PROGRAM EDUCATIONAL OBJECTIVES (PEOs):
1. To enable graduates to pursue research, or have a successful career in academia or industries associated with Communication and Networking, or as entrepreneurs.

2. To provide students with strong foundational concepts and also advanced techniques and tools in order to enable them to build solutions or systems of varying complexity.

3. To prepare students to critically analyze existing literature in an area of specialization and ethically develop innovative and research oriented methodologies to solve the problems identified.

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.

**PROGRAM SPECIFIC OBJECTIVES (PSOs)**

1. To analyze, design and develop computing solutions by applying foundational concepts of Communication and Networking.

2. To apply communication and network engineering principles and practices for developing quality protocols for scientific and business applications.

3. To adapt to emerging information and communication technologies (ICT) to innovate ideas and solutions to existing/novel problems.

Provide mapping of 1) POs to PEOs and 2) PSOs to PEOs.

Use the following marking:

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MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES:

A broad relation between the programme objective and the outcomes is given in the following table:

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<td>NC5001</td>
<td>Analysis and Design of CMOS Analog Integrated Circuits</td>
<td>PE</td>
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<td>3.</td>
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<td>Real Time Embedded Systems</td>
<td>PE</td>
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<td>MEMS and NEMS</td>
<td>PE</td>
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<td>5.</td>
<td>AP5094</td>
<td>Signal Integrity for High Speed Design</td>
<td>PE</td>
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### SEMESTER II

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<td>1.</td>
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<td>VLSI for Wireless Communication</td>
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<td>Digital Communication Receivers</td>
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<td>Electromagnetic Interference and Compatibility</td>
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<td>Detection and Estimation Theory</td>
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<td>Advanced Satellite Communication and Navigation Systems</td>
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<td>1.</td>
<td>NC5003</td>
<td>Fundamentals of Cloud Computing</td>
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<td>Advanced Digital Image Processing</td>
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<td>Radar Signal Processing</td>
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<td>Speech Processing and Synthesis</td>
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<td>Pattern Recognition and Machine Learning</td>
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### SEMESTER II
#### ELECTIVE IV

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<th>CONTACT PERIODS</th>
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<tr>
<td>1</td>
<td>CU5093</td>
<td>Wavelet Transforms and its Applications</td>
<td>PE</td>
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<tr>
<td>2</td>
<td>DS5191</td>
<td>DSP Processor Architecture and Programming</td>
<td>PE</td>
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<tr>
<td>3</td>
<td>CU5095</td>
<td>Space Time Wireless Communication</td>
<td>PE</td>
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<td>4</td>
<td>NC5005</td>
<td>Broad Band Wireless Access Technologies</td>
<td>PE</td>
<td>3</td>
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<tr>
<td>5</td>
<td>CU5094</td>
<td>Software Defined Radio</td>
<td>PE</td>
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### SEMESTER III
#### ELECTIVE V

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<thead>
<tr>
<th>Sl. No</th>
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<th>COURSE TITLE</th>
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<tbody>
<tr>
<td>1</td>
<td>NC5071</td>
<td>Network Routing Algorithms</td>
<td>PE</td>
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<tr>
<td>2</td>
<td>CU5192</td>
<td>Optical Networks</td>
<td>PE</td>
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<td>3</td>
<td>MU5091</td>
<td>Multimedia Compression Techniques</td>
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<td>4</td>
<td>CU5074</td>
<td>Ultra Wide Band Communication</td>
<td>PE</td>
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<td>5</td>
<td>NC5006</td>
<td>Game theory for Wireless Communication and Networking</td>
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### SEMESTER III
#### ELECTIVE VI

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<tbody>
<tr>
<td>1</td>
<td>MP5092</td>
<td>Soft Computing Techniques</td>
<td>PE</td>
<td>3</td>
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<tr>
<td>2</td>
<td>NC5072</td>
<td>Network Processors</td>
<td>PE</td>
<td>3</td>
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<td>3</td>
<td>NE5071</td>
<td>Network Management</td>
<td>PE</td>
<td>3</td>
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<tr>
<td>4</td>
<td>CU5097</td>
<td>Wireless Adhoc and Sensor Networks</td>
<td>PE</td>
<td>3</td>
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<tr>
<td>5</td>
<td>NC5007</td>
<td>Parallel Processing</td>
<td>PE</td>
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</table>
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:

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 algorithms.
- The student learns relevant figures of merit such as power, energy, bias and consistency.
- The student is familiar with estimation, prediction and filtering concepts and techniques.

