PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- To provide students with strong fundamental concepts and also advanced techniques and tools to build various communication systems.

- To enable graduates to attain successful professional careers by applying their engineering skills in communication system design to meet out the challenges in industries and academia.

- To engage graduates in lifelong learning, adapt emerging technology and pursue research for the development of innovative products.

PROGRAM OUTCOMES (POS):

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**PROGRAMME SPECIFIC OBJECTIVES (PSOs)**
- To inculcate the ability in graduates to design and analyze the subsystems such as RF, Signal Processing, Modern communication systems and networks.
- To enhance problem solving skills in communication systems design using latest hardware and software tools.
- To apply communication engineering principles and practices for developing products for scientific and business applications.

**MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) WITH PROGRAMME OUTCOMES (POs):**

The mapping between the Programme Educational Objectives (PEOs) and the Programme Outcomes (POs) is given in the following table

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ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
M.E. COMMUNICATION SYSTEMS
REGULATIONS – 2017
CHOICE BASED CREDIT SYSTEM
CURRICULA AND SYLLABI

SEMMESTER - I

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OBJECTIVES:
The primary objective of this course is to demonstrate various analytical skills in applied mathematics and extensive experience with the tactics of problem solving and logical thinking applicable in communication engineering. This course also will help the students to identify, formulate, abstract, and solve problems in electrical engineering using mathematical tools from a variety of mathematical areas, including linear algebra, matrix linear programming, probability, numerical solution of ordinary differential equations and queuing models.

UNIT I  LINEAR ALGEBRA  12

UNIT II  LINEAR PROGRAMMING  12

UNIT III  NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS  12

UNIT IV  PROBABILITY AND RANDOM VARIABLES  12
Probability – Axioms of probability – Conditional probability – Baye’s theorem - Random variables - Probability function - Two dimensional random variables - Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

UNIT V  QUEUEING MODELS  12

TOTAL: 60 PERIODS

OUTCOMES:
After completing this course, students should demonstrate competency in the following skills:

- Concepts on vector spaces, linear transformation, inner product spaces, eigenvalues and generalized eigenvectors.
- Apply various methods in linear algebra to solve system of linear equations.
- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- Numerical solution of differential equations by single and multistep methods.
- Computation of probability, random variables and their associated distributions, correlations and regression.
- Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
- Exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models.
- Using discrete time Markov chains to model computer systems.
REFERENCES:

CU5191 ADVANCED RADIATION SYSTEMS  L T P C
3 0 0 3

OBJECTIVES:
• To understand antenna radiation and its parameters.
• To enhance the student knowledge in the area of various antenna design.
• To design mono pole, dipole and patch antenna and to impart the knowledge about modern antennas.

UNIT I ANTENNA FUNDAMENTALS
Wave equations, radiation pattern, HPBW, FNBW, gain and directivity, polarization, equivalent circuit, radiation resistance, Radiation integrals, Radiation from surface and line current distributions – dipole, monopole, loop antenna, Antenna parameters, Image theory; Induction, reciprocity theorem, Balance to unbalance transformer, Introduction to numerical techniques.

UNIT II RADIATION FROM APERTURES
Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture, distribution on an infinite ground plane; Slot antenna; Horn antenna; Reflector antenna, aperture blockage, design considerations.

UNIT III ARRAYS
Introduction-General structure of phased array, linear array theory, variation of gain as a function of pointing direction, effects of phase quantization, frequency scanned arrays, analog beam forming matrices-Active modules, digital beam forming, MEMS technology in phased arrays-Retrodirective and self phased arrays.

UNIT IV MICRO STRIP ANTENNA
Radiation mechanism from patch; Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch, and Ring antenna – radiation analysis from transmission line model, cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Applications of microstrip array antenna.

UNIT V SPECIAL ANTENNAS AND MEASUREMENTS
Mobile phone antenna, base station, hand set antenna, UWB antenna, PIFA, Vivaldi antenna, Antenna for automobiles, Broadband antenna, antenna factor, Gain, impedance and radiation pattern measurements, Test sites and anechoic chamber.

TOTAL : 45 PERIODS
OUTCOMES:
- Ability to understand antenna concepts
- Ability to design antenna for various applications
- Knowledge of modern antenna design

REFERENCES:

ADVANCED DIGITAL COMMUNICATION TECHNIQUES

OBJECTIVES:
- To understand the basics of signal-space analysis and digital transmission.
- To understand the coherent and noncoherent receivers and its impact on different channel characteristics.
- To understand the different Equalizers.
- To understand the different block coded and convolutional coded digital communication systems.
- To understand the basics of Multicarrier and Multiuser Communications.

UNIT I COHERENT AND NON-COHERENT COMMUNICATION

UNIT II EQUALIZATION TECHNIQUES

UNIT III BLOCK CODED DIGITAL COMMUNICATION
Architecture and performance – Binary block codes; Orthogonal; Biorthogonal; Transorthogonal – Shannon’s channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hammning; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes.
UNIT IV CONVOLUTIONAL CODED DIGITAL COMMUNICATION 9

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

OUTCOMES:
Upon Completion of the course, the students will be able to:

- Develop the ability to understand the concepts of signal space analysis for coherent and non-coherent receivers.
- Conceptually appreciate different Equalization techniques
- Possess knowledge on different block codes and convolutional codes.
- Comprehend the generation of OFDM signals and the techniques of multiuser detection.

REFERENCES:

AP5152 ADVANCED DIGITAL SIGNAL PROCESSING L T P C
3 2 0 4

OBJECTIVES:
- The student comprehends mathematical description and modelling of discrete time random signals.
- The student is conversant with important theorems and random signal processing algorithms.
- The student learns relevant figures of merit such as power, energy, bias and consistency.
- The student is familiar with estimation, prediction, filtering, multirate concepts and techniques.

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9+6
UNIT II  SPECTRUM ESTIMATION  9+6

UNIT III  SIGNAL MODELING AND OPTIMUM FILTERS  9+6

UNIT IV  ADAPTIVE FILTERS  9+6

UNIT V  MULTIRATE SIGNAL PROCESSING  9+6
Decimation - Interpolation - Sampling Rate conversion by a rational factor I/D – Multistage implementation of sampling rate conversion – Polyphase filter structures – Applications of multirate signal processing.

TOTAL 45+30: 75 PERIODS

OUTCOMES:
• Formulate time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts.
• State W-K theorem, spectral factorization theorem, spectrum estimation, bias and consistency of estimators.
• Wiener filtering, LMS algorithms, Levinson recursion algorithm, applications of adaptive filters
• Decimation, interpolation, Sampling rate conversion, Applications of multirate signal processing

REFERENCES:

CU5192  OPTICAL NETWORKS  L T P C  3 0 0 3

OBJECTIVES:
The students should be made to understand:
• Optical system components like optical amplifiers, wavelength converters.
• Up-to-date survey of development in Optical Network Architectures.
• Packet switching.
• Network design perspectives.
• Different Optical Network management techniques and functions.

UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V
Network topologies and protection schemes: Robust networks, Line and path protection switching, Types of topology, Point to point topology, bi-directional line-switched ring (BLSR), meshed topology, Passive optical networks, Metro optical networks 28 MPLS and Optical Networks: IS label switching, Forwarding equivalence class (FEC), Types of MPLS nodes, Label distribution and binding, label swapping and traffic forwarding, MPLS support of Virtual Private Networks (VPN), MPLS traffic engineering, Multi protocol Lambda switching (MPIS).

OUTCOMES:
At the end of the course, the student should be able to:
• Design and Analyze Network Components
• Assess and Evaluate optical networks

REFERENCES:
2. Optical Networks, Third Generation Transport Systems, Ulysses Black, Pearson
OBJECTIVES:
- To acquire knowledge on Transmission line and S-parameter estimation of microwave devices.
- To introduce the basics of Microstrip Patch Antenna and its analysis.
- 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
USE NETWORK ANALYSER FOR THE FOLLOWING EXPERIMENTS:
1. Measurement of transmission line parameters.
3. Design and testing of a Microstrip coupler.

USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:
1. Generation & detection of binary digital modulation techniques.
2. Spread Spectrum communication system-Pseudo random binary sequence generation-Baseband DSSS.
3. Digital Filter Design
4. Performance evaluation of simulated CDMA system
5. Channel equalizer design(LMS,RLS)
6. Antenna Radiation Pattern measurement

TOTAL: 60 PERIODS

OUTCOMES:
Upon the completion of course, students are able to
- Measure and analyze various transmission line parameters.
- Design Microstrip patch antennas.
- Implement the adaptive filtering algorithms
- To generate and detect digital communication signals of various modulation techniques using MATLAB.
- Evaluate cellular mobile communication technology and propagation model.
UNIT I  INFORMATION THEORETIC ASPECTS OF MIMO  
Review of SISO fading communication channels, MIMO Channel models, Classical i.i.d. and extended channels, Frequency selective and correlated channels models, Capacity of MIMO channels, Ergodic and outage capacity, capacity bounds and influence of channel properties on the capacity.

UNIT II  MIMO DIVERSITY AND SPATIAL MULTIPLEXING  
Sources and types of diversity, analysis under Rayleigh fading, Diversity and channel knowledge. Alamouti space time code. MIMO spatial multiplexing: Space time receivers, ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade - off.

UNIT III  MASSIVE MIMO SYSTEM  
Introduction - MIMO for LTE, capacity of massive MIMO, Pilot Design for massive MIMO, Resource allocation and transceivers design, Base band and RF implementation, Channel Models.

UNIT IV  MILLIMETER WAVE COMMUNICATION  
Spectrum regulation, Channel propagation, Hardware technology for mmW systems, architecture and mobility, Beam forming techniques, Beam finding, Physical layer techniques - Duplex scheme and Transmission Scheme.

UNIT V  SOFTWARE DEFINED RADIO AND COGNITIVE RADIO  
SDR - Definition, Origin, key characteristic, hardware and software architecture, waveforms. Cognitive Radio - Definitions, Cognitive theories, architectures, Cognitive radio as self controlling system, Ontology based cognitive radio.

OUTCOMES:  
At the end of the course, the student should be able to:
- Analyze MIMO system.
- Discuss millimeter wave communication.
- Demonstrate software defined radio and cognitive radio.

REFERENCES:

CU5201  MIC AND RF SYSTEM DESIGN  
L  T  P  C  3  0  0  3

OBJECTIVES:
- To understand the fundamentals of RF design and Microwave integrated circuits.
- To understand the various components of RF system for Wireless Communications.
- To know the basic techniques needed for analysis of RF systems.
UNIT I  CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES  9
CMOS: Introduction to MOSFET Physics, Noise: Thermal, shot, flicker, popcorn noise transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures, Transmitter: Direct up conversion, Two step up conversion schemes.

UNIT II  IMPEDANCE MATCHING AND AMPLIFIERS  9

UNIT III  FEEDBACK SYSTEMS AND POWER AMPLIFIERS  9
Feedback Systems: Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation Power Amplifiers: General model – Class A, AB, B, C, D, E and F amplifiers, Linearization Techniques, Efficiency boosting techniques, ACPR metric, Design considerations

UNIT IV  RF FILTER, OSCILLATOR, MIXER  9
Overview-basic resonator and filter configuration, special filter realizations, filter implementation. Basic oscillator model, high frequency oscillator configuration, basic characteristics of mixers, phase locked loops, RF directional couplers, hybrid couplers, detector and demodulator circuits.

UNIT V  MIC COMPONENTS  9
Introduction to MICs, Fabrication Technology, Advantages and applications, MIC components- Micro strip components, Coplanar circuits: Transistors, switches, active filters. Coplanar microwave amplifiers: LNA design and Medium power amplifiers.

TOTAL : 45 PERIODS

OUTCOMES:
• Capability to design RF circuits.
• To be able to analyze RF circuits.

REFERENCES:

CU5292 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY  L T P C
3 0 0 3

OBJECTIVES:
The students should be made to be familiar with:
• The basics of EMI
• EMI sources.
- EMI problems.
- Solution methods in PCB.
- Measurements techniques for emission.
- Measurement techniques for immunity.

UNIT I BASIC THEORY
Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories EMC Engineering Application.

UNIT II COUPLING MECHANISM
Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radioactive coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.

UNIT III EMI MITIGATION TECHNIQUES
Working principle of Shielding and Murphy’s Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient Protection.

UNIT IV STANDARD AND REGULATION

UNIT V EMI TEST METHODS AND INSTRUMENTATION
Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber, Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods.

OUTCOMES:
At the end of this course, the student should be able to:
- Identify Standards
- Compare EMI test methods
- Discuss EMI mitigation techniques
REFERENCES:
5. Electromagnetic Compatibility by Norman Violette, Published by Springer, 2013
Publisher-Don white consultants Original from the University of Michigan Digitized Dec 2007

CU5211 RF SYSTEM DESIGN LABORATORY L T P C
0 0 4 2

OBJECTIVES:
• To enable the students to verify the basic principles and design aspects involved in high frequency communication systems components
• To expose the student to different high frequency components and conduct the experiments to analyze and interpret data to produce meaningful conclusion and match with theoretical concepts.
• To design and develop RF components using microstrip technology

LIST OF EXPERIMENTS:
(ADS/IE3D/HFSS or any similar/ equivalent tool may be used for the design)
1. Measurement of S parameters for a) Inductor b) Capacitor c) impedance matching circuits, filters using network analyzer
2. Design of λ/2, λ/4 microstrip transmission line.
3. Design of microstrip inductor and capacitor.
5. Design of low pass, high pass, band pass and band stop filter at RF.
6. Design and characterization of micro strip patch antennas
7. Design and characterization of LNA
8. Design and characterization of Mixer
9. Design and characterization of VCO

TOTAL: 60 PERIODS
OUTCOMES:
Upon Completion of the course, the students will be able to:
  • Apply knowledge to identify a suitable architecture and systematically design an RF system.
  • Comprehensively record and report the measured data, and would be capable of analyzing, interpreting the experimentally measured data and produce the meaningful conclusions.
  • Design and develop microstrip filters.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:
Network analyser Equipment - 1.5 GHz (Minimum) - 1 No
ADS/IE3D/HFSS or any similar / equivalent Electromagnetic Simulation tool for Design experiments - 10 User license
Desktop PC’s for hosting Electromagnetic simulation tool – 10 Numbers
Inductor, Capacitor, matching circuits, filters capable of operating at 500 MHz or above

CP5281 TERM PAPER WRITING AND SEMINAR L T P C
0 0 2 1

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.

