, types and procedures

CO5: Execute patent filing and licensing

CO-PO MAPPING

CO	PO 1	PO 2	PO3
1	3	2	3
2	3	2	2
3	3	1	3
4	2	1	3
5	3	3	1

125COP07

DIGITAL COMMUNICATION SYSTEMS LABORATORY

L T P C

0 0 2 1

COURSE OBJECTIVES

- To study & measure the performance of digital communication systems.
- To provide a comprehensive knowledge of Wireless Communication.
- To learn about the design of digital filter and its adaptive filtering algorithms.

LIST OF EXPERIMENTS

1. Generation & detection of binary digital modulation techniques using SDR
2. MIMO system transceiver design using MATLAB/SCILAB/LABVIEW
3. OFDM transceiver design using MATLAB /SCILAB/LABVIEW.
4. Channel equalizer design using MATLAB (LMS, RLS algorithms)
5. Design and Analysis of Spectrum Estimators (Bartlett, Welch) using MATLAB
6. BER performance Analysis of M-ary digital Modulation Techniques (coherent & non coherent) in AWGN Environment using MATLAB/SCILAB/LABVIEW
7. Design and performance analysis of Lossless Coding Techniques - Huffman Coding and Lempel Ziv Algorithm using MATLAB/SCILAB/LABVIEW
8. Noise / Echo cancellation using MATLAB (LMS / RLS algorithms).
9. Wireless channel characterization.

TOTAL:45 PERIODS

COURSE OUTCOMES

CO1 Implement the adaptive filtering algorithms

CO2 Generate and detect digital communication signals of various modulation techniques using MATLAB.

- CO3** Apply mathematical formulation to analyze spectrum estimation of a signal and bit rate determination of a transmission link
- CO4** Analyze the performance of optimization algorithms for equalizing the channel or noise/echo cancellation
- CO5** Able to design synchronization algorithm for Digital Communication systems

CO-PO MAPPING

CO	PO 1	PO 2	PO3
1	3	2	2
2	3	2	2
3	3	2	2
4	2	2	2
5	2	2	2

125COP08

**ADVANCED DIGITAL SIGNAL PROCESSING
LABORATORY**

**L T P C
0 0 2 1**

COURSE OBJECTIVES:

- To enable the student to verify the basic principles of random signal processing, spectral estimation methods and additive white Gaussian noise (AWGN) channel characterization
- To design and conduct experiments, as well as to analyze and interpret data to produce meaningful conclusions and match with theoretical concepts.

LIST OF EXPERIMENTS

USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:

1. Generation of Standard discrete time sequences (Unit Impulse, Unit Step, Unit Ramp, Sinusoidal and exponential signals) and carrying out of arithmetic operations and plot the results
2. Generation of random sequences satisfying the given probability distributions such as Uniform, Gaussian, Rayleigh and Rician.
3. Design of FIR filters for the given specification and plot the frequency response of the designed filter
4. Design of IIR filters for the given specification and plot the frequency response of the designed filter
5. Analysis of finite word length effects of FIR filter coefficients
6. Estimation of power spectrum of the given random sequence using Nonparametric methods (Bartlett, Welch and Blackman Tukey)
7. Estimation of power spectrum of the given random sequence using parametric methods (AR, MA and ARMA)
8. Upsampling the discrete time sequence by L times and plot the spectrum of both the given sequence and upsampled sequence
9. Downsampling the discrete time sequence by M times and plot the spectrum of both the given sequence and downsampled sequence
10. Design an adaptive filter to extract a desired signal from the given noisy signal by cancelling the noise using LMS Algorithm
11. Design an adaptive filter to extract a desired signal from the given noisy signal by cancelling the noise using RLS Algorithm

12. Implementation of Digital Filter Banks for the given specifications

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon the completion of course, students will be able to

- CO1:** Generate deterministic/Random sequences using simulation tool
- CO2:** Design and analyze the frequency response of FIR/IIR digital filters for the givenspecifications
- CO3:** Estimate power spectrum of the given random sequence usingparametric/nonparametric estimation methods
- CO4:** Implement adaptive filters using LMS/RLS algorithm
- CO5:** Analyze the discrete time systems at various sampling rates

CO-PO MAPPING

CO	PO 1	PO 2	PO3
1	3	2	2
2	3	-	2
3	3	2	2
4	2	-	-
5	3	2	2

AUDIT COURSES

X25COA01

ENGLISH FOR RESEARCH PAPER WRITING

L T P C

2 0 0 0

Prerequisite: English

Course Objectives

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are

needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS

6

Useful phrases, checking Plagiarism, how to ensure paper is as good a sit could possibly be the first-time submission

Total: 30 Periods

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO1: Understand that how to improve your writing skills and level of readability

CO2: Learn about what to write in each section

CO3: Understand the skills needed when writing a Title

CO4: Understand the skills needed when writing the Conclusion

CO5: Ensure the good quality of paper at very first-time submission

REFERENCE BOOKS

- 1 Adrian Wallwork, Englishfor WritingResearchPapers, SpringerNew YorkDordrechtHeidelbergLondon,2011
- 2 DayR How to Write and Publish a Scientific Paper, Cambridge University Press2006
- 3 Goldbort R Writing for Science, Yale University Press (available on Google Books)2006
- 4 HighmanN, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

CO-PO MAPPING

CO	PO 1	PO 2	PO3
1	3	-	2
2	3	-	2
3	3	-	2
4	3	-	1
5	3	-	2

X25COA02

DISASTER MANAGEMENT

L T P C
2 0 0 0

COURSE OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION

6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS

6

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6
 Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6
 Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6
 Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

Total: 30 Periods

COURSE OUTCOMES

On the successful completion of the course, students will be able to

- CO1: Ability to summarize basics of disaster
- CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCE BOOKS

- 1 Goel S.L., Disaster Administration And Management Text And Case Studies”, Deep & Deep Publication Pvt.Ltd., New Delhi, 2009.
- 2 Nishitha Rai, Singh AK, “Disaster Management in India: Perspectives, issues and strategies” New Royal book Company, 2007.
- 3 Sahni, Pardeep Et. Al., “Disaster Mitigation Experiences And Reflections”, Prentice Hall Of India, New Delhi, 2001.

CO-PO MAPPING

CO	PO 1	PO 2	PO 3
1	3	2	2
2	3	2	2
3	3	2	2
4	3	1	1
5	3	2	2

X25COA03

CONSTITUTION OF INDIA

L T P C
2 0 0 0

Course Objectives

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik

Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I	HISTORY OF MAKING OF THE INDIAN CONSTITUTION	5
History, Drafting Committee, (Composition & Working)		
UNIT II	PHILOSOPHY OF THE INDIAN CONSTITUTION	5
Preamble, Salient Features		
UNIT III	CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	5
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.		
UNIT IV	ORGANS OF GOVERNANCE	5
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.		
UNIT V	LOCAL ADMINISTRATION	5
District's Administration head: role and Importance, Municipalities: Introduction, Mayor and Role of Elected Representative, CEO, Municipal Corporation. Panchayati raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.		

TOTAL: 30 PERIODS

COURSE OUTCOMES

On the successful completion of the course, students will be able to

- CO1: Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- CO2: Discuss the intellectual origins of the framework of argument that informed the conceptualization
- CO3: of social reforms leading to revolution in India.
- CO4: Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- CO5: Discuss the passage of the Hindu Code Bill of 1956.