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9+6

UNIT II SPECTRUM ESTIMATION 9+6

UNIT III LINEAR ESTIMATION AND PREDICTION 9+6

UNIT IV ADAPTIVE FILTERS 9+6

UNIT V MULTIRATE DIGITAL SIGNAL PROCESSING 9+6

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.
- Explain various noise types, Yule-Walker algorithm, parametric and non-parametric methods, Wiener and Kalman filtering, LMS and RMS algorithms, Levinson Durbin algorithm, adaptive noise cancellation and adaptive echo cancellation, speed verses convergence issues, channel equalization, sampling rate change, subband coding and wavelet transform.
- Calculate mean, variance, auto-correlation and PSD for WSS stochastic processes, and derive prediction error criterion, Wiener-Hoff equations, Parseval’s theorem, W-K theorem and normal equations.
- Design AR, MA, ARMA models, Weiner filter, anti aliasing and anti imaging filters, and develop FIR adaptive filter and polyphase filter structures.
- Simulate spectral estimation algorithms and basic models on computing platform.

REFERENCES:


CU5151 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 9

UNIT III BLOCK CODED DIGITAL COMMUNICATION 9
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; Hamming; 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:
OBJECTIVES:
The students should be made to:
- Understand Concepts of MIMO diversity and spatial multiplexing.
- Learn Massive MIMO system
- Know millimeter wave communication

UNIT I INFORMATION THEORETIC ASPECTS OF MIMO 10
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 10
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 9
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 8
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 8
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.

TOTAL: 45 PERIODS

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:
NC5101 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

UNIT V HIGHER LAYER MODELING & MODELING THE NETWORK TOPOLOGY

TOTAL: 45 PERIODS

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:

CU5161 COMMUNICATION SYSTEMS LABORATORY

OBJECTIVES:
- To understand the functioning of various modulation and coding techniques in Wireless Environment.
- To understand the functioning of adaptive filters and equalizers
- To understand wireless channel simulation and pathloss measurements
- To understand about the OFDM, MIMO and STBC.

LIST OF EXPERIMENTS:
1. Simulation of Modulation and Coding in a AWGN/ wireless Communication Channel using SDR kit / Simulation Packages.
2. Implementation of Linear and Cyclic Codes
3. Implementation of Adaptive Filters, periodogram and multistage multirate system in DSP Processor
4. Simulation of QMF using Simulation Packages.
5. Wireless Channel simulation and characterization
6. Pathloss Measurement and Characterization of Wireless Channels
7. Wireless Channel equalizer design (ZF / LMS / RLS ) using Simulation Packages.
8. OFDM transceiver design using Simulation Packages.
10 Implementation of STBC using Simulation Packages

OUTCOMES:
Upon Completion of the course, the students will be able to:
- Ability to design various modulation and coding techniques for Wireless Environment.
- Ability to design various filters and equalizers.
- Ability to design OFDM signals
- Ability to design MIMO system with STBC

TOTAL: 60 PERIODS
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 CRYPTOSYSTEMS

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:
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

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 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 9

UNIT II  WIRELESS IP NETWORK ARCHITECTURES 9

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

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:

NC5211 Networking Laboratory (Experiments using NS2/ QUALNET /NS3/ OMNET/ Equivalent)

OBJECTIVES:
- To understand the functioning of various protocols in Wireless Environment.
- To understand the functioning of IP network
- To understand about the mobile ad hoc network
- To understand about the wireless routing protocol, Wi-Fi network and sensor protocol

LIST OF EXPERIMENTS:
1. Implement wireless to wireless communication using wireless protocol
2. Implement and test Wireless Network Design with Small World Properties.
4. Implement IP Networks protocol.
5. Simulating a Mobile Adhoc Network.
6. Simulating a Wi-Fi Network.
9. Implement applications using TCP & UDP sockets like DNS (ii)SNMP (iii) File Transfer
10. Implement different routing protocols to select the network path with its optimum energy and cost during data transfer
   Link state routing (ii) Flooding (iii) Distance vector

TOTAL: 60 PERIODS
OUTCOMES:
Upon Completion of the course, the students will be able to:
- Ability to design WIRELESS NETWORK and routing protocols in Wireless Environment.
- Ability to design mobile ad hoc network and Wi-Fi network.
- Ability to design wireless routing in wireless network
- Ability to design wireless sensor and transport protocol in sensor environment

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.