Activity to be carried Out

<table>
<thead>
<tr>
<th>Activity</th>
<th>Instructions</th>
<th>Submission week</th>
<th>Evaluation</th>
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<tbody>
<tr>
<td>Selection of area of interest</td>
<td>You are requested to select an area of interest, topic and state an objective</td>
<td>2nd week</td>
<td>3 % Based on clarity of thought, current relevance and clarity in writing</td>
</tr>
<tr>
<td>Topic</td>
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<tr>
<td>Stating an Objective</td>
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</table>
| Collecting Information about your area & topic | 1. List 1 Special Interest Groups or professional society  
2. List 2 journals  
3. List 2 conferences, symposia or workshops  
4. List 1 thesis title  
5. List 3 web presences (mailing lists, forums, news sites)  
6. List 3 authors who publish regularly in your area  
7. Attach a call for papers (CFP) from your area. | 3rd week | 3%  
( the selected information must be area specific and of international and national standard) |
|---|---|---|---|
| Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter | • You have to provide a complete list of references you will be using - Based on your objective - Search various digital libraries and Google Scholar  
• When picking papers to read - try to:  
  • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them,  
  • Favour papers from well-known journals and conferences,  
  • Favour “first” or “foundational” papers in the field (as indicated in other people’s survey paper),  
  • Favour more recent papers,  
  • Pick a recent survey of the field so you can quickly gain an overview,  
  • Find relationships with respect to each other and to your topic area (classification scheme/categorization)  
  • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered | 4th week | 6%  
( the list of standard papers and reason for selection) |
| Reading and notes for first 5 papers | Reading Paper Process  
• For each paper form a Table answering the following questions:  
  • What is the main topic of the article?  
  • What was/were the main issue(s) the author said they want to discuss?  
  • Why did the author claim it was important?  
  • How does the work build on other’s work, in the author’s opinion?  
  • What simplifying assumptions does the author claim to be making?  
  • What did the author do?  
  • How did the author claim they were going to evaluate their work and | 5th week | 8%  
( the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper) |
<table>
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<tr>
<th>Activity</th>
<th>Activity Description</th>
<th>Week</th>
<th>Evaluation Criteria</th>
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</thead>
<tbody>
<tr>
<td>Reading and notes for next 5 papers</td>
<td>Repeat Reading Paper Process</td>
<td>6th</td>
<td>8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)</td>
</tr>
<tr>
<td>Reading and notes for final 5 papers</td>
<td>Repeat Reading Paper Process</td>
<td>7th</td>
<td>8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)</td>
</tr>
<tr>
<td>Draft outline 1 and Linking papers</td>
<td>Prepare a draft Outline, your survey goals, along with a classification / categorization diagram</td>
<td>8th</td>
<td>8% (this component will be evaluated based on the linking and classification among the papers)</td>
</tr>
<tr>
<td>Abstract</td>
<td>Prepare a draft abstract and give a presentation</td>
<td>9th</td>
<td>6% (Clarity, purpose and conclusion) 6% Presentation &amp; Viva Voce</td>
</tr>
<tr>
<td>Introduction Background</td>
<td>Write an introduction and background sections</td>
<td>10th</td>
<td>5% (clarity)</td>
</tr>
<tr>
<td>Sections of the paper</td>
<td>Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey</td>
<td>11th</td>
<td>10% (this component will be evaluated based on the linking and classification among the papers)</td>
</tr>
<tr>
<td>Your conclusions</td>
<td>Write your conclusions and future work</td>
<td>12th</td>
<td>5% (conclusions – clarity and your ideas)</td>
</tr>
<tr>
<td>Final Draft</td>
<td>Complete the final draft of your paper</td>
<td>13th</td>
<td>10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report</td>
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</table>
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
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
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
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
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 ANTEÑAS FOR MM WAVE SYSTEMS
Antenna beamwidth, polarization, advanced beam steering and beam forming, mm wave design consideration, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Device to Device communications over 5G systems, Design techniques of 5G mobile.

TOTAL: 30 PERIODS

CU5301 MILLIMETER WAVE COMMUNICATIONS

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TOTAL: 45 PERIODS
OUTCOMES:
- Ability to understand Millimeter devices and circuits
- Ability to design antenna for Millimeter wave frequencies
- Knowledge of Millimeter wave technology

REFERENCES:

CU5091 ADVANCED SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS

OBJECTIVES:
The students should be made to be
- Learn M2M developments and satellite applications
- Understand Satellite Communication In Ipv6 Environment

UNIT I OVERVIEW OF SATELLITE COMMUNICATION
Overview of satellite communication and orbital mechanics Link budget Parameters, Link budget calculations, Auxiliary Equations, Performance Calculations.

UNIT II M2M DEVELOPMENTS AND SATELLITE APPLICATIONS

UNIT III SATELLITE COMMUNICATION IN IPV6 ENVIRONMENT

UNIT IV SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM

UNIT V DEEP SPACE NETWORKS AND INTER PLANETARY MISSIONS
OUTCOMES:
At the end of this course, the student should be able to:

- Discuss satellite navigation and global positioning system
- Outline deep space networks and inter planetary missions

REFERENCES:


DS5191 DSP PROCESSOR ARCHITECTURE AND PROGRAMMING 3 0 0 3

OBJECTIVES:
The objective of this course is to provide in-depth knowledge on

- Digital Signal Processor basics
- Third generation DSP Architecture and programming skills
- Advanced DSP architectures and some applications.

UNIT I FUNDAMENTALS OF PROGRAMMABLE DSPs
Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.