REFERENCE BOOKS

- 1 The Constitution of India, 1950 (Bare Act), Government Publication.
- 2 Dr. S.N. Busi, Dr. B.R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
- 3 M.P. Jain, Indian Constitution Law, 7th Edn., LexisNexis, 2014.
- 4 D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015.

CO-PO MAPPING

CO	PO 1	PO 2	PO 3
1	3	2	2
2	2	1	2
3	2	2	2
4	2	2	1
5	3	2	2

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	3	3
2	3	3	3
3	3	3	3
4	3	3	3
5	3	3	3

1-Low, 2-medium, 3-high.

225COT02

PHOTONIC AND MICROWAVE INTEGRATED CIRCUITS

L T P C
3 0 0 3

COURSE OBJECTIVES

- Develop a deep insight into modern photonic devices and circuits through a thorough understanding of the underlying physics
- Learn about photonic Integrated circuits and its applications
- Study about the technologies involved in MICs.
- Learn the types and components of Micro-strip.

UNIT I INTRODUCTION TO PHOTONICS

9

Introduction to photonics-Optical waveguide theory- Photonic crystals, Metamaterials, Plasmonics- Photonic components switch ,couplers etc.

UNIT II PHOTONIC INTEGRATED CIRCUIT

9

Introduction to photonic integrated circuits-Fabrication techniques: Lithography, ion-exchange deposition, diffusion process and device characteristics-Photonic Band Gap structure-Applications: Micro-Opto-Electro-Mechanical system(MOEMS).-Bio-Photonics.-VLSI Photonics

UNIT III MICROSTRIP COMPONENTS

9

Component using Microstrips: flat resistors – flat inductors – interdigital capacitors – sandwich capacitors – ferromagnetic substrates for non-reciprocal devices – microstrip circulators – latching circulators – isolators – phase shifters

UNIT IV ANALYSIS OF MICROSTRIP LINE

9

Coupled microstrips – even and odd mode analysis – Microstrip directional couplers – branch line couplers – periodic branch line couplers – synchronous branch line couplers. Losses in microstrip.

UNIT V TECHNOLOGY OF MICS

9

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.

MONOLITHIC MICS: Processes involved in fabrication – epitaxial growth of semiconductor layer – growth of dielectric layer – diffusion-ion implantation – electron beam technology.

TOTAL : 45 PERIODS

COURSE OUTCOMES

Upon Completion of this course, students will be able to :

CO1: Design the Photonics components.

CO2: Acquire knowledge in the design and fabrication of the Photonic Integrated Circuits

CO3: Design and fabricate the hybrid MIC's in thick and thin film technology.

CO4: Analyse even and odd mode coupled microstrips.

CO5: Implement the different methods for the fabrication of the monolithic MICs.

TEXT BOOKS

1. K. C. Gupta, Amarjit Singh, *Microwave Integrated Circuits*, Wiley, 2nd Edition, 2019.

REFERENCE BOOKS

1. Lukas Chrostowski, Michael Hochberg, *Silicon Photonics Design*, Cambridge University Press, 1st Edition, 2015.
2. Graham Reed, Andrew Knights, *Silicon Photonics*, Wiley, 2nd Edition, 2018.
3. Ari T. Friberg, Rene Dandliker, *Advances in Information Optics and Photonics*, PHI, 1st Edition, 2017.

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	2
2	3	3	2
3	3	2	2
4	3	3	2
5	3	2	3

1-Low, 2-medium, 3-high.

225COT03

EMBEDDED SYSTEMS FOR COMMUNICATION WITH AI

LT P C

3 0 0 3

COURSE OBJECTIVES

- To provide a strong foundation in embedded system architecture and real-time communication interfaces.
- To integrate AI/ML techniques into embedded platforms for intelligent communication systems.
- To enable students to design, develop, and optimize embedded solutions for IoT, wireless, and networked applications using AI.
- To understand industry-driven embedded communication standards, protocols, and edge-AI hardware platforms.
- To develop hands-on ability to build AI-enabled communication modules for real-time processing, prediction, and optimization.

UNIT I EMBEDDED SYSTEM ARCHITECTURE & COMMUNICATION FUNDAMENTALS 9

Introduction to Embedded Systems – Components, Microcontrollers, SoCs, Edge Processors, ARM Cortex-M/A Architecture, RISC-V basics, Memory hierarchy, bus structures, GPIO, timers, ADC/DAC, Fundamentals of digital and wireless communication in embedded systems, Embedded communication interfaces: UART, SPI, I²C, CAN.

UNIT II EMBEDDED COMMUNICATION PROTOCOLS & RTOS FOR COMMUNICATION 9

Real-time embedded system behavior, RTOS concepts: task scheduling, inter-task communication, synchronization, Communication-aware RTOS design, Networking protocols for embedded systems: Ethernet, UDP, TCP/IP, MQTT, CoAP, 5G/6G IoT-ready embedded communication.

UNIT III AI/ML FOR EMBEDDED COMMUNICATION SYSTEMS 9

Introduction to AI/ML in embedded systems, TinyML concepts, model compression, pruning, quantization, Feature extraction for communication systems: signal features, anomaly detection, AI for communication optimization: Channel prediction, Adaptive modulation. ML algorithms for small

embedded devices: decision trees, SVM, lightweight neural networks, Embedded AI workloads for communication signal processing

UNIT IV EDGE AI HARDWARE PLATFORMS & DEPLOYMENT FOR COMMUNICATION 9

Edge AI platforms: NVIDIA Jetson, Google Edge TPU, ARM Ethos-U, ESP32 with AI accelerators, AI frameworks for embedded deployment: TensorFlow Lite Micro, Neural network deployment workflow: training, conversion, optimization, deployment.

UNIT V INTELLIGENT EMBEDDED COMMUNICATION SYSTEM DESIGN & CASE STUDIES 9

System design methodology: requirement, architecture, integration, Designing AI-enabled communication modules for: Smart IoT hubs, Autonomous robots, Smart antennas & cognitive radio nodes, Embedded security for AI-assisted communication, Case study: AI for wireless spectrum allocation.

TOTAL : 45 PERIODS

COURSE OUTCOMES

Upon Completion of this course, students will be able to :

- CO1:** Explain embedded system components, architectures, and communication interfaces.
- CO2:** Apply communication protocols and real-time OS concepts in embedded environments.
- CO3:** Implement AI/ML techniques on embedded platforms for communication enhancement.
- CO4:** Design intelligent communication subsystems using embedded AI frameworks.
- CO5:** Analyze and evaluate embedded communication performance using AI-based optimization..

TEXT BOOKS

1. Raj Kamal, *Embedded Systems: Architecture, Programming and Design*, McGraw-Hill Education, 4th Edition, 2018.
2. Frank Vahid, Tony Givargis, *Embedded System Design: A Unified Hardware/Software Introduction*, Wiley, 3rd Edition, 2019.

REFERENCE BOOKS

1. . Muhammad Ali Mazidi, Sepehr Naimi, Sarmad Naimi, *ARM Cortex-M Microcontroller Programming and Embedded Systems*, Pearson, 2nd Edition, 2021.
2. Pete Warden, Daniel Situnayake, *TinyML: Machine Learning with TensorFlow Lite on Arduino and Microcontrollers*, O’Reilly, 1st Edition, 2019.
3. Qing Zhao, *Machine Learning for Wireless Communications*, Cambridge University Press, 1st Edition, 2020.
4. Dogan Ibrahim, *Embedded Artificial Intelligence*, Elsevier, 1st Edition, 2020.
5. S. Yerramalli, A. Kumar, *AI-Enabled Wireless Communication Systems*, Springer, 1st Edition, 2022

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	2
2	3	3	2
3	3	3	3
4	3	2	3
5	3	3	3

1-Low, 2-medium, 3-high.