Activities to be carried Out

<table>
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<tr>
<th>Activity</th>
<th>Instructions</th>
<th>Submission week</th>
<th>Evaluation</th>
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<tr>
<td>Selection of area of interest and Topic</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>
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<tr>
<td>Stating an Objective</td>
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</tbody>
</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) |
<table>
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<tr>
<th>Collection of Journal papers in the topic in the context of the objective – collect 20 &amp; then filter</th>
<th>4th week</th>
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<tbody>
<tr>
<td>• You have to provide a complete list of references you will be using - Based on your objective - Search various digital libraries and Google Scholar</td>
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<tr>
<td>• When picking papers to read - try to:</td>
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<tr>
<td>• 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,</td>
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<tr>
<td>• Favour papers from well-known journals and conferences,</td>
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<tr>
<td>• Favour “first” or “foundational” papers in the field (as indicated in other people’s survey paper),</td>
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<tr>
<td>• Favour more recent papers,</td>
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<tr>
<td>• Pick a recent survey of the field so you can quickly gain an overview,</td>
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<tr>
<td>• Find relationships with respect to each other and to your topic area (classification scheme/categorization)</td>
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<tr>
<td>• Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered</td>
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<tr>
<td>6% (the list of standard papers and reason for selection)</td>
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<th>Reading and notes for first 5 papers</th>
<th>5th week</th>
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<tbody>
<tr>
<td>Reading Paper Process</td>
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<tr>
<td>• For each paper form a Table answering the following questions:</td>
<td></td>
</tr>
<tr>
<td>• What is the main topic of the article?</td>
<td></td>
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<tr>
<td>• What was/were the main issue(s) the author said they want to discuss?</td>
<td></td>
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<tr>
<td>• Why did the author claim it was important?</td>
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<tr>
<td>• How does the work build on other’s work, in the author’s opinion?</td>
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<tr>
<td>• What simplifying assumptions does the author claim to be making?</td>
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<tr>
<td>• What did the author do?</td>
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</tr>
<tr>
<td>• How did the author claim they were going to evaluate their work and compare it to others?</td>
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<tr>
<td>• What did the author say were the limitations of their research?</td>
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<tr>
<td>8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)</td>
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<tr>
<td>Task</td>
<td>Activity Description</td>
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<td>----------------------------------------------------------------------</td>
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<tr>
<td><strong>Reading and notes for next 5 papers</strong></td>
<td>Repeat Reading Paper Process</td>
</tr>
<tr>
<td><strong>Reading and notes for final 5 papers</strong></td>
<td>Repeat Reading Paper Process</td>
</tr>
<tr>
<td><strong>Draft outline 1 and Linking papers</strong></td>
<td>Prepare a draft Outline, your survey goals, along with a classification / categorization diagram</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Prepare a draft abstract and give a presentation</td>
</tr>
<tr>
<td><strong>Introduction Background</strong></td>
<td>Write an introduction and background sections</td>
</tr>
<tr>
<td><strong>Sections of the paper</strong></td>
<td>Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey</td>
</tr>
<tr>
<td><strong>Your conclusions</strong></td>
<td>Write your conclusions and future work</td>
</tr>
<tr>
<td><strong>Final Draft</strong></td>
<td>Complete the final draft of your paper</td>
</tr>
<tr>
<td><strong>Seminar</strong></td>
<td>A brief 15 slides on your paper</td>
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</table>

**TOTAL : 30 PERIODS**
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 - Amazon Web Services for IoT.

TOTAL : 45 PERIODS

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 learn the different biasing circuits for amplifiers.
- To study the different types of current mirrors
- To know the concepts of voltage and current reference circuits.

UNIT I SINGLE STAGE AMPLIFIERS 9
MOS physics, Large signal and Small signal analysis of Common source stage, Source follower, Common gate stage, Cascode stage. Single ended and differential operation of differential amplifier, Basic differential pair, Differential pair with MOS loads.

UNIT II BIASING CIRCUITS 9
Basic current mirrors, cascode current mirrors, active current mirrors, voltage references, supply independent biasing, temperature independent references, PTAT current generation, Constant-Gm Biasing.

UNIT III FREQUENCY RESPONSE AND NOISE ANALYSIS 9
Miller effect, Association of poles with nodes, frequency response of common source stage, Source followers, Common gate stage, zero value time constant model, Cascode stage, Differential pair amplifier, PSRR+, PSRR-, CMRR measurement of differential amplifier, Statistical characteristics of noise, noise in single stage amplifiers, noise in differential amplifiers.