UNIT II TMS320C5X PROCESSOR
Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

UNIT III TMS320C6X PROCESSOR

UNIT IV ADSP PROCESSORS
Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.
UNIT V ADVANCED PROCESSORS

TOTAL : 45 PERIODS

OUTCOMES:
Students should be able to:
- Become Digital Signal Processor specialized engineer
- DSP based System Developer

REFERENCES:

CU5001 ANALOG AND MIXED MODE VLSI DESIGN L T P C 3 0 0 3

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 Challenges in analog design-Mixed signal layout issues- MOS FET 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 cascade amplifiers

UNIT II SUBMICRON CIRCUIT DESIGN Submicron CMOS process flow, Capacitors and resistors, Current mirrors, Digital Circuit Design, Delay Elements – Adders- OP Amp parameters and Design

UNIT III DATA CONVERTERS 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.

TOTAL: 45PERIODS

OUTCOMES:
At the end of this course, the student should be able to:
- Discuss submicron circuit design
- Compare data converters
- Design and analyze switched capacitor circuits

REFERENCES:

CU5092  REAL TIME EMBEDDED SYSTEMS  LT P C
3 0 0 3

OBJECTIVES:
- To study the basic concepts of ARM processors
- To understand the computing platform and design analysis of ARM processors
- To study the concepts of Operating systems in ARM
- To study the concept of embedded networks
- To understand case studies related to embedded systems

UNIT I  INTRODUCTION TO ARM PROCESSORS  9

UNIT II  COMPUTING PLATFORM AND DESIGN ANALYSIS  9
CPU buses – Memory devices – I/O devices – Memory Protection Units – Memory Management Units – Component interfacing – Design with microprocessors – Development and Debugging – Program design – Model of programs – Assembly and Linking – Basic compilation techniques – Analysis and optimization of execution time, power, energy, program size – Program validation and testing.

UNIT III  PROCESS AND OPERATING SYSTEMS  9

UNIT IV  HARDWARE ACCELERATES & NETWORKS  9
Accelerators – Accelerated system design – Distributed Embedded Architecture – Networks for Embedded Systems – Network based design – Internet enabled systems.
UNIT V CASE STUDY
Hardware and software co-design - Data Compressor - Software Modem – Personal Digital Assistants – Set–Top–Box. – System-on-Silicon – FOSS Tools for embedded system development.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the student should be able to:
- Revise computing platform and design analysis
- Demonstrate multiple tasks and multi processes
- Discuss hardware and software co-design

REFERENCES:

VL5091 MEMS AND NEMS

OBJECTIVES:
- To introduce the concepts of micro electro mechanical devices.
- To know the fabrication process of Microsystems.
- To know the design concepts of micro sensors and micro actuators.
- To familiarize concepts of quantum mechanics and nano systems.

UNIT I OVERVIEW

UNIT II MEMS FABRICATION TECHNOLOGIES

UNIT III MICRO SENSORS
MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Microsensors. Case study: Piezo-resistive pressure sensor.
UNIT IV  MICRO ACTUATORS  

UNIT V  NANOSYSTEMS AND QUANTUM MECHANICS  
Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

OUTCOMES:  
At the end of this course, the student should be able to:
- Discuss micro sensors
- Explain micro actuators
- Outline nanosystems and Quantum mechanics

REFERENCES:  

CU5002  COMMUNICATION NETWORKS MODELLING AND SIMULATION  
OBJECTIVES:  
The students should be made to be
- Learn modeling and simulation
- Understand Monte Carlo simulation
- Study channel modeling and mobility modeling

UNIT I  INTRODUCTION TO MODELING AND SIMULATION  

UNIT II  MONTE CARLO SIMULATION  
Fundamental concepts, Application to communication systems, Monte Carlo integration, Semianalytic techniques, Case study: Performance estimation of a wireless system.

UNIT III  LOWER LAYER & LINK LAYER WIRELESS MODELING  
UNIT IV CHANNEL MODELING & MOBILITY MODELING 9

UNIT V HIGHER LAYER MODELING & MODELING THE NETWORK TOPOLOGY 9


OUTCOMES:
At the end of this course, the student should be able to
- Apply Monte Carlo simulation
- Discuss Lower Layer and Link Layer Wireless Modeling
- Compare channel modeling and mobility modeling

REFERENCES:

CU5071 DIGITAL COMMUNICATION RECEIVERS L T P C 30 0 3

OBJECTIVES:
- To understand the basic principles of digital communication techniques.
- To gain knowledge about receivers for AWGN channel and Fading channels.
- To understand the concepts of synchronization and adaptive equalization techniques.

UNIT I REVIEW OF DIGITAL COMMUNICATION TECHNIQUES 9
Base band communication; signal space representation, linear and nonlinear modulation techniques, Error tracking and Spectral characteristics of digital modulation.

UNIT II OPTIMUM RECEIVERS FOR AWGN CHANNEL 9
Correlation demodulator, matched filter, maximum likelihood sequence detector, optimum receiver for CPM signals, optimum receivers for signals with random phase in AWGN channel, envelope detection of M-ary orthogonal signals and correlated binary signals.
UNIT III RECEIVERS FOR FADING CHANNELS
Characterization of fading multiple channels, statistical models, flat and frequency selective fading, diversity technique, parameter synchronization for flat fading channels, digital signaling over a frequency selective and slowly fading channel, coded waveform for fading channel.

UNIT IV SYNCHRONIZATION TECHNIQUES
Carrier and signal synchronization, carrier phase estimation-PLL, Decision directed loops, symbol timing estimation, maximum likelihood and non-decision directed timing estimation, joint estimation.

UNIT V ADAPTIVE EQUALIZATION

OUTCOMES:
Upon Completion of the course, the students will be able to
- Apply basic principles of digital communication techniques.
- Discuss on receivers for AWGN & Fading channel
- Describe various synchronization techniques.
- Design adaptive equalization algorithms to satisfy the evolving demands in digital communication.

REFERENCES:

CU5072 DETECTION AND ESTIMATION THEORY

OBJECTIVES:
- To understand the concepts of detection and estimation.
- To learn the basics of multi-user detection theory
- To understand the theory behind various estimation techniques.
- To understand Wiener filter and Kalman filter in detail.

UNIT I REVIEW OF PROBABILITY AND STOCHASTIC PROCESS

TOTAL: 45 PERIODS
UNIT II  SINGLE AND MULTIPLE SAMPLE DETECTION  9
Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson Criterion, Sequential Detection, The Optimum Digital Detector in Additive Gaussian Noise , Performance of Binary Receivers in AWGN.

UNIT III  FUNDAMENTALS OF ESTIMATION THEORY  9

UNIT IV  WIENER AND KALMAN FILTERS  9

UNIT V  APPLICATIONS  9
Detector Structures in Non-Gaussian Noise , Examples of Noise Models, Receiver Structures, and Error-Rate Performance, Estimation of Non-Gaussian Noise Parameters Fading Multipath Channel Models, Receiver Structures with Known Channel Parameters, Receiver Structures without Knowledge of Phase, Receiver Structures without Knowledge of Amplitude or Phase, Receiver Structures and Performance with No Channel Knowledge.