COURSE OBJECTIVES

- To provide fundamental knowledge on digital signal and image processing concepts.
- To introduce AI/ML techniques for processing, analyzing, and interpreting signals and images.
- To apply machine learning and deep learning models for feature extraction, classification, enhancement, and reconstruction.
- To familiarize students with advanced AI-based algorithms for speech, vision, and pattern recognition tasks.
- To enable learners to design AI-driven signal and image processing applications for real-world problems.

UNIT I FUNDAMENTALS OF SIGNAL AND IMAGE PROCESSING 9

Digital signals and systems, Sampling, quantization, discrete-time Fourier transforms, Filtering: FIR, IIR, convolution operations, Image representation, formation, and transformations, Spatial and frequency domain processing, Histograms, smoothing & sharpening filters.

UNIT II MACHINE LEARNING FOR SIGNAL AND IMAGE PROCESSING 9

Overview of AI & ML for signal/data processing, Feature extraction techniques: PCA, LDA, wavelets, SIFT, HOG, Signal and image classification using ML, Regression models and clustering techniques, Support Vector Machines, Decision Trees, Random Forest, Dimensionality reduction and feature selection

UNIT III DEEP LEARNING FOR SIGNAL AND IMAGE PROCESSING 9

Introduction to Deep Neural Networks, Convolutional Neural Networks (CNNs) for image processing, Recurrent Neural Networks (RNN), LSTM for signal/speech processing, Autoencoders for feature learning and image reconstruction, Transfer learning and pretrained models (VGG, ResNet, MobileNet), Optimization techniques and loss functions

UNIT IV AI TECHNIQUES FOR SPEECH, VISION, AND PATTERN RECOGNITION 9

Speech enhancement, noise reduction, speech recognition using AI, Computer vision tasks: object detection, segmentation, tracking, Pattern recognition and feature matching, GANs for image synthesis and restoration, AI for medical image analysis, Edge-AI for real-time signal and image processing.

UNIT V APPLICATIONS AND CASE STUDIES 9

AI techniques for speech analysis and enhancement, implement AI-based computer vision algorithms, and analyze the use of GANs, pattern recognition, and edge-AI methods in image and signal processing

TOTAL : 45 PERIODS**COURSE OUTCOMES**

Upon Completion of this course, students will be able to :

- CO1:** Explain the fundamentals of digital signal and image processing.
- CO2:** Apply AI/ML algorithms for processing and analysis of signals and images.
- CO3:** Develop deep learning-based systems for feature extraction, enhancement, and classification.
- CO4:** Evaluate AI-based techniques in speech, vision, and pattern recognition tasks.
- CO5:** Design and implement AI-driven signal and image processing applications

TEXT BOOKS

1. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, Pearson, 4th Edition, 2018.
2. John G. Proakis, Dimitris Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, Pearson, 4th Edition, 2019.

REFERENCE BOOKS

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, MIT Press, 1st Edition, 2016.
2. Simon Haykin, *Neural Networks and Learning Machines*, Pearson, 3rd Edition, 2016.
3. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2nd Edition, 2023.
4. D. Forsyth, J. Ponce, *Computer Vision: A Modern Approach*, Pearson, 2nd Edition, 2018.

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	1
2	3	3	2
3	3	3	3
4	3	3	3
5	3	2	3

1-Low, 2-medium, 3-high.

225COP07

WIRELESS COMMUNICATION SYSTEM LABORATORY

L T P C

0 0 2 1

COURSE OBJECTIVES

- To provide hands-on understanding of spectral characteristics, digital modulation, and wireless communication signals.
- To enable students to design and analyse spectrum estimation methods, error-control coding, and equalization techniques.
- To develop skills in modelling and simulating wireless channels such as Rayleigh, Rician, OFDM, CDMA, and MIMO systems.
- To train students in implementing channel estimation, synchronization, RAKE receiver concepts, and diversity techniques.
- To strengthen analytical and simulation skills using MATLAB/Simulink, DSP processors, and wireless communication toolboxes.

LIST OF EXPERIMENTS

1. Spectral Characterisation of Communication Signals (Using Spectrum Analyzer)
2. Design and Analysis of Spectrum Estimators (Bartlett and Welch Methods)
3. Design and Analysis of Digital Modulation Techniques (BPSK, QPSK, QAM, FSK etc.)
4. Simulation of Rayleigh and Rician Fading Channels

5. CDMA Signal Generation and RAKE Receiver Design
6. Design and Performance Analysis of Error Control Encoder and Decoder (Block Codes, Convolutional Codes – Viterbi)
7. Wireless Channel Equalizer Design (ZF / LMS / RLS)
8. Wireless Channel Estimation and Diversity Combining
9. Generation and Analysis of OFDM Signal and PAPR
10. Simulation of MIMO System with Spatial Multiplexing

COURSE OUTCOMES

Upon Completion of this course, students will be able to :

- CO1: Characterize the spectral properties of communication signals using analyzers and simulation tools.
 CO2: Apply and evaluate spectrum estimation techniques and digital modulation schemes.
 CO3: Model wireless channels and implement CDMA, OFDM, and diversity techniques.
 CO4: Design and analyse error-control coding, equalizers, and channel estimation algorithms.
 CO5: Simulate and evaluate advanced wireless communication systems such as MIMO and RAKE receivers.

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	1
2	3	3	2
3	3	3	3
4	3	3	3
5	3	3	3

1-Low, 2-medium, 3-high.

225COP08

EMBEDDED SYSTEMS DESIGN LABORATORY

L T P C

0 0 2 1

COURSE OBJECTIVES

- To develop hands-on skills in programming 8-bit microcontrollers using both assembly and C.
- To enable students to perform I/O programming and interface common peripherals such as LCDs, sensors, ADC/DAC, motor drivers, and serial devices.
- To provide practical exposure to PIC microcontroller programming and peripheral interfacing using both assembly and high-level languages.
- To familiarize students with modern embedded platforms such as Raspberry Pi and Arduino for rapid prototyping and real-time applications.
- To expose students to professional embedded development tools such as in-circuit emulators, cross compilers, and debugging utilities.

LIST OF EXPERIMENTS

1. Programming with 8-bit Microcontrollers – Assembly Programming

- Basic assembly instructions, arithmetic & logical operations
- Delay generation programs
- Port manipulation using assembly
- Memory access and branching instructions

2. Programming with 8-bit Microcontrollers – C Programming

- I/O port programming in C
- Timer and counter programming
- Interrupt handling in C
- Embedded C program structure for microcontrollers

3. Programming with PIC Microcontrollers – Assembly and C

- Programming GPIO, timers, and interrupts

4. I/O Interfacing with PIC Microcontrollers

- PWM generation and motor speed control
- ADC and DAC interfacing
- LCD modules and sensor interfacing

5. Programming with Raspberry Pi

- Serial communication and I2C/SPI interfacing
- Sensor interfacing

6. Programming with Arduino and Raspberry Pi – I/O Interfacing

- Timer programming
- Interrupt programming
- Serial communication
- Sensor interfacing (DHT, PIR, accelerometer, gas sensors, etc.)
- Small integrated project using Arduino / Raspberry Pi

COURSE OUTCOMES

Upon Completion of this course, students will be able to :

CO1: Develop assembly and C-based programs for 8-bit microcontrollers.