UNIT IV OPERATIONAL AMPLIFIERS 9

UNIT V STABILITY AND FREQUENCY COMPENSATION 9
General considerations, Multipole systems, Phase Margin, Frequency Compensation, and Compensation of two stage Op Amps, Slewing in two stage Op Amps, and Other compensation techniques.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the student should be able to:
- Design the single stage amplifiers using pmos and nmos driver circuits with different loads.
- Analyze high frequency concepts of single stage amplifiers and noise characteristics associated with differential amplifiers.

REFERENCES:
OBJECTIVES:

- To understand the fundamentals of integrated circuits operating at microwave frequencies.
- To learn RFIC design techniques, including system architecture, key building blocks and design methodologies in CMOS technology.

UNIT I  BASIC RF IC COMPONENTS  9
Skin effect, Resistors, Capacitor, Inductor and Transformers at high frequency, Interconnect options. S-parameters with Smith chart, Impedance matching networks, Transmission lines, finite length effects, MOSFET characteristics, Noise: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR.

UNIT II  RECEIVERS ARCHITECTURE AND LOW NOISE AMPLIFIERS  9
Homodyne Receiver, Heterodyne Receiver, Image reject, Low IF Receiver Architectures Direct up conversion Transmitter, Two step up conversion Transmitter, CMOS amplifiers, Single ended and Differential LNAs terminated with Resistors and Source Degeneration LNAs, OC Time constants in bandwidth estimation and enhancement, Power match and Noise match.

UNIT III  FEEDBACK SYSTEMS AND POWER AMPLIFIERS  9

UNIT IV  PLL AND FREQUENCY SYNTHESIZERS  9
Linearised PLL Model, Noise properties, Phase detectors, Loop filters and Charge pumps, PLL Design examples. Integer-N frequency synthesizers, Direct Digital Frequency synthesizers.

UNIT V  MIXERS AND OSCILLATORS  9
Mixer characteristics, Non-linear mixers, Multiplier based mixers, Single balanced and double balanced mixers, sub sampling mixers, Oscillators describing Functions, Resonators, Phase noise, Chip Design Examples: GPS Receiver, WLAN receiver.

TOTAL :  45 PERIODS

OUTCOMES:

- The ability to analyze and design the high frequency effects on basic circuit components.
- To design RF LNAs and receivers.
- To design RF power amplifiers.
- To design PLL and frequency synthesizers.

REFERENCES:

CU5092 REAL TIME EMBEDDED SYSTEMS

L T 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

UNIT II COMPUTING PLATFORM AND DESIGN ANALYSIS
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

UNIT IV HARDWARE ACCELERATES & NETWORKS
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 microelectromechanical 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 Wavefunction 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 nano systems and Quantum mechanics

REFERENCES:
OBJECTIVES:
- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics.

UNIT I SIGNAL PROPAGATION ON TRANSMISSION LINES
Transmission line equations, wave solution, wave vs. circuits, initial wave, delay time, Characteristic impedance, wave propagation, reflection, and bounce diagrams Reactive terminations – L, C, static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan-out, logic switching, input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.

UNIT II MULTI-CONDUCTOR TRANSMISSION LINES AND CROSS-TALK
Multi-conductor transmission-lines, coupling physics, per unit length parameters, Near and far-end cross-talk, minimizing cross-talk (stripline and microstrip) Differential signalling, termination, balanced circuits, S-parameters, Lossy and Lossless models.

UNIT III NON-IDEAL EFFECTS
Non-ideal signal return paths – gaps, BGA fields, via transitions, Parasitic inductance and capacitance, Transmission line losses – Rs, tanδ, routing parasitic, Common-mode current, differential-mode current, Connectors.

UNIT IV POWER CONSIDERATIONS AND SYSTEM DESIGN
SSN/SSO, DC power bus design, layer stack up, SMT decoupling, Logic families, power consumption, and system power delivery, Logic families and speed Package types and parasitic, SPICE, IBIS models, Bit streams, PRBS and filtering functions of link-path components, Eye diagrams, jitter, inter-symbol interference Bit-error rate, Timing analysis.

UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS
Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, canceling parasitic capacitance, Clock jitter.

TOTAL: 45 PERIODS

OUTCOMES:
- Ability to identify sources affecting the speed of digital circuits.
- Able to improve the signal transmission characteristics.