TOTAL: 45 PERIODS

OUTCOMES:
- To be able to apply detection and estimation theory to solve communication problems.
- To apply probability and stochastic process concepts in detection and estimation.
- To design Wiener and Kalman filters to solve linear estimation problems.

REFERENCES:

CU5073  VLSI FOR WIRELESS COMMUNICATION  L T P C  3 0 0 3

OBJECTIVES:
- To understand the concepts of basic wireless communication concepts.
- To study the parameters in receiver and low noise amplifier design.
- To study the various types of mixers designed for wireless communication.
- To study and design PLL and VCO.
- To understand the concepts of transmitters and power amplifiers in wireless communication.
UNIT I COMMUNICATION CONCEPTS

UNIT II RECEIVER ARCHITECTURE & LOW NOISE AMPLIFIERS
Receiver front end – Filter design – Non-idealities – Design parameters – Noise figure & Input intercept point. LNA Introduction – Wideband LNA design – Narrow band LNA design: Impedance matching & Core amplifier.

UNIT III MIXERS

UNIT IV FREQUENCY SYNTHESIZERS
PLL – Phase detector – Dividers – Voltage Controlled Oscillators – LC oscillators – Ring Oscillators – Phase noise – Loop filters & design approaches – A complete synthesizer design example (DECT) – Frequency synthesizer with fractional divider.

UNIT V TRANSMITTER ARCHITECTURES & POWER AMPLIFIERS
Transmitter back end design – Quadrature LO generator – Power amplifier design.

TOTAL : 45 PERIODS

OUTCOMES:
At the end of this course, the student should be able to
- Design LNA and Mixers
- Evaluate frequency synthesizers
- Design and analyze power amplifiers

REFERENCES:

NC5251 COGNITIVE RADIO NETWORKS
L T P C
3 0 0 3

OBJECTIVES:
The students should be made to be
- Understand the concepts of cognitive radio
- Learn spectrum sensing and dynamic spectrum access
UNIT I  INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO

Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

UNIT II  COGNITIVE RADIO ARCHITECTURE


UNIT III  SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS


UNIT IV  MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO

MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques.

UNIT V  ADVANCED TOPICS IN COGNITIVE RADIO


TOTAL : 45 PERIODS

OUTCOMES:

At the end of this course, the student should be able to
- Compare MAC and network layer design for cognitive radio
- Discuss cognitive radio for Internet of Things and M2M technologies

REFERENCES:

OBJECTIVES:
- To understand the antenna radiation characteristics and arrays.
- To enhance the student knowledge in the area of various antenna design.
- To enhance the student knowledge in the area of antenna for practical applications.

UNIT I   ANTENNA FUNDAMENTALS AND ARRAYS  9

UNIT II  MICRO STRIP ANTENNA  9
Radiation Mechanism from patch; transmission line model based analysis, cavity model, Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch, Microstrip Yagi antenna, Microstrip array, Gain improvement techniques in microstrip antenna.

UNIT III APERTURES AND REFLECTOR ANTENNAS  9
Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture distribution on an infinite ground plane, Babinet's principle, Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration, Design of C band and Ku band reflector antenna.

UNIT IV MODERN ANTENNA STRUCTURES  9
Frequency independent antenna, spiral antenna, active antenna, dielectric antenna, Leaky wave antenna, Plasma antenna, wearable antenna, reconfigurable antenna, meta material, EBG antenna, Frequency selective structures, Broad band and multi band antenna, Antenna for cellular base stations, MIMO antennas.

UNIT V  ANTENNA FOR SPECIAL APPLICATIONS  9
Antenna for EMI/EMC testing, Antenna for EM issues in medical diagnosis and treatment, Antenna for MRI systems, Antenna for 60 GHz applications, RFID antenna, Antenna for wireless charging systems, Antenna for automobile radar, Terahertz antennas, antenna for sensor applications.

TOTAL : 45 PERIODS

OUTCOMES:
- The student would be able to understand recent design techniques in antenna.
- Ability to design and assess the performance of various antenna
- The student would be able to design the antenna for various industrial, medical and sensor applications.

REFERENCES:
OBJECTIVES:
- To understand the image fundamentals.
- To understand the various image segmentation techniques.
- To extract features for image analysis.
- To introduce the concepts of image registration and image fusion.
- To illustrate 3D image visualization.

UNIT I  FUNDAMENTALS OF DIGITAL IMAGE PROCESSING  9
Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, SVD. Image enhancement in spatial and frequency domain, Review of Morphological image processing.

UNIT II  SEGMENTATION  9
Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour models, Texture feature based segmentation, Graph based segmentation, Wavelet based Segmentation - Applications of image segmentation.

UNIT III  FEATURE EXTRACTION  9
First and second order edge detection operators, Phase congruency, Localized feature extraction - detecting image curvature, shape features, Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Runlength features, Fractal model based features, Gabor filter, wavelet features.

UNIT IV  REGISTRATION AND IMAGE FUSION  9

UNIT V  3D IMAGE VISUALIZATION  9
Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiple connected surfaces, Image processing in 3D, Measurements on 3D images.

OUTCOMES:
Upon Completion of the course, the students will be able to
- Explain the fundamentals digital image processing.
- Describe image various segmentation and feature extraction techniques for image analysis.
- Discuss the concepts of image registration and fusion.
- Explain 3D image visualization.

TOTAL: 45 PERIODS
REFERENCES:

DS5292 RADAR SIGNAL PROCESSING

OBJECTIVES:
- To understand the basic concepts of Radar systems and Signal models.
- To illustrate the concepts of Sampling and Quantization of pulsed radar signals.
- To provide in-depth knowledge in Radar waveforms and Doppler processing.

UNIT I INTRODUCTION TO RADAR SYSTEMS
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
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
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
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
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
OUTCOMES:
Upon completion of the course, students will be able to:

- Explain the principles of elements and functions involved in radar signal processing.
- Describe different types of radar waveforms.
- Discuss on Doppler processing and its issues

REFERENCES:
1. Francois Le Chevalier, "Principles of Radar and Sonar Signal Processing", Artech House
5. Peyton Z. Peebles, "Radar Principles", 2009 Wiley India

CP5096 SPEECH PROCESSING AND SYNTHESIS L T P C
3 0 0 3

OBJECTIVES:
- To introduce speech production and related parameters of speech.
- To illustrate the concepts of speech signal representations and coding.
- To understand different speech modeling procedures such as Markov and their implementation issues.
- To gain knowledge about text analysis and speech synthesis.

UNIT I FUNDAMENTALS OF SPEECH PROCESSING 9

UNIT II SPEECH SIGNAL REPRESENTATIONS AND CODING 9

UNIT III SPEECH RECOGNITION 9

UNIT IV TEXT ANALYSIS 9

UNIT V SPEECH SYNTHESIS 9

TOTAL: 45 PERIODS
OUTCOMES:
Students will be able to:
- Model speech production system and describe the fundamentals of speech.
- Extract and compare different speech parameters.
- Choose an appropriate statistical speech model for a given application.
- Design a speech recognition system.
- Use different text analysis and speech synthesis techniques.

REFERENCES:

NC5252 ADVANCED WIRELESS NETWORKS

OBJECTIVES:
- To study about advanced wireless network, LTE, 4G and Evolutions from LTE to LTE.
- To study about wireless IP architecture, Packet Data Protocol and LTE network architecture
- To study about adaptive link layer, hybrid ARQ and graphs routing protocol.
- To study about mobility management, cellular network, and micro cellular networks

UNIT I INTRODUCTION

UNIT II WIRELESS IP NETWORK ARCHITECTURES
UNIT III ADAPTIVE LINK AND NETWORK LAYER 9

UNIT IV MOBILITY MANAGEMENT 9
Cellular Networks-Cellular Systems with Prioritized Handoff-Cell Residing Time Distribution-Mobility Prediction in Pico- and Micro-Cellular Networks

UNIT V QUALITY OF SERVICE 9

TOTAL :45 PERIODS

OUTCOMES:
- Familiar with the latest 4G networks and LTE
- Understand about the wireless IP architecture and LTE network architecture.
- Familiar with the adaptive link layer and network layer graphs and protocol.
- Understand about the mobility management and cellular network.
- Understand about the wireless sensor network architecture and its concept.

REFERENCES:

CU5093 WAVELET TRANSFORMS AND ITS APPLICATIONS L T P C
3 0 0 3

OBJECTIVE:
- To introduce the fundamentals concepts of wavelet transforms.
- To study system design using Wavelets
- To learn the different wavelet families & their applications.
UNIT I  INTRODUCTION TO WAVELETS  9
Introduction to Multirate signal processing- Decimation and Interpolation, Quadrature Mirror Filters, Subband coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous Wavelet transform, Time frequency representation, Wavelet System and its characteristics, Orthogonal and Orthonormal functions and function space

UNIT II  MULTIRESOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM  9
Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banks-Analysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured filter bank, Multichannel filter bank, Undecimated wavelet transform.

UNIT III  WAVELET SYSTEM DESIGN  9
Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets.

UNIT IV  WAVELET FAMILIES  9

UNIT V  WAVELET APPLICATIONS  9
Denoising of Signals and Images, Image enhancement, Edge detection, Image Fusion, Image compression, Wavelet based feature extraction, Analysis of phonocardiogram signals, Analysis of EEG signals, Speech enhancement for hearing aids

TOTAL: 45 PERIODS

OUTCOME:
• The students will be able to apprehend the detailed knowledge about the Wavelet transforms & its applications.

REFERENCES:
5. P.P.Vaidyanathan, Multi rate systems and filter banks, Prentice Hall 1993
OBJECTIVES:
- To give fundamental concepts related to broadband access technologies.
- To understand the current and emerging wired and wireless access technologies.
- To acquire knowledge about cable modems and fiber access technologies.
- To have an exposure to different systems standards for next generation broadband access networks.

UNIT I REVIEW OF ACCESS TECHNOLOGIES 5
Phone-Line modem, cable-access, ISDN, Emerging Broad band Technologies, Cable DSL, Fiber and Wireless, Standards for access network.

UNIT II DIGITAL SUBSCRIBER LINES 10
Asymmetric Digital subscriber lines (ADSL) – Rate Adaptive subscriber line (RADSL)-ISDN Digital subscriber line (IDSL) - High bit rate DSL (HDSL)-Single line DSL (SDSL) - very high bit rate DSL (VDSL) - Standards for XDSL & Comparison.

UNIT III CABLE MODEM 10

UNIT IV FIBER ACCESS TECHNOLOGIES 10
Optical Fiber in access networks, Architecture and Technologies- Hybrid fiber – Coax (HFC) system, Switched Digital Video (SDV) – Passive optical networks (PON) – FTTX (FTTH, FTTB, FTTC, FTT cab) comparison, Broadband PON , Gigabit-Capable PON.

UNIT V BROAD BAND WIRELESS 10
Fixed Wireless, Direct Broadcast Satellite (DBS), Multi channel multi point distribution services (MMDS), Local multi point distribution services (LMDS), and Wideband integrated Digital Interactive Services (WIDIS), Mobile Wireless 3G – IMT 2000, Introduction to LTE-A.

TOTAL : 45 PERIODS

OUTCOMES:
- To able to design systems meeting out the requirements of the recent standards.
- To meet out the industry requirements for man power in next generation networks.
- To be able to contribute towards the enhancement of the existing wireless technologies.

REFERENCES:
OBJECTIVES:
The students should be made to:
- Understand radio frequency implementation
- Learn multi rate signal processing and digital generation of signals

UNIT I  INTRODUCTION & CASE STUDIES

UNIT II  RADIO FREQUENCY IMPLEMENTATION
The purpose of the RF Front End, Dynamic Range, RF receivers front end Topologies, Importance of the components to Overall performance, Transmitter Architecture, Noise and Distortion in the RF Chain, ADC and DAC Distortion, Flexible RF systems using MEMS.

UNIT III  MULTI RATE SIGNAL PROCESSING AND DIGITAL GENERATION OF SIGNALS.

UNIT IV  DATA CONVERTERS AND SMART ANTENNAS
Parameters of Ideal and practical Data Converters, Techniques to Improve Data Converter performance, Common ADC and DAC Architectures. Smart Antennas- Hardware implementation of Smart Antennas.

UNIT V  DIGITAL HARDWARE AND SOFTWARE CHOICES
DSP Processors, FPGA, ASIC s. Trade offs, Object oriented programming, Object Brokers, GNU Radio-USRP.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the students should be able to:
- Design data converters
- Evaluate smart antennas
- Discuss digital hardware and software choices
REFERENCES:

CU5095 SPACE TIME WIRELESS COMMUNICATION L T P C
3 0 0 3

OBJECTIVES:
• To acquire the knowledge on various modulation and coding schemes for space-time Wireless Communications.
• To understand transmission and decoding techniques associated with Wireless Communications.
• To understand multiple-antenna systems such as multiple-input multiple-output (MIMO) and Space-Time Codes.

UNIT I MULTIPLE ANTENNA PROPAGATION AND ST CHANNEL CHARACTERIZATION
Wireless channel, Scattering model in macrocells, Channel as a ST random field, Scattering functions, Polarization and field diverse channels, Antenna array topology, Degenerate channels, reciprocity and its implications, Channel definitions, Physical scattering model, Extended channel models, Channel measurements, sampled signal model, ST multiuser and ST interference channels, ST channel estimation.

UNIT II CAPACITY OF MULTIPLE ANTENNA CHANNELS
Capacity of frequency flat deterministic MIMO channel: Channel unknown to the transmitter, Channel known to the transmitter, capacity of random MIMO channels, Influence of ricean fading, fading correlation, XPD and degeneracy on MIMO capacity, Capacity of frequency selective MIMO channels.

UNIT III SPATIAL DIVERSITY
Diversity gain, Receive antenna diversity, Transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, Combined space and path diversity, Indirect transmit diversity, Diversity of a space-time- frequency selective fading channel.

UNIT IV MULTIPLE ANTENNA CODING AND RECEIVERS
Coding and interleaving architecture, ST coding for frequency flat channels, ST coding for frequency selective channels, Receivers(SISO, SIMO, MIMO), Iterative MIMO receivers, Exploiting channel knowledge at the transmitter: linear pre-filtering, optimal pre-filtering for maximum rate, optimal pre-filtering for error rate minimization, selection at the transmitter, Exploiting imperfect channel knowledge.
UNIT V ST OFDM, SPREAD SPECTRUM AND MIMO MULTIUSER DETECTION

TOTAL: 45 PERIODS

OUTCOMES:
• To be able to design and evaluate receiver and transmitter diversity techniques.
• To be able to design and develop OFDM based MIMO systems.
• To be able to calculate capacity of MIMO systems.

REFERENCES:

CU5096 PATTERN RECOGNITION AND MACHINE LEARNING L T P C
3 0 0 3

OBJECTIVES:
• Study the fundamental of pattern classifier.
• To know about various clustering concepts.
• To originate the various structural pattern recognition and feature extraction.
• To understand the basic of concept learning and decision trees
• To explore recent advances in pattern recognition.

UNIT I PATTERN CLASSIFIER

UNIT II CLUSTERING
Clustering for unsupervised learning and classification -Clustering concept – C-means algorithm – Hierarchical clustering procedures -Graph theoretic approach to pattern clustering -Validity of clusters.

UNIT III FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION

UNIT IV INTRODUCTION, CONCEPT LEARNING AND DECISION TREES
UNIT V  RECENT ADVANCES


TOTAL:45 PERIODS

OUTCOMES:
Upon Completion of the course, the students will be able to

- Classify the data and identify the patterns.
- Utilize the given data set to extract and select features for Pattern recognition.
- Describe the decision tree and concept learning.
- Discuss on recent advances in pattern recognition.

REFERENCES:

NC5071 NETWORK ROUTING ALGORITHMS

OBJECTIVES:

- To expose the students to the layered architecture for communication networks and the specific functionality of the network layer.
- To enable the student to understand the basic principles of routing and the manner this is implemented in conventional networks and the evolving routing algorithms based on internetworking requirements, optical backbone and the wireless access part of the network.
- To enable the student to understand the different routing algorithms existing and their performance characteristics.

UNIT I  INTRODUCTION

UNIT II  INTERNET ROUTING
Interior protocol : Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Bellman Ford Distance Vector Routing. Exterior Routing Protocols: Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). Multicast Routing: Pros and cons of Multicast and Multiple Unicast Routing, Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), MBONE, Core Based Tree Routing.
UNIT III ROUTING IN OPTICAL WDM NETWORKS
Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength Rerouting- Benefits and Issues, Lightpath Migration, Rerouting Schemes, Algorithms- AG, MWPG.

UNIT IV MOBILE - IP NETWORKS

UNIT V MOBILE AD –HOC NETWORKS
Internet-based mobile ad-hoc networking communication strategies, Routing algorithms – Proactive routing: destination sequenced Distance Vector Routing (DSDV), Reactive routing:Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV), Hybrid Routing: Zone Based Routing (ZRP).

TOTAL : 45 PERIODS
OUTCOMES:
Upon Completion of the course, the students will be able to
- Given the network and user requirements and the type of channel over which the network has to operate, the student would be in a position to apply his knowledge for identifying a suitable routing algorithm, implementing it and analyzing its performance.
- The student would also be able to design a new algorithm or modify an existing algorithm to satisfy the evolving demands in the network and by the user applications.

REFERENCES:
OBJECTIVES:
- To understand the basics of Ad-hoc & Sensor Networks.
- To learn various fundamental and emerging protocols of all layers.
- To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.
- To understand the nature and applications of Ad-hoc and sensor networks.
- To understand various security practices and protocols of Ad-hoc and Sensor Networks.

UNIT I  MAC & TCP IN AD HOC NETWORKS

UNIT II  ROUTING IN AD HOC NETWORKS

UNIT III  MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS

UNIT IV  SENSOR MANAGEMENT

UNIT V  SECURITY IN AD HOC AND SENSOR NETWORKS

TOTAL : 45 PERIODS

OUTCOMES:
Upon Completion of the course, the students should be able to
- Identify different issues in wireless ad hoc and sensor networks.
- To analyze protocols developed for ad hoc and sensor networks.
- To identify and address the security threats in ad hoc and sensor networks.
- Establish a Sensor network environment for different type of applications.
REFERENCES:

CP5292
INTERNET OF THINGS

OBJECTIVES:
- To understand the fundamentals of Internet of Things
- To learn about the basics of IOT protocols
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real world scenario.

UNIT I INTRODUCTION TO IoT
Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

UNIT II IoT ARCHITECTURE
M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture

UNIT III IoT PROTOCOLS

UNIT IV BUILDING IoT WITH RASPBERRY PI & ARDUINO

UNIT V CASE STUDIES AND REAL-WORLD APPLICATIONS
Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT -
OUTCOMES:
Upon completion of the course, the student should be able to:

- Analyze various protocols for IoT
- Develop web services to access/control IoT devices.
- Design a portable IoT using Raspberry Pi
- Deploy an IoT application and connect to the cloud.
- Analyze applications of IoT in real time scenario

REFERENCES:

OBJECTIVES:
- To understand the basic ideas of compression algorithms related to multimedia components – Text, speech, audio, image and Video.
- To understand the principles and standards and their applications with an emphasis on underlying technologies, algorithms, and performance.
- To appreciate the use of compression in multimedia processing applications
- To understand and implement compression standards in detail.

UNIT I  FUNDAMENTALS OF COMPRESSION

UNIT II  TEXT COMPRESSION

UNIT III  IMAGE COMPRESSION
UNIT IV  AUDIO COMPRESSION  

UNIT V  VIDEO COMPRESSION  

TOTAL : 45 PERIODS

OUTCOMES:
Upon Completion of the course, the students should be able to
- Implement basic compression algorithms with MATLAB and its equivalent open source environments.
- Design and implement some basic compression standards
- Critically analyze different approaches of compression algorithms in multimedia related mini projects.

REFERENCES:

CU5074  ULTRA WIDEBAND COMMUNICATION  
L T P C  3 0 0 3

OBJECTIVES:
- To give fundamental concepts related to Ultra wide band
- To understand the channel model and signal processing for UWB.
- To acquire knowledge about UWB antennas and regulations.

UNIT I  INTRODUCTION TO UWB  
History, Definition, FCC Mask, UWB features, UWB Interference: IEEE 802.11.a Interference, Signal to Interference ratio calculation, Interference with other wireless services.

UNIT II  UWB TECHNOLOGIES AND CHANNEL MODELS  
Impulse Radio, Pulsed Multiband, Multiband OFDM, features : Complexity, Power Consumption, Security and achievable data rate. MIMO Multiband OFDM, Differential multiband OFDM, Performance characterization, Ultra Wide Band Wireless Channels

UNIT III UWB SIGNAL PROCESSING
9
Data Modulation schemes, UWB Multiple Access Modulation, BER, Rake Receiver, Transmit- Reference (T-R) Technique, UWB Range- Data Rate Performance, UWB Channel Capacity, UWB Wireless Locationing: Position Locationing Methods, Time of Arrival Estimation, NLOS Location Error, Locationing with OFDM

UNIT IV UWB ANTENNAS
9
Antenna Requirements, Radiation Mechanism of the UWB Antennas, Types of Broad band antennas, Parameters, Analysis of UWB Antennas, Link Budget for UWB System. Design examples of broad band UWB antennas.

UNIT V UWB APPLICATIONS AND REGULATIONS
9
Wireless Ad hoc Networking, UWB Wireless Sensor, RFID, Consumer Electronics and Personal, Asset Location, Medical applications, UWB Regulation and standards in various countries, UWB Regulation in ITU, IEEE Standardization

TOTAL: 45 PERIODS

OUTCOMES:
- The student would be able to understand UWB technologies.
- Ability to assess the performance of UWB channels.
- The student would be able to design UWB antenna for various applications.

REFERENCES:

MP5092 SOFT COMPUTING TECHNIQUES

OBJECTIVES:
- To know the basics of artificial neural networks
- To provide adequate knowledge about feed forward/feedback neural networks
- To apply the concept of fuzzy logic in various systems.
- To have the idea about genetic algorithm
- To provide adequate knowledge about the applications of Soft Computing.

UNIT I ARTIFICIAL NEURAL NETWORK
9
UNIT II  FUZZY LOGIC  9

UNIT III  NEURO-FUZZY MODELLING  9
ANFIS Architecture-Classification and Regression Trees-Data Clustering algorithms-Rulebase Structure Identification.

UNIT IV  GENETIC ALGORITHMS  9

UNIT V  APPLICATIONS OF SOFTCOMPUTING  9

TOTAL : 45 PERIODS

OUTCOMES:
- Knowledge on concepts of soft computational techniques.
- Able to apply soft computational techniques to solve various problems.
- Motivate to solve research oriented problems.

REFERENCES:

NC5072  NETWORK PROCESSORS  L T P C
3 0 0 3

OBJECTIVES :
The students should be made to:
- Learn network processors
- Study commercial network processors
- Understand network processor architecture

UNIT I  INTRODUCTION  9
Traditional protocol processing Systems – Network processing Hardware – Basic Packet Processing Algorithms and data Structures - Packet processing functions – Protocol
UNIT II  NETWORK PROCESSOR TECHNOLOGY  9

UNIT III  COMMERCIAL NETWORK PROCESSORS  9

UNIT IV  NETWORK PROCESSOR: ARCHITECTURE AND PROGRAMMING  9

UNIT V  IOS TECHNOLOGIES  9

TOTAL : 45  PERIODS

OUTCOMES:
At the end of this course, the students should be able to:
• Discuss network processor architecture
• Compare different programming
• Explain IOS technologies

REFERENCES:
OBJECTIVES:
- To appreciate the need for interoperable network management as a typical distributed application
- To familiarize concepts and terminology associated with SNMP
- To be aware of current trends in network management technologies

UNIT I  OSI NETWORK MANAGEMENT  8
OSI Network management model - Organizational model - Information model, Communication model. Abstract Syntax Notation - Encoding Structure, Macros Functional Model CMIP/CMIS

UNIT II  BROADBAND NETWORK MANAGEMENT  9

UNIT III  SIMPLE NETWORK MANAGEMENT PROTOCOL  10

UNIT IV  NETWORK MANAGEMENT SYSTEMS  9

UNIT V  WEB-BASED MANAGEMENT  9

TOTAL:  45  PERIODS

OUTCOMES:
After the completion of this course, students will be able to
- Diagnose problems and make minor repairs to computer networks using appropriate diagnostics software
- Demonstrate how to correctly maintain LAN computer systems
- Maintain the network by performing routine maintenance tasks
- Apply network management tools
REFERENCES:

WEB REFERENCES:
2. ycchen.im.ncnu.edu.tw/nm/ch_5x.ppt

NC5291 COMMUNICATION NETWORK SECURITY L T P C
3 0 0 3

OBJECTIVES:
The students should be made to:
- Understand the need and concept of security
- Learn cryptosystems

UNIT I INTRODUCTION AND NUMBER THEORY

UNIT II SYMMETRIC AND ASYMMETRIC CRYPTO SYSTEMS

UNIT III AUTHENTICATION, DIGITAL SIGNATURES AND CERTIFICATES

UNIT IV TRUSTED IDENTITY
UNIT V SECURITY AT LAYERS

OUTCOMES:
At the end of this course, the students should be able to:
- Explain digital signature standards
- Discuss authentication
- Explain security at different layers

REFERENCES:

CU5004 HIGH PERFORMANCE SWITCHING ARCHITECTURES

OBJECTIVES:
- To enable the student to understand the basics of switching technologies and their implementation in LANs, ATM networks and IP networks.
- To enable the student to understand the different switching architectures and queuing strategies and their impact on the blocking performances.
- To expose the student to the advances in packet switching architectures and IP addressing and switching solutions and approaches to exploit and integrate the best features of different architectures for high speed switching.

UNIT I LAN SWITCHING TECHNOLOGY
Switching Concepts, LAN Switching, switch forwarding techniques - cut through and store and forward, Layer 3 switching, Loop Resolution, Switch Flow control, virtual LANs.

UNIT II ATM SWITCHING ARCHITECTURES
UNIT III  QUEUES IN ATM SWITCHES
Internal Queueing - Input, output and shared queueing, multiple queueing networks – combined Input, output and shared queueing - performance analysis of Queued switches.

UNIT IV  PACKET SWITCHING ARCHITECTURES
Architectures of Internet Switches and Routers - Bufferless and buffered Crossbar switches, Multi-stage switching, Optical Packet switching; Switching fabric on a chip; Internally buffered Crossbars.

UNIT V  IP SWITCHING
Addressing model, IP Switching types - flow driven and topology driven solutions, IP Over ATM address and next hop resolution, multicasting, Ipv6 over ATM.

TOTAL : 45 PERIODS

OUTCOMES:
- The student would be able to identify suitable switch architectures for a specified networking scenario and demonstrate its blocking performance.
- The student would be in a position to apply his knowledge of switching technologies, architectures and buffering strategies for designing high speed communication networks and analyse their performance

REFERENCES