CO2: Interface essential peripherals such as sensors, ADC/DAC, LCDs, and motor drivers with microcontrollers.

CO3: Build and test applications using PIC microcontroller peripherals including timers, interrupts, PWM, and ADC modules.

CO4: Design and implement embedded applications using Raspberry Pi and Arduino with real-time sensor interfacing.

CO5: Utilize in-circuit emulators, debugging tools, and cross-compilers for embedded system development and troubleshooting.

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	2
2	3	3	2
3	3	3	2
4	3	3	3
5	3	3	3

1-Low, 2-medium, 3-high.

COURSE OBJECTIVES

- Understand the EMI/EMC concept in Time and Frequency domain
- Understand the EMI Coupling Concept
- Learn the EMI standards and Measurements
- Learn the EMI control Techniques and to design a PCB for various application

UNIT I EMI ENVIRONMENT 9

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.

UNIT II EMI COUPLING PRINCIPLES 9

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.

UNIT III EMI/EMC STANDARDS AND MEASUREMENTS 9

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).

UNIT IV EMI CONTROL TECHNIQUES 9

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

UNIT V EMC DESIGN OF PCBs 9

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

TOTAL:45 PERIODS

COURSE OUTCOMES

Upon Completion of this course, students will be able to :

- CO1: Demonstrate the EMI/EMC concept in Time and Frequency domain
- CO2: Demonstrate the EMI Coupling Concept
- CO3: Knowledge in EMI standards and Measurements
- CO4: Knowledge in EMI Control Techniques
- CO5: Design the PCB for various applications

TEXT BOOKS

1. Henry W. Ott, *Electromagnetic Compatibility Engineering*, Wiley, 1st Edition, 2017.

REFERENCE BOOKS

1. Clayton R. Paul, *Introduction to Electromagnetic Compatibility*, Wiley, 2nd Edition, 2018.
2. V. P. Kodali, *Engineering EMC*, IEEE Press, 2nd Edition, 2019.

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	1
2	3	2	1

3	3	3	2
4	3	3	2
5	3	3	3

1. 1-Low, 2-medium, 3-high.

225COE02

WDM OPTICAL NETWORKS

L T P C

3 0 0 3

COURSE OBJECTIVES

- Categorize Optical System Components
- Extrapolate Optical Network Architecture
- Outline the Wavelength Routing Network,
- Develop skills on Packet Switching Network ,Access Networks
- Interpolate about the Network Design and Management Techniques

UNIT I OPTICAL SYSTEM COMPONENTS 9

Light propagation in optical fibers – Loss & bandwidth, System limitations, Non-Linear effects; Solitons; Optical Network Components – Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters.

UNIT II OPTICAL NETWORK ARCHITECTURES 9

Introduction to Optical Networks; SONET / SDH, Metropolitan-Area Networks, Layered Architecture ; Broadcast and Select Networks – Topologies for Broadcast Networks, Media-Access Control Protocols, Test beds for Broadcast & Select WDM; Wavelength Routing Architecture.

UNIT III WAVELENGTH ROUTING NETWORKS 9

The optical layer, Node Designs, Optical layer cost tradeoff, Routing and wavelength assignment, Virtual topology design, Wavelength Routing Test beds, Architectural variations.

UNIT IV PACKET SWITCHING AND ACCESS NETWORKS 9

Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing, Synchronization, Broadcast OTDM networks, Switch-based networks; Access Networks – Network Architecture overview, Future Access Networks, Optical Access Network Architectures; and OTDM networks.

UNIT V NETWORK DESIGN AND MANAGEMENT 9

Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, crosstalk, dispersion; Wavelength stabilization ; Overall design considerations; Control and Management – Network management functions, Configuration management, Performance management, Fault management, Optical safety, Service interface.

TOTAL:45 PERIODS

COURSE OUTCOMES

Upon Completion of this course, students will be able to :

- CO1: Apply the Optical System Components worldwide
- CO2: Create Optical Network Architecture for reasoning
- CO3: Develop skills on Wavelength Routing Network,
- CO4: Integrate on Packet Switching Network, Access Network

CO5: Devise and Manage Optical Network for desired Application

TEXT BOOKS

1. Rajiv Ramaswami, Kumar Sivarajan, Galen Sasaki, *Optical Networks: A Practical Perspective*, Morgan Kaufmann, 4th Edition, 2023.

REFERENCE BOOKS

1. C. Siva Ram Murthy, Mohan Gurusamy, *WDM Optical Networks*, Pearson, 1st Edition, 2018
2. Design and Algorithms”, Prentice Hall of India, 1st Edition, 2002
3. P.E. Green, Jr., “Fiber Optic Networks”, Prentice Hall, NJ, 1993.

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	1
2	3	3	2
3	3	3	3
4	3	3	2
5	3	3	3

4. 1-Low, 2-medium, 3-high.

225COE03

HIGH SPEED SWITCHING ARCHITECTURE

**LT P C
3 0 0 3**

COURSE OBJECTIVES

- Learn the switching concept of High Speed Networks
- Learn the concept of ISDN and B-ISDN with the functions, Layers and services
- Learn the ATM Architecture with different networks
- Analyze various Queuing in ATM and IP switching

UNIT I HIGH SPEED NETWORK 9

LAN and WAN network evolution through ISDN to BISDN - Transfer mode and control of BISDN - SDH multiplexing structure - ATM standard; ATM adaptation layers.

UNIT II LAN SWITCHING TECHNOLOGY 9

Switching concepts; Switch forwarding techniques; switch path control - LAN switching; cut through forwarding; store and forward - virtual LANs.

UNIT III ATM SWITCHING ARCHITECTURE 9

Switch models - Blocking networks – basic and enhanced banyan networks - sorting networks – merge sorting - rearrangeable networks - full and partial connection networks - nonblocking networks – recursive network – construction and comparison of non-blocking network.

UNIT IV QUEUES IN ATM SWITCHES 9

Internal queuing – Input, output and shared queuing - multiple queuing networks –combined input, output and shared queuing – performance analysis of queued switches.

UNIT V IP SWITCHING 9

Architectures of Internet Switches and Routers-IP Over ATM address and next hop resolution –IPv6 over ATM - Optical Packet switching - Switching fabric on a chip.

COURSE OUTCOMES

Upon Completion of this course, students will be able to :

- CO1: Familiar with switching of High Speed Networks
- CO2: Knowledge in ISDN and B-ISDN functions, Layers and services
- CO3: Understand ATM architecture with different networks
- CO4: Knowledge in Queues.
- CO5: Learn concepts of IP switching.

TEXT BOOKS

1. Elhanan H. Reiss, *High Performance Packet Switching*, Springer, 2nd Edition, 2019.

REFERENCE BOOKS

1. Rich Siefert, Jim Edwards, "The All New Switch Book – The Complete Guide to LAN Switching Technology", Wiley Publishing, Inc., Second Edition, 2008
2. Elhanany M. Hamdi, "High Performance Packet Switching architectures", Springer Publications, 2007
3. Christopher Y Metz, *Switching protocols & Architectures*. McGraw Hill, New York.1998.
4. Achille Patavina, *Switching Theory: Architectures and performance in Broadband ATM Networks*. John Wiley & Sons Ltd., New York.1998
5. Ranier Handel, Manfred N Huber, Stefan Schrodder. *ATM Networks-concepts, protocols, applications*, 3rd Edition, Adisson Wesley, New York,1999.
6. John A. Chiong: *Internetworking ATM for the internet and enterprise networks*. McGraw Hill, New York, 1998.