REFERENCES:
5. S. Hall, G. Hall, and J. McCall, High-Speed Digital System Design: A Handbook of

TOOLS REQUIRED
1. SPICE, source - http://www-cad.eecs.berkeley.edu/Software/software.html
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:
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  
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  
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  

TOTAL: 45 PERIODS

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:
OBJECTIVES:
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.

TOTAL: 45 PERIODS

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
UNIT V  APPLICATIONS
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:

CU5091  ADVANCED SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS  L T P C
3 0 0 3

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  9


OUTCOMES:
At the end of this course, the student should be able to:
- Discuss satellite navigation and global positioning system
- Outline deep space navigation and inter planetary missions

REFERENCES:

NC5003    FUNDAMENTALS OF CLOUD COMPUTING  

OBJECTIVES
- To Introduce the fundamentals of Cloud Computing and virtualization.
- To familiarize various standards related to cloud computing.

UNIT I  INTRODUCTION TO CLOUD  

UNIT II  CLOUD BASED WEB SERVICES  
Understanding Private and Public cloud environments – Communication as a Service (CaaS)- Infrastructure as a Service (IaaS) – On-demand, Amazon’s Elastic, Amazon EC2, Mosso– Monitoring as a Service (MaaS) –Platform as a Service (PaaS) – On-Premises model, new cloud model – Software as a Service (SaaS) –implementation issues, characteristics, SaaS model.
UNIT III  CLOUD COMPUTING FOR EVERYONE  9
Centralizing Email Communications – Collaborating on Schedules – Collaborating on To-Do Lists – Collaborating Contact Lists – Cloud Computing for the Community – Collaborating on Group Projects and Events – Cloud Computing for the Corporation

UNIT IV  USING CLOUD SERVICES  9

UNIT V  FUTURE DIRECTIONS TO CLOUD  9

TOTAL:45 PERIODS

OUTCOMES:
- To be able to build custom made clouds.
- To be able to develop remote access applications, alert generation using cloud.
- To be able to work with commercial cloud packages.

REFERENCES:

DS5291  ADVANCED DIGITAL IMAGE PROCESSING  L T P C
3 0 0 3

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
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

UNIT V 3D IMAGE VISUALIZATION
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.

TOTAL: 45 PERIODS

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.

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  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

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", Wiley India 2009

NC5004  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 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:

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  9

UNIT II  CLUSTERING  9
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  9

UNIT IV  INTRODUCTION, CONCEPT LEARNING AND DECISION TREES  9

UNIT V  RECENT ADVANCES  9

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:
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
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
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
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

UNIT V  WAVELET APPLICATIONS
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

OUTCOMES:
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:
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
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  

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:
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

Phone-Line modem, cable-access, ISDN, Emerging Broad band Technologies, Cable DSL, Fiber and Wireless, Standards for access network.

UNIT II DIGITAL SUBSCRIBER LINES

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


UNIT IV FIBER ACCESS TECHNOLOGIES

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

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:

CU5094 SOFTWARE DEFINED RADIO

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:

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

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:

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).

TOTAL : 45 PERIODS

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

REFERENCES:

MU5091
MULTIMEDIA COMPRESSION TECHNIQUES

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:
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

UNIT III  UWB SIGNAL PROCESSING
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
Antenna Requirements, Radiation Mechanism of the UWB Antennas, Types of Broadband antennas, Parameters, Analysis of UWB Antennas, Link Budget for UWB System. Design examples of broad band UWB antennas.

UNIT V  UWB APPLICATIONS AND REGULATIONS
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:
OBJECTIVES:
- To give an overview of a broad range of models that is studied in game theory.
- To understand a range of mathematical models of Conflict and cooperation between two or more agents.
- To discuss the main concepts in the game theory and to explain the classes of games.
- To discuss the application of game theory in wireless communication and networking.

UNIT I INTRODUCTION
Introduction to theory of games - conflict, strategy, utility theory, games in extensive and normal forms, Examples: prisoners dilemma, battle of sexes,

UNIT II CLASSIFICATION of GAMES
COOPERATIVE GAMES : Basics of Cooperative games, bargaining theory – Introduction, Nash bargaining solution, Coalition game theory – shapley value, Dynamic Coalition formation algorithms, Hedonic coalition

UNIT III BAYESIAN GAMES
Overview of Bayesian Games, Bayesian Games in extensive form, Cournot duopoly model with incomplete information, Super-Modular games, Learning in games: Fictitious play, and Regret minimization, Vickrey-Clarke-Groves Auction, Optimal Auction

UNIT IV APPLICATIONS TO NETWORKING - I
Cellular & Broadband wireless access networks – Routing & Resource allocation, Power allocation, Network selection in Multi-technology, WLAN – MAC Protocol design, Random Access Control, Rate Selection for VOIP services, throughput efficiency, competition and implication on network performance

UNIT V APPLICATIONS TO NETWORKING - II

TOTAL: 45 PERIODS

OUTCOMES:
- To be able to design game theory based models.
- To be able to apply game theory to solve network related issues.