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	2
2	3	3	2
3	3	3	2
4	3	2	2
5	3	2	3

1-Low, 2-medium, 3-high.

225COE04

WAVELETS AND MULTIREOLUTION PROCESSING

L T P C

3 0 0 3

COURSE OBJECTIVES

- Study the basics of signal representation and Fourier theory
- Understand Multi Resolution Analysis and Wavelet concepts
- Study the wavelet transform in both continuous and discrete domain
- Understand the design of wavelets using Lifting scheme

UNIT I FUNDAMENTALS

9

Vector Spaces – Properties– Dot Product – Basis – Dimension, Orthogonality and Orthonormality – Relationship Between Vectors and Signals – Signal Spaces – Concept of Convergence – Hilbert Spaces

5. Soman K P and Ramachandran K I, —Insight into Wavelets From Theory to practice, Prentice Hall, 2004

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	2
2	3	3	2
3	3	2	3
4	3	2	3
5	3	3	3

1-Low, 2-medium, 3-high.

225COE05

SIGNAL INTEGRITY FOR HIGH SPEED DESIGN

L T P C
3 0 0 3

COURSE OBJECTIVES

- Study about cross talk in signal integrity
- Study the various parameters of different di-electric material
- Learn the concept of differential signalling and its significance
- Study the physical transmission model

UNIT I FUNDAMENTALS

9

The importance of signal integrity-new realm of bus design-Electromagnetic fundamentals for signal integrity-maxwell equations common vector operators-wave propagations-Electrostatics magneto statics-Power flow and the poynting vector-Reflections of electromagnetic waves

UNIT II CROSS TALK

9

Introduction -mutual inductance and capacitance-coupled wave equation-coupled line analysis modal analysis-cross talk minimization signal propagation in unbounded conductive media-classic conductor model for transmission model

UNIT III DI-ELECTRIC MATERIALS

9

Polarization of Dielectric-Classification of Di electric material-frequency dependent di electric material- Classification of Di electric material fiber-Weave effect-Environmental variation in di electric behaviour Transmission line parameters for loosy dielectric and realistics conductors

UNIT IV DIFFERENTIAL SIGNALING

9

Removal of common mode noise-Differential Cross talk-Virtual reference plane-propagation of model voltages common terminology-drawbacks of Differential signaling

UNIT V PHYSICAL TRANSMISSION LINE MODEL

9

Introduction- non ideal return paths-Vias-IO design consideration-Push-pull transmitter-CMOSreceivers-ESSD protection circuits-On chip Termination

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon Completion of this course, students will be able to :

- CO1: Knowledge in fundamentals of signal integrity
- CO2: Knowledge in cross talk in signal integrity
- CO3: Knowledge in various parameters of different di-electric material
- CO4: Understanding the differential signalling and its drawback in signal integrity
- CO5: Knowledge in physical transmission model

TEXT BOOKS

1. Stephen H. Hall, Howard L. Heck, *Advanced Signal Integrity for High-Speed Digital Designs*, Wiley, 2nd Edition, 2017.

REFERENCE BOOKS

1. Eric Bogatin, *Signal and Power Integrity – Simplified*, Pearson, 3rd Edition, 2018.
1. M S Lundstorm, *Fundamentals of Carrier Transport*, 2nd Ed., Cambrid University Press, Cambridge UK, 2000

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	2
2	3	2	2
3	3	3	2
4	3	2	3
5	3	3	2

1-Low, 2-medium, 3-high.

225COE06

ADVANCED SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS

**L T P C
3 0 0 3**

COURSE OBJECTIVES:

To enable the students to

- Learn M2M developments and satellite applications
- Understand Satellite Communication In Ipv6 Environment

UNIT I OVERVIEW OF SATELLITE COMMUNICATION

9

Overview of satellite communication and orbital mechanics Link budget Parameters, Link budget calculations, Auxiliary Equations, Performance Calculations.

UNIT II M2M DEVELOPMENTS AND SATELLITE APPLICATIONS

9

Overview of the Internet of Things and M2M- M2M Applications Examples and Satellite Support- Satellite Roles Context and Applications- Antennas for Satellite M2M Applications- M2M Market Opportunities for Satellite Operators-Ultra HD Video/TV and Satellite Implications-High Throughput Satellites (HTS) and Ka/Ku Spot Beam Technologies-Aeronautical, Maritime and other Mobility Services.

UNIT III SATELLITE COMMUNICATION IN IPV6 ENVIRONMENT

9

Overview of IPv6 and its benefits for Satellite Networks - Migration and Coexistence- Implementation scenarios and support- Preparations for IPv6 in Satellite communication- Satellite specific Protocol issues in IPv6 — Impact of IPv6 on Satellite Network architecture and services- Detailed transitional plan- IPv6 demonstration over satellites - Key results and recommendations.

UNIT IV SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM 9

Over view of Radio and Satellite Navigation, GPS Principles, Signal model and Codes, Satellite Signal Acquisition, Mathematical model of GPS observables, Methods of processing GPS data, GPS Receiver Operation and Differential GPS. IRNSS, GAGAN, GLONASS and Galileo.

UNIT V DEEP SPACE NETWORKS AND INTER PLANETARY MISSIONS 9

Introduction — Functional description - Design procedure and performance criterion-Mars exploration Rover- Mission and space craft summary-Telecommunication subsystem overview-Ground Subsystem-Telecom subsystem and Link performance Telecom subsystem Hardware and software Chandrayaan-1 Mission - Mission and space craft summary-Telecommunication subsystem overview-Ground Subsystem-Telecom subsystem and Link performance.Mangalyaan Mission - Mission and space craft summary-Telecommunication subsystem overview- Ground Subsystem-Telecom subsystem and Link performance

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

- CO1: Discuss Satellite navigation and global positioning system
- CO2: Outline deep space networks and inter planetary missions
- CO3: Able to demonstrate an understanding of the different interferences and attenuation mechanisms affecting the satellite link design.
- CO4: The student would be able to demonstrate an understanding of the different communication,sensing and navigational applications of satellite.
- CO5: Familiar with the implementation aspects of existing satellite based systems.

TOTAL:45 PERIODS

TEXT BOOKS

- 1. Anil K. Maini, Varsha Agrawal, *Satellite Technology: Principles and Applications*, Wiley, 4th Edition, 2022.

REFERENCES

- 1. Daniel Minoli, *Satellite Systems Engineering in an IPv6 Environment*, CRC Press, 2nd Edition, 2018.
- 2. Jim Taylor, *Deep Space Communications*, Wiley, 2nd Edition, 2019.
- 3. Adimurthy.V, "Concept design and planning of India's first interplanetary mission" *CurrentScience*, VOL. 109, NO. 6, 1054 25 SEPTEMBER 2015.

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	3	2
2	3	2	3
3	3	3	3
4	3	2	3
5	3	3	2

1-Low, 2-medium, 3-high.

COURSE OBJECTIVES

- Learn the basic concepts in the multimedia compression techniques.
- Learn the various algorithms and coding techniques of the text compression.
- Learn the audio compression techniques and its applications.
- Understand the predictive techniques and wavelet based image compressions

UNIT I INTRODUCTION 9

Special features of multimedia – Graphics & Image data representation-Compression techniques-Overview of Source coding-Unique decodable codes, prefix codes, Kraft McMillan inequality-Source modeling –physical model, Probability model, Markov model-Scalar and Vector quantization theory-Evaluation and Error analysis

UNIT II TEXT COMPRESSION 9

Compaction techniques – Huffman coding – Adaptive Huffman Coding – Arithmetic coding – Dictionary techniques – LZW family algorithms.

UNIT III AUDIO COMPRESSION 9

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

UNIT IV IMAGE COMPRESSION 9

Predictive techniques – DM, PCM, DPCM: Optimal Predictors and Optimal Quantization– Transform Coding – JPEG Standard – Sub-band coding algorithms: Design of Filter banks – Wavelet based compression: Implementation using filters – EZW, SPIHT coders.

UNIT V VIDEO COMPRESSION 9

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.

TOTAL : 45 PERIODS**COURSE OUTCOMES**

Upon Completion of this course, students will be able to :

- CO1: Understand the various requirements of the multimedia compression techniques.
 CO2: Implement text compression using the LZW algorithms and coding techniques.
 CO3: Acquire knowledge in the various audio compression techniques and its applications.
 CO4: Design and analyze of images compression using wavelet based compression
 CO5: Acquire knowledge in the various video compression techniques and its applications

TEXT BOOKS

1. Khalid Sayood, *Introduction to Data Compression*, Morgan Kaufmann, 5th Edition, 2018.

REFERENCE BOOKS

1. David Salomon, *Data Compression: The Complete Reference*, Springer, 4th Edition, 2019..
2. Yun Q.Shi, HuifangSun : *Image and Video Compression for Multimedia Engineering Fundamentals, Algorithms & Standards*, CRC press, 2003.
3. Peter Symes : *Digital Video Compression*, McGraw Hill Pub., 2004
4. Mark Nelson : *Data compression*, BPB Publishers, New Delhi,1998

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	2
2	3	3	2
3	3	3	3
4	3	2	3
5	3	3	2

5. 1-Low, 2-medium, 3-high.

225COE08

COGNITIVE RADIO

L T P C
3 0 0 3

COURSE OBJECTIVES

- Study the different techniques and computational methods for Cognitive Radio.
- Know the main rules underlying in Cognitive techniques.
- Address the difficulties related to the present day techniques.
- Adopt Cognitive techniques in solving problems in the real world

UNIT I INTRODUCTION TO SOFTWARE DEFINED RADIO 9

Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications.

UNIT II SDR ARCHITECTURE 9

Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.

UNIT III INTRODUCTION TO COGNITIVE RADIOS 9

Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.

UNIT IV COGNITIVE RADIO ARCHITECTURE 9

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture

UNIT V NEXT GENERATION WIRELESS NETWORKS 9

The XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design

TOTAL : 45 PERIODS

COURSE OUTCOMES

- CO1: Describe the basics of the software defined radios.
CO2: Design the wireless networks based on the cognitive radios.
CO3: Understand the Architecture of cognitive radio
CO4: Explain the concepts behind the wireless networks
CO5: Explain the concepts behind the next generation networks

TEXT BOOKS

1. Bruce A. Fette, *Cognitive Radio Technology*, Elsevier, 2nd Edition, 2019.

REFERENCE BOOKS

1. Simon Haykin, *Cognitive Radio*, IEEE Press, 1st Edition, 2017.
2. Joseph Mitola III, "Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering", John Wiley & Sons Ltd. 2000
3. Bruce A. Fette, "Cognitive Radio Technology", Elsevier, 2009
4. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, "Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey" Elsevier Computer Networks, May 2006
5. Simon Haykin, "Cognitive Radio: Brain –Empowered Wireless Communications", IEEE Journal on selected areas in communications, Feb 2005
6. Hasari Celebi, Huseyin Arslan, "Enabling Location and Environment Awareness in Cognitive Radios", Elsevier Computer Communications , Jan 2008
7. Markus Dillinger, Kambiz Madani, Nancy Alonistioti, "Software Defined Radio", John Wiley, 2003.
8. Huseyin Arslan, "Cognitive Radio, SDR and Adaptive System", Springer, 2007

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	2
2	3	3	3
3	3	3	2
4	3	2	3
5	3	3	3

1-Low, 2-medium, 3-high.

225COE09

SPEECH AND AUDIO SIGNAL PROCESSING

L T P C
3 0 0 3

COURSE OBJECTIVES

- Learn the concept of Speech and Audio
- Implement the time and Frequency domain methods for speech processing
- Develop about Homomorphic Speech Analysis
- Acquire about Linear Predictive Analysis of Speech

UNIT I MECHANICS OF SPEECH

9

Speech production: Mechanism of speech production, Acoustic phonetics - Digital models for speech signals - Representations of speech waveform: Sampling speech signals, basics of quantization, delta modulation, and Differential PCM - Auditory perception: psycho acoustics.

UNIT II TIME DOMAIN METHODS FOR SPEECH PROCESSING

9

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

UNIT III FREQUENCY DOMAIN METHOD FOR SPEECH PROCESSING

9

COURSE OBJECTIVES:

- To understand the fundamentals of Millimeter wave devices and circuits.
- To understand the various components of Millimeter wave Communications system.
- To know the antenna design at Millimeter wave frequencies.

UNIT I INTRODUCTION 9

Millimeter wave characteristics- millimeter wave wireless, implementation challenges, Radio wave propagation for mm wave: Large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Emerging applications of millimeter wave communications.

UNIT II MM WAVE DEVICES AND CIRCUITS 9

Millimeter wave generation and amplification: Peniotrons, Ubitrons, Gyrotrons and Free electron lasers. HEMT, models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm wave devices, Consumption factor theory, Trends and architectures for mm wave wireless, ADC's and DAC's.

UNIT III MM WAVE COMMUNICATION SYSTEMS 9

Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM, Millimeter wave link budget, Transceiver architecture, Transceiver without mixer, Receiver without Oscillator, Millimeter wave calibration, production and manufacture, Millimeter wave design considerations.

UNIT IV MM WAVE MIMO SYSTEMS 9

Massive MIMO Communications, Spatial diversity of Antenna Arrays, Multiple Antennas, Multiple Transceivers, Noise coupling in MIMO system, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation.

UNIT V ANTENNAS FOR MM WAVE SYSTEMS 9

Antenna beamwidth, polarization, advanced beam steering and beam forming, mm wave design consideration, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Device to Device communications over 5G systems, Design techniques of 5G mobile.

TOTAL: 45 PERIODS**COURSE OUTCOMES:**

Upon completion the student will be able to

CO1: understand the Millimeter wave characteristics and implementation challenges faced.CO2:

understand Millimeter devices and circuits

CO3: apply his knowledge on the Modulation techniques for millimeter wave communicationsCO4:

design antenna for Millimeter wave frequencies

CO5: Familiar with Millimeter wave technology

TEXT BOOKS

1. Theodore S. Rappaport et al., *Millimeter Wave Wireless Communications*, Pearson, 1st Edition, 2015

REFERENCE BOOKS

1. Kai-Cheng Huang, Zhen Wang, *Millimeter Wave Communication Systems*, Wiley-IEEE, 2nd Edition,

2020.

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

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	2	2
2	3	3	2
3	3	3	3
4	3	3	3
5	3	2	3

1-Low, 2-medium, 3-high.

225COE11

ANALOG AND MIXED SIGNAL VLSI DESIGN

L T P C
3 0 0 3

COURSE OBJECTIVES

- To study the concepts of MOS large signal model and small signal model
- To understand the concepts of D/A conversion methods and their architectures.
- To learn filters for ADC.
- To study about the switched capacitor circuits.

UNIT I INTRODUCTION AND BASIC MOS DEVICES 9

Challenges in analog design-Mixed signal layout issues- MOSFET structures and characteristics large signal and small signal model of single stage Amplifier-Source follower- Common gate stage – Cascode Stage – large and small signal analysis of differential amplifier with active load, pole zero estimation, zero value time constant method, frequency response of CS, cascade and Cascode amplifiers.

UNIT II SUBMICRON CIRCUIT DESIGN 9

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

UNIT III DATA CONVERTERS 9

Static and dynamic errors in DAC and ADC – Architectures & Characteristics of Sample and Hold Digital to Analog Converters- DAC- R-2R, weighted DAC, multiplying DAC, segmented DAC and sigma delta DAC. ADC – Flash ADC, pipelined ADC, successive approximation ADC, sigma delta ADC

UNIT IV SNR IN DATA CONVERTERS 9

Overview of SNR of Data Converters- Clock Jitters- Improving Using Averaging – Decimating Filters for ADC- Band pass and High Pass Sinc Filters- Interpolating Filters for DAC.

UNIT V SWITCHED CAPACITOR CIRCUITS 9

Resistors, First order low pass Circuit, Switched capacitor Amplifier, Switched Capacitor Integrator – Design of flip around sample and hold circuit – pipelined ADC.

COURSE OUTCOMES:

Upon Completion of this course, students will be able to :

- CO1: Understand the Basic MOS devices characteristics & Analyze their frequency responses
- CO2: Design submicron circuit.
- CO3: Apply his knowledge on the DAC & ADC conversions.
- CO4: Analyze the SNR in Data converters.
- CO5: Design and analyze switched capacitor circuits

TEXT BOOKS

1. Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, McGraw-Hill, 2nd Edition, 2017.

REFERENCE BOOKS

1. Rudy Van de Plassche, *CMOS Integrated ADCs and DACs*, Springer, 2nd Edition, 2019.
2. J. Jacob Wikner, Mikael Gustavsson, Nianxiong Tan “CMOS Data Converters for Communications” Springer, 2000.
3. Van de Plassche, Rudy J., “CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters” Springer, 2003.

CO-PO Mapping

CO	PO 1	PO 2	PO 3
1	3	3	2
2	3	3	3
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4	3	2	3
5	3	3	3

4. 1-Low, 2-medium, 3-high.

225COE12

SENSOR NETWORKS AND IOT

L T P C

3 0 0 3

COURSE OBJECTIVES:

- Computer science, information technology and Electronics & Telecommunication engineering to understand the interconnection and integration of the physical world with the cyber space and begin designing and developing simple IoT devices.
- Illustrates end-to-end framework for Wireless Sensor Networks in IoT.
- Illustrates the IoT Standards and Protocols, Sensors and Actuators in IoT and IoT in the Cloud

UNIT I EMERGENCE OF IOT

9

Background and Vision, IoT as a Disruptive Technology, Standardization. **Concept of Smart Things / Objects:** Thing in the context of IoT, Needs of an IoT Thing, Commonly used Things can become smart, Machine to Machine (M2M) Technology

UNIT II WIRELESS SENSOR NETWORKS IN IOT

9

Introduction, Types of WSN and Their Architecture, Characteristics of Wireless Sensor Network, Network Topologies in Wireless Sensor Network, WSN Communication Protocols, Security in WSN, Distributed Sensor Network, Wireless Sensor Network Data Aggregation Approaches, Real World WSN Applications, Evolution of WSN Towards Internet of

Things, Quality of Information in WSN.

UNIT III IOT STANDARDS AND PROTOCOLS 9

An overview of Internet Principles, IPv6 and Its Role in IoT, Low Power Wide Area Network (LPWAN), Wireless Technologies supporting IoT applications.

Sensors and Actuators in IoT: Perception Layer of IoT, Understanding Various Commonly Used Sensors, Environment Measuring Sensors, Medical Sensors, Flow and Fluid Measuring Sensors, Range and Motion Capture Sensors, Actuators, IoT Examples.

UNIT IV Big IoT Data Science 9

Foundations and Principles of Big Data Science, Concept of a Data Lake/Swamp, Relation between Big Data and IoT, Big Data Analytics in IoT, Machine Learning and Deep Learning Tools.

UNIT V IoT in the Cloud 9

Cloud Computing and IoT: Introduction, Integrating Cloud computing with IoT, Cloud services oriented towards IoT, Selected Cloud Service providers, RESTful Web API design.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of course student should be able to

- CO1: Understand various concept of smart things and Internet of Things (IoT)
- CO2: Understand the evolution of WSN towards IOT
- CO3: Understanding of various IoT standards and measuring sensors.
- CO4: Understand the effects in Big data science.
- CO5: Understand the effects of Cloud services oriented towards IoT.

TEXT BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-On Approach*, VPT, 2nd Edition, 2018.

REFERENCE BOOKS

1. Rajkumar Buyya, Amir Vahid Dastjerdi, *Internet of Things: Principles and Paradigms*, Morgan Kaufmann, 1st Edition, 2016.

CO-PO Mapping

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1-Low, 2-medium, 3-high.

225COE13

RADAR SIGNAL PROCESSING

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the Radar Signal acquisition and sampling in multiple domains
- To provide clear instruction in radar DSP basics
- To equip the skills needed in both design and analysis of common radar algorithms

- To understand the basics of synthetic aperture imaging and adaptive array processing
- To illustrate how theoretical results are derived and applied in practice

UNIT I INTRODUCTION TO RADAR SYSTEMS 9

History and application of radar, basic radar function, elements of pulsed radar, review of signal processing concepts and operations, A preview of basic radar signal processing, radar system components, advanced radar signal processing.

UNIT II SIGNAL MODELS 9

Components of a radar signal, amplitude models, types of clutters, noise model and signal-to noise ratio, jamming, frequency models: the doppler shift, spatial models, spectral model.

UNIT III SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS 9

Domains and criteria for sampling radar signals, Sampling in the fast time dimension, Sampling in slow time: selecting the pulse repetition interval, sampling the doppler spectrum, Sampling in the spatial and angle dimension, Quantization, I/Q Imbalance and Digital I/Q.

UNIT IV RADAR WAVEFORMS 9

Introduction, The waveform matched filter, Matched filtering of moving targets, The ambiguity function, The pulse burst waveform, frequency-modulated pulse compression waveforms, Range sidelobe control for FM waveforms, the stepped frequency waveform, Phase-modulated pulse compression waveforms, COSTAS Frequency Codes.

UNIT V DOPPLER PROCESSING 9

Alternate forms of the Doppler spectrum, Moving target indication (MTI), Pulse Doppler processing, dwell-to-dwell stagger, Pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, MTI for moving platforms: adaptive displaced phase center antenna processing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of course student should be able to

- CO1: : Understand the fundamental principles of radar systems and their applications.
- CO2: : Analyze radar signal models including noise, clutter, and jamming effects.
- CO3: : Apply sampling and quantization techniques for pulsed radar signal processing.
- CO4: : Evaluate radar waveforms, matched filtering, and pulse compression methods.
- CO5: : Perform Doppler processing and moving target indication for practical radar scenarios.

TEXT BOOKS

1. Mark Richards, Fundamentals of Radar Signal Processing, McGraw-Hill, 3rd Edition, 2022.

REFERENCE BOOKS

1. Merrill Skolnik, *Introduction to Radar Systems*, McGraw-Hill, 3rd Edition, 2017.
2. Introduction To Radar Systems 3/E, Skolnik, McGraw Hill. 2017
3. Radar Principles, Peyton Z. Peebles, Wiley India 2009
4. And Marvin N. Cohen, Fred E. Nathanson, Radar Design Principles-Signal Processing and the environment PHI, 2nd edition, 2006.

CO-PO Mapping

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2. 1-Low, 2-medium, 3-high.

225COE14 TELECOMMUNICATION SYSTEM MODELING AND SIMULATION

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To enable the student to understand the various aspects of simulation methodology and Performance
- To appreciate the significance of selecting sampling frequency and modeling different types of signals and processing them
- To expose the student to the different simulation techniques, their pros and cons, to understand and interpret results using case studies

UNIT I SIMULATION METHODOLOGY

9

Introduction, Aspects of methodology, Performance Estimation, Simulation sampling frequency, Low pass equivalent simulation models for bandpass signals, Multicarrier signals, Non-linear and time varying systems, Post processing – Basic graphical techniques and estimation.

UNIT II RANDOM SIGNAL GENERATION & PROCESSING

9

Uniform random number generation, Mapping uniform random variables to an arbitrary pdf, Correlated and Uncorrelated Gaussian random number generation, PN sequence generation, Random signal processing, Testing of random number generators.

UNIT III MONTE CARLO SIMULATION

9

Fundamental concepts, Application to communication systems, Monte Carlo integration, Semi-analytic techniques, Case study: Performance estimation of a wireless system.

UNIT IV ADVANCED MODELS & SIMULATION TECHNIQUES

9

Modeling and simulation of non-linearities : Types, Memoryless non-linearities, Non-linearities with memory, Modeling and simulation of Time varying systems : Random process models, Tapped delay line model, Modeling and simulation of waveform channels, Discrete memoryless channel models, Markov model for discrete channels with memory.

UNIT V EFFICIENT SIMULATION TECHNIQUES

9

Tail extrapolation, pdf estimators, Importance Sampling methods, Case study: Simulation of a Cellular Radio System.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of course student should be able to

CO1: : Understand simulation methodology and performance estimation in telecommunication systems.

CO2: : Generate and process random signals for system modeling.

- CO3: : Apply Monte Carlo simulation techniques to evaluate communication system performance.
- CO4: : Model and simulate advanced communication systems including nonlinearities and time-varying channels.
- CO5: : Implement efficient simulation techniques and analyze results for cellular and wireless systems.

TEXT BOOKS

1. M. C. Jeruchim, P. Balaban, K. Shanmugan, *Simulation of Communication Systems*, Springer, 3rd Edition, 2019.

REFERENCE BOOKS

1. K. Pahlavan, A. H. Levesque, *Wireless Information Networks*, 2nd Edition, Wiley, 2005.
2. D. K. Cheng, *Analysis of Linear Systems*, Addison-Wesley, 1995.

CO-PO Mapping

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3. 1-Low, 2-medium, 3-high.

225COE15

INDUSTRIAL INTERNET OF THINGS AND INDUSTRY 4.0

L T P C

3 0 0 3

COURSE OBJECTIVES

- To provide foundational understanding of Industrial IoT (IIoT), Industry 4.0 concepts, architectures, and evolution.
- To familiarize students with industrial communication technologies, protocols, and IIoT system components.
- To develop skills in handling industrial data, analytics, AI/ML techniques, Digital Twins, and IIoT cybersecurity.
- To introduce Industry 4.0 enabling technologies such as AI, robotics, cobots, AR/VR, blockchain, and smart logistics.
- To enable learners to design, analyze, and evaluate IIoT applications through real-world case studies and mini-projects.

UNIT I INTRODUCTION TO IIOT AND INDUSTRY 4.0

9

Evolution from IoT to IIoT, Industry 1.0 to Industry 4.0 transformation, Key pillars of Industry 4.0, Smart factories: characteristics & architecture, Cyber-Physical Systems (CPS), Role of AI, big data, cloud computing in Industry 4.0, Applications of IIoT in manufacturing, energy, transportation, healthcare.

UNIT II IIOT ARCHITECTURE, TECHNOLOGIES & COMMUNICATION

9

IIoT reference architecture, Sensors, actuators, PLCs, SCADA systems, Wired protocols: Ethernet/IP, Modbus, PROFIBUS, Wireless protocols: Wi-Fi, Bluetooth, ZigBee, LoRaWAN, NB-IoT, Industrial protocols: OPC-UA, MQTT, AMQP, CoAP, Edge, Fog, and Cloud computing in IIoT, Industrial networks & time-sensitive networking (TSN)

UNIT III DATA MANAGEMENT, ANALYTICS & SECURITY IN IIOT 9

Industrial data acquisition & preprocessing, Big data analytics for IIoT, Predictive maintenance using ML, Condition monitoring of machines, Digital Twins concept & implementation, Security requirements in IIoT systems, Secure communication protocols, encryption, authentication, access control, Fault detection & diagnosis in industrial systems.

UNIT IV INDUSTRY 4.0 ENABLING TECHNOLOGIES 9

AI & ML in smart industries, Robotics and autonomous systems, Additive manufacturing (3D printing), AR & VR in industry, Cloud Manufacturing, Smart logistics & supply chain automation, Human-machine collaboration (cobots), Blockchain for industrial applications.

UNIT V IIOT APPLICATIONS, CASE STUDIES 9

Smart manufacturing & assembly lines, Smart grids & energy systems, Industrial automation and process optimization, Intelligent transportation and fleet management, Oil & gas monitoring systems, Smart agriculture with IIoT, Real-time dashboards and industrial KPIs, Case studies: Siemens MindSphere, GE Predix, Bosch IoT Suite, AWS IoT.

TOTAL : 45 PERIODS

COURSE OUTCOMES

Upon Completion of this course, students will be able to :

- CO1:** Explain the concepts, evolution, and architecture of IIoT and Industry 4.0.
- CO2:** Apply industrial communication technologies, protocols, and IIoT platforms.
- CO3:** Analyze industrial data using analytics, AI/ML, and ensure IIoT system security.
- CO4:** Explore and integrate enabling technologies of Industry 4.0 in industrial automation.
- CO5:** Design IIoT-based applications and evaluate real-world industrial case studies.

TEXT BOOKS

1. Alasdair Gilchrist, *Industry 4.0: The Industrial Internet of Things*, Apress, 2nd Edition, 2023.

REFERENCE BOOKS

1. Klaus Schwab, *The Fourth Industrial Revolution*, Crown Business, 2nd Edition, 2017.
2. Rajkumar Buyya et al., *Cloud Computing and Big Data Technologies*, Morgan Kaufmann, 1st Edition, 2019.
3. Wolfgang Wahlster, *Foundations of Industry 4.0 and Cyber-Physical Systems*, Springer, 1st Edition, 2021.
4. R. K. Rajput, *Industrial Automation: Concepts, Tools and Techniques*, S. Chand Publishing, 2nd Edition, 2019.
5. Pethuru Raj, Anupama C. Raman, *The Internet of Things: Enabling Technologies, Platforms, and Use Cases*, CRC Press, 1st Edition, 2017.

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