REFERENCES:
MP5092  SOFT COMPUTING TECHNIQUES  L  T  P  C

3  0  0  3

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


UNIT II  FUZZY LOGIC


UNIT III  NEURO-FUZZY MODELLING

ANFIS Architecture-Classification and Regression Trees-Data Clustering algorithms-Rulebase Structure Identification.

UNIT IV  GENETIC ALGORITHMS


UNIT V  APPLICATIONS OF SOFTCOMPUTING


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

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

UNIT I INTRODUCTION

UNIT II NETWORK PROCESSOR TECHNOLOGY

UNIT III COMMERCIAL NETWORK PROCESSORS

UNIT IV NETWORK PROCESSOR: ARCHITECTURE AND PROGRAMMING

UNIT V IOS TECHNOLOGIES

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:
   Jan. 2003
2. Erik, J. Johnson and Aaron R. Kunze, “IXP2400/2806 Programming: The Microengine
   Coding Grade” Intel Press.
5. Patrick Crowley, M a Franklin, H. Hadminglu, PZ Onfryk, “Network Processor Design,
6. Patrick Crowley, M a Franklin, H. Hadimioglyum PZ Onufryk, Network Processor
7. Ran Giladi, Network Processors: Architecture, Programming, and Implementation,
   Morgan Kauffmann, 2008.

NE5071 NETWORK MANAGEMENT

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
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
Broadband networks and services, ATM Technology - VP, VC, ATM Packet, Integrated
service, ATM LAN emulation, Virtual LAN, ATM Network Management - ATM Network
reference model, Integrated local Management Interface. ATM Management Information base,
Role of SNMP and ILMI in ATM Management, M1, M2, M3, M4 interface. ATM Digital
Exchange Interface Management.

UNIT III SIMPLE NETWORK MANAGEMENT PROTOCOL
SNMPv1 Network Management: Communication and Functional Models. The SNMP
Communication Model, Functional model. SNMP Management SNMPv2: Major Changes in
SNMPv2, SNMPv2 System Architecture, SNMPv2 Structure of Management Information, The
Correlation Techniques 168 security management, Accounting management, Report
Management, Policy Based Management, Services Level Management.
UNIT IV NETWORK MANAGEMENT SYSTEMS


UNIT V WEB-BASED MANAGEMENT


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
3. en.wikipedia.org/wiki/Systems_management

CU5097 WIRELESS ADHOC AND SENSOR NETWORKS

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  9

UNIT II  ROUTING IN AD HOC NETWORKS  9

UNIT III  MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS  9

UNIT IV  SENSOR MANAGEMENT  9

UNIT V  SECURITY IN AD HOC AND SENSOR NETWORKS  9

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:
6. Holger Karl, Andreas willig, Protocols and Architectures for Wireless Sensor
NC5007 PARALLEL PROCESSING

OBJECTIVES:
- To understand the architectures for parallel processing.
- To learn the concepts of pipelining and multithreading.

UNIT I THEORY OF PARALLELISM
Parallel computer models- the state of computing, Multiprocessors and multi computers and multivectors and SIMD computers, PRAM and VLSI models, Architecture development tracks Program and network properties.

UNIT II PARALLEL PROCESSING APPLICATIONS

UNIT III HARDWARE TECHNOLOGIES
Processor and memory hierarchy- advanced processor technology, superscalar and vector processors, memory hierarchy technology, virtual memory technology, bus cache and shared memory, backplane bus systems, cache memory organizations, shared memory Organizations, sequential and weak consistency models.

UNIT IV INSTRUCTION LEVEL PARALLEL PROCESSING

UNIT V PARALLEL ALGORITHMS
Classification of Parallel Algorithms: Synchronized and Asynchronized parallel algorithms, Performance of Parallel algorithms- Elementary parallel algorithms: Searching, Sorting, Matrix Operations

OUTCOMES:
- Apply the problem solving techniques in parallel computing.
- To be able to solve problems related to memory management.
- To be able to design efficient parallel algorithms.
REFERENCES: