# I Year

# I Semester

# Syllabus

## 24MECT01: WIRELESS COMMUNICATIONS AND NETWORKS

**Credits:** 3 **Sessional Marks:** 40
**L: T: P::** 2: 1 :0 **University Exam. Marks:** 60

**Course Objectives:** The objectives of this course are to make the student

1. To study the Channel planning for Wireless Systems
2. To study the Mobile Radio Propagation
3. To study the Equalization and Diversity
4. To study the Wireless Networks

**Course Outcomes:** At the end of this course, students will be able to

1. Understand Cellular communication concepts
2. Study the mobile radio propagation
3. Study the Equalization and Diversity
4. Study the wireless networks & different types of WLAN topologies'.

**UNIT -I**

**The Cellular Concept-System Design Fundamentals:** Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies- Prioritizing Handoffs, Practical Handoff Considerations, Interference and system capacity – Co channel Interference and system capacity, Channel planning for Wireless Systems, Adjacent Channel interference, Power Control for Reducing interference, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular Systems- Cell Splitting, Sectoring.

**UNIT –II**

**Mobile Radio Propagation: Large-Scale Path Loss:** Introduction to Radio Wave Propagation, Free Space Propagation Model, Relating Power to Electric Field, The Three Basic Propagation Mechanisms, Reflection-Reflection from Dielectrics, Brewster Angle, Reflection from prefect conductors, Ground Reflection (Two-Ray) Model, Diffraction-Fresnel Zone Geometry, Knife-edge Diffraction Model, Multiple knife-edge Diffraction, Scattering, Outdoor Propagation Models- Longley- Ryce Model, Okumura Model, Hata Model, PCS Extension to Hata Model, Walfisch and Bertoni Model, Wideband PCS Microcell Model, Indoor Propagation Models-Partition losses (Same Floor), Partition losses between Floors, Log-distance path loss model, Ericsson Multiple Breakpoint Model, Attenuation Factor Model, Signal penetration into buildings, Ray Tracing and Site Specific Modeling.

**UNIT –III**

**Mobile Radio Propagation: Small –Scale Fading and Multipath:** Small Scale Multipath propagation-Factors influencing small scale fading, Doppler shift, Impulse Response Model of a multipath channel- Relationship between Bandwidth and Received power, Small-Scale Multipath Measurements-Direct RF Pulse System, Spread Spectrum Sliding Correlator Channel Sounding, Frequency Domain Channels Sounding, Parameters of Mobile Multipath

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Channels-Time Dispersion Parameters, Coherence Bandwidth, Doppler Spread and Coherence Time, Types of Small-Scale Fading-Fading effects Due to Multipath Time Delay Spread, Flat fading, Frequency selective fading, Fading effects Due to Doppler Spread-Fast fading, slow fading, Statistical Models for multipath FadingChannels-Clarke's model for flat fading, spectral shape due to Doppler spread in Clarke's model, Simulation of Clarke and Gans Fading Model, Level crossing and fading statistics, Two-ray Rayleigh Fading Model.

**UNIT -IV**

**Equalization and Diversity:** Introduction, Fundamentals of Equalization, Training A Generic Adaptive Equalizer, Equalizers in a communication Receiver, Linear Equalizers, Nonlinear Equalization-

Decision Feedback Equalization (DFE), Maximum Likelihood Sequence Estimation (MLSE) Equalizer,Algorithms for adaptive equalization-Zero Forcing Algorithm, Least Mean Square Algorithm, Recursive least squares algorithm. Diversity Techniques-Derivation of selection Diversity improvement, Derivation of Maximal Ratio Combining improvement, Practical Space Diversity Consideration-Selection Diversity, Feedback or Scanning Diversity, Maximal Ratio Combining, Equal Gain Combining, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver.

**UNIT -V**

**Wireless Networks:** Introduction to wireless Networks, Advantages and disadvantages of Wireless Local Area Networks, WLAN Topologies, WLAN Standard IEEE 802.11, IEEE 802.11 Medium Access Control, Comparison of IEEE 802.11 a,b,g and n standards, IEEE 802.16 and its enhancements, Wireless PANs, Hiper Lan, WLL.

**TEXT BOOKS**


1. Wireless Communications, Principles, Practice – Theodore, S. Rappaport, 2nd Ed., 2002, PHI.
2. Wireless Communications-Andrea Goldsmith, 2005 Cambridge University Press.
3. Principles of Wireless Networks – Kaveh Pah Laven and P. Krishna Murthy, 2002, PE
4. Mobile Cellular Communication – Gottapu Sasibhushana Rao, Pearson Education, 2012.


**REFERENCES:**


1. Wireless Digital Communications – Kamilo Feher, 1999, PHI.
2. Wireless Communication and Networking – William Stallings, 2003, PHI.


**Course Outcomes-Program Outcomes -Program Specific Outcomes (CO-PO-PSO) Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | L | | | | H | M | L |
| CO2 | | L | H | M | | | M | H | L |
| CO3 | | L | H | M | | | M | H | L |
| CO4 | | L | M | H | | | L | M | H |

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## 24MECT02: AD-HOC AND WIRELESS SENSOR NETWORKS

**Credits:** 3 **Sessional Marks:** 40
**L: T: P:** 2: 1 :0 **University Exam. Marks:** 60

**Course Objectives:**
The objectives of this course are to make the student
1. To study the fundamentals of wireless Ad-Hoc Networks.
2. To study the operation and performance of various Ad-hoc wireless network protocols.
3. To study the architecture and protocols of Wireless sensor networks.
4. To study the Sensor network Platforms and tools

**Course Outcomes:**
At the end of this course the student will be able to
**CO1:** Understand the basis of Ad-hoc wireless networks.
**CO2:** Understand design, operation and the performance of MAC layer protocols of Ad-hoc wireless networks.
**CO3:** Understand design, operation and the performance of routing and transport layer protocol of Ad-hoc wireless networks.
**CO4:** Understand sensor network Architecture and will be able to distinguish between protocols used in Ad-hoc wireless network and wireless sensor networks.

**UNIT - I**
**Wireless LANs and PANs:** Introduction, Fundamentals of WLANS, IEEE 802.11 Standards, HIPERLAN Standard, Bluetooth, Home RF.
**AD HOC WIRELESS NETWORKS:** Introduction, Issues in Ad Hoc Wireless Networks.

**UNIT - II**
**MAC Protocols:** Introduction, Issues in Designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention - Based Protocols, Contention - Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use DirectionalAntennas, Other MAC Protocols.

**UNIT - III**
**Routing Protocols:** Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table –Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power – Aware Routing Protocols.

**UNIT – IV**
**Transport Layer Protocols:** Introduction, Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocol for Ad Hoc Wireless Networks.

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**UNIT – V**

**Wireless Sensor Networks:** Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering, MAC Protocols for Sensor Networks, Location Discovery, Quality of a Sensor Network, Evolving Standards, Other Issues.

**TEXT BOOKS**

1. Ad Hoc Wireless Networks: Architectures and Protocols - C. Siva Ram Murthy andB.S.Manoj, 2004, PHI.
2. Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control - JagannathanSarangapani, CRC Press.

**REFERENCES:**

1. Ad- Hoc Mobile Wireless Networks: Protocols & Systems, C.K. Toh , 1st Ed. PearsonEducation.
2. Wireless Sensor Networks - C. S. Raghavendra, Krishna M. Sivalingam, 2004, Springer.

**Course Outcomes-Program Outcomes -Program Specific Outcomes (CO-PO-PSO) Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | L | | | | H | M | L |
| CO2 | | L | H | M | | | M | H | L |
| CO3 | | L | H | M | | | M | H | L |
| CO4 | | L | M | H | | | L | M | H |

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## 24MECT03:OPTICAL COMMUNICATIONS & NETWORKS

**Credits:** 3 **Sessional Marks:** 40
**L: T: P:** 3: 0 :0 **University Exam. Marks:** 60

**Course Objectives:**

The objectives of this course is to make the students

1. To Learn the basic elements of optical fiber transmission link, fiber glass modes configurations & structures.
2. To understand different kinds of losses, signal attenuation in optical fibers and other dispersion factor.
3. Understanding of optical network system components, variety of networking aspects, SONET/SDH.
4. Study of network operations, OTDM, OTDN etc link budget and network design and management.

**Course Outcomes:**

At the end of the course the students will able to

**CO1:** Apply the fundamental principles of optics and light wave to design optical fiber communication systems.

**CO2:** Analyze losses in optical fiber link and state transmission characteristics of optical fiber.

**CO3:** Knowledge on optical fiber communication links using appropriate optical fibers light sources, detectors.

**CO4:** Apply concept of designing and operating principles of modern optical systems and networks.

### UNIT I

**Introduction to Optic Communication:** Evolution of fiber types, guiding properties of fibers, cross talk between fibers, coupled modes and mode mixing, dispersion properties of fibers.

**Optical and Mechanical Characterization of Fibers, Optical Cable Design:** Design objectives and cable structures, fiber splicing, fiber end preparation, single and array splices, measurement of splicing efficiency, optical fiber connectors, connector alignments, optical sources for communication, LED, injection lasers, modulation technique, direct and indirect methods, optical waveguide devices.

### UNIT II

**Optical Detectors:** Photodiodes in repeaters, receiver design, digital and analog, transmission system design, system design choices, passive and low speed active optical components for fiber system, micro-optic components, lens-less components.

**Optical Fiber Components:** Couplers, Isolators and Circulators, Multiplexers, Bragg grating, Fabry-Perot Filters, Mach zenderinterferometers, Arrayed waveguide grating, tunable filters, hi-channel count multiplexer architectures, optical amplifiers, direct and external modulation transmitters, pump sources for amplifiers, optical switching and wavelength converters.

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## UNIT III

**Optical Fiber Techniques-1**: Modulation and demodulation, signal formats, direction detection receivers, coherent detection.

**Optical Fiber Techniques-2:** Optical switching, polarization control, inter office transmission system, trunking system, performance and architecture, undersea cable system, optical fibers in loop distribution system, photonic local network.

## UNIT IV

**Access Network:** Network Architecture, HFC, FTTC, Optical Access Network Architecture, deployment considerations, upgrading the transmission capacity, SDM, TDM, WDM, Application areas, Inter exchange, Undersea, Local Exchange Networks; Packaging and cabling of Photonics Components- Photonic Packet Switching, OTDM, Multiplexing and Demultiplexing, Optical Logic Gates, Synchronization, broadcast and select WDM network, OTDM testbeds.

## UNIT V

**Soliton Communication:** Basic Principle, Metropolitan Optical Network, Cable TV network, Optical Access Network, Photonics Simulation Tools, Error Control Coding Techniques, Nonlinear Optical Effects in WDM transmission.

**Text Books:**

1. Gil Held, "Deploying Optical Network Components".
2. Gerd Kaiser, "Optical Fiber Communication", McGraw Hill.
3. Rajiv Ramaswamy and Kumar and N. Sivaranjan, "Optical Networks".

**References:**

1. S E Miller, A G Chynoweth, "Optical Fiber Telecommunication".

**Course Outcomes-Programs Outcomes –Program Specific Outcomes-(CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | L | | | | H | L | |
| CO2 | H | M | | L | | | H | L | |
| CO3 | H | M | | L | | | H | M | L |
| CO4 | H | | L | | | M | H | M | |

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## 24MECT06: TCP/IP INTERNET WORKING
**(Professional Elective –I)**

**Credits:** 3
**L: T: P:** 3: 0 :0

**Sessional Marks:** 40
**University Exam. Marks:** 60

**Course Objectives:**

1. This Course provides a solid foundation for understanding the communication process of the internet.
2. The student will understand the fundamental concepts of computer networking in the context of the TCP/IP model and protocols.
3. To study about protocols, congestion control and flow control.
4. To study about SCTP services and features.

**Course Outcomes:**

At the end of this course student will:
CO1: Summarize basic principles of different layers and its addressing mechanisms.
CO2: Understand UDP services and applications in Transport.
CO3: Discuss various flow, Error and congestion control mechanisms of TCP.
CO4: Understand the SCTP services, SCTP features, Flow control, Error control.

**UNIT - I**

**Network Models:** Layered Tasks, The OSI Model, Layers in OSI Model, TCP/IP Protocol suite, Addressing.
Connecting devices: Passive Hubs, Repeaters, Active Hubs, Bridges, Two Layer Switches, Routers, Three Layer Switches, Gateway, Backbone Networks.

**UNIT -II**

**Internetworking Concepts:** Principles of Internetworking, Connectionless Interconnection, Application Level Interconnection, Network Level Interconnection, Properties of the Internet, Internet Architecture, Interconnection through IP Routers
TCP, UDP & IP: TCP Services, TCP Features, Segment, A TCP Connection, Flow Control, Error Control, Congestion Control, Process to Process Communication, User Datagram, Checksum, UDP Operation, IP Datagram, Fragmentation, Options, IP Addressing: Classful Addressing, IPV6.

**UNIT -III**

**Congestion and Quality of Service:** Data Traffic, Congestion, Congestion Control, Congestion Control in TCP, Congestion Control in Frame Relay, Source Based Congestion Avoidance, DEC Bit Scheme, Quality of Service, Techniques to Improve QOS: Scheduling, Traffic Shaping, Admission Control, Resource Reservation, Integrated Services and Differentiated Services.

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**UNIT - IV**

**Queue Management:** Concepts of Buffer Management, Drop Tail, Drop Front, Random Drop, Passive Buffer Management Schemes, Drawbacks of PQM, Active Queue Management: Early Random Drop, RED Algorithm.

**UNIT - V**

**Stream Control Transmission Protocol:** SCTP Services, SCTP Features, Packet Format, Flow Control, Error Control, Congestion Control.

**Mobile Network Layer:** Entities and Terminology, IP Packet Delivery, Agents, Addressing, Agent Discovery, Registration, Tunneling and Encapsulating, Inefficiency in Mobile IP.

**Mobile Transport Layer:** Classical TCP Improvements, Indirect TCP, Snooping TCP, Mobile TCP, Fast Retransmit/Fast Recovery, Transmission, Timeout Freezing, Selective Retransmission, Transaction Oriented TCP.

**TEXT BOOKS:**

1. Behrouz A Forouzan, "TCP/IP Protocol Suite", TMH, 3rd Edition
2. B.A. Forouzan, "Data communication & Networking", TMH, 4th Edition.

**REFERENCES:**

1. Mahbub Hasan & Raj Jain," High performance TCP/IP Networking", PHI -2005
2. Douglas. E.Comer, "Internetworking with TCP/IP ", Volume I PHI
3. Larry L. Perterson and Bruce S.Davie , "Computer Networks- A Systems Approach", 2011,Morgan Kaufmann
4. Jochen Schiiler, "Mobile Communications" , Pearson , 2nd Edition.

**Course Outcomes-Program Outcomes -Program Specific Outcomes (CO-PO-PSO) Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | L | | H | H | |
| CO2 | | H | M | L | L | | M | M | |
| CO3 | | L | M | H | | | L | H | H |
| CO4 | | M | H | L | | | M | M | |

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## 24MECT07: DETECTION AND ESTIMATION THEORY
**(Professional Elective –I)**

**Credits:** 3
**L: T: P:** 3: 0 :0

**Sessional Marks:** 40
**University Exam. Marks:** 60

**Course Objectives:** The main objectives of the course are:

1. The main objective of this course is to provide basic estimation and detection backgroundfor engineering applications.
2. This course provides the main concepts and algorithms for detection and estimationtheory.
3. Students learn the statistics and estimating the parameters of Random Process fromdetection.
4. To apply estimation methods for real time engineering problems.

**Course Outcomes:** On completion of this course student will be able to

1. Understand the basic Random Process and detection methods.
2. Known the significance of Probability of error
3. Learn about basic estimation methods and filters
4. Measure the statistical parameters for random processes

**UNIT –I**

**Random Processes:** Discrete Linear Models, Markov Sequences and Processes, Point Processes, and Gaussian Processes.

**UNIT –II**

**Detection Theory:** Basic Detection Problem, Maximum A posteriori Decision Rule, Minimum Probability of Error Classifier, Bayes Decision Rule, Multiple-Class Problem (Bayes)-minimum probability error with and without equal a priori probabilities, Neyman-Pearson Classifier, General Calculation of Probability ofError, General Gaussian Problem, Composite Hypotheses.

**UNIT –III**

**Linear Minimum Mean-Square Error Filtering:** Linear Minimum Mean Squared Error Estimators, Nonlinear Minimum Mean Squared Error Estimators. Innovations, Digital Wiener Filters with Stored Data, Real-time Digital Wiener Filters, Kalman Filters.

**UNIT –IV**

**Estimation Theory:** Measurements, Nonparametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.

**UNIT –V**

**Estimating the Parameters of Random Processes from Data:** Tests for Stationarity and Ergodicity, Model-free Estimation, Model-based Estimation of Autocorrelation Functions, Power Special Density Functions.

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**TEXT BOOKS**

1. Random Signals: Detection, Estimation and Data Analysis – K. Sam Shanmugan & A.M.Breipohl, Wiley India Pvt. Ltd, 2011.
2. Random Processes: Filtering, Estimation and Detection – Lonnie C. Ludeman, Wiley IndiaPvt. Ltd., 2010.

**REFERENCES:**

1. Fundamentals of Statistical Signal Processing: Volume I Estimation Theory– Steven. M. Kay,Prentice Hall, USA, 1998.
2. Introduction to Statistical Signal Processing with Applications – Srinath, Rajasekaran,Viswanathan, 2003, PHI.
3. Statistical Signal Processing: Detection, Estimation and Time Series Analysis – Louis L.Scharf, 1991, Addison Wesley.
4. Signal Processing: Discrete Spectral Analysis – Detection & Estimation – Mischa Schwartz,Leonard Shaw, 1975, Mc Graw Hill

**Course Outcomes-Program Outcomes -Program Specific Outcomes (CO-PO-PSO) Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | L | H | | L | | M | M | H | L |
| CO2 | L | H | | L | | L | M | H | L |
| CO3 | L | H | | | | H | M | H | L |
| CO4 | L | H | | M | | H | M | H | L |

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## 24MECT08: ANTENNA THEORY AND DESIGN
**(Professional Elective –I)**

**Credits:** 3
**L: T: P:** 3: 0 :0

**Sessional Marks:** 40
**University Exam. Marks:** 60

**Course Objectives:**

1. Understand Basic Antenna Concepts: Introduce fundamental antenna concepts, types, radiation principles, and key parameters.
2. Learn Aperture Antenna Design: Study the design and analysis of aperture antennas, including pyramidal, conical, and corrugated horns.
3. Analyze Micro-strip Radiators: Examine design techniques for micro-strip radiators, focusing on rectangular and circular configurations.
4. Explore Slot Antennas: Understand and design micro-strip slot antennas, including various types like narrow, wide, tapered, and circularly polarized antennas.

**Course Outcomes:**

1. Fundamental Understanding: Explain basic antenna theory, types, and radiation mechanisms.
2. Aperture Antenna Design Skills: Design and analyze aperture antennas such as pyramidal and conical horns.
3. Microstrip Radiator Analysis: Design and analyze rectangular and circular microstrip antennas.
4. Slot Antenna Proficiency: Design and compare various microstrip slot antennas and understand their applications.

**UNIT - I**

**Fundamentals of Antenna:** Radiation Pattern, radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, Radiation efficiency, Antenna vector effective Length, Friis Transmission equation, Antenna Temperature.

**Types of antennas:** wire antennas, aperture antennas, micro strip antennas, array antennas, Reflector antennas, Lens Antennas, Radiation Mechanism, Current distribution on thin wire antenna.

**UNIT - II**

Introduction, Horn Antennas, Pyramidal Horns- Design Procedure, Conical and Corrugated Horns, Aperture Corrugated Horns, Reflected Antennas- Parameters, Analysis of front-fed parabolic reflector, Feed methods and feed types, Cassegrain Reflector Horns.

**UNIT - III**

**Microstrip Radiators:** Introduction, Rectangular Microstrip Antenna analysis and Design, Circular Microstrip Antenna Analysis and Design,

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**UNIT – IV**

**Microstrip Slot Antennas:** Wave guide fed slots, Radiation mechanism, Micro strip slot antennas, Introduction to rectangular slot antennas, narrow, wide, tapered and circularly polarized slot antennas, Annular slot antennas, Comparison of microstrip slot antennas with patch antennas.

**UNIT - V**

**Micro Strip Antenna Arrays:** Introduction, Micro strip array antennas, Characteristics of fixed beam linear antenna arrays, Linear micro strip arrays, Characteristics of planar arrays, Microstrip planar arrays, Microstrip scanned array antennas, Phase scanned microstrip arrays, Time delay scanning, Electronic feed switching, Frequency scanned microstrip arrays, Advantage and disadvantages of phased array antennas.

**TEXT BOOKS:**

1. Constantine Balanis. A, "Antenna Theory-Analysis and Design", 3rd Edition, John Wiley, 2005.
2. Bahl IJ, and P. Bhartia, "Microstrip Antennas", Artech House, 1980.

**REFERENCE BOOKS:**

1. Ramesh Garg, Prakash Bhatia, Inder Bahl, Apisak Ittipiboon, "Microstrip Antenna DesignHand Book", Artech House Inc., 2001.
2. Samuel Silver, "Microwave Antenna - Theory and design", IEE Press, 1984.
3. James. J R. Hall, P S. Wood. C, "Micro strip Antenna-Theory and Design", Peter PeregrinusLtd., 1981.

**Course Outcomes-Program Outcomes -Program Specific Outcomes (CO-PO-PSO) Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PS01 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | M | L | M | | M | M | M | L |
| CO2 | M | H | | | M | | H | | |
| CO3 | | H | | | | | | H | |
| CO4 | | | | | | | | | L |

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## 24MECT09: CODING THEORY AND TECHNIQUES
**(Professional Elective –II)**

**Credits:** 3 **Sessional Marks:** 40
**L: T: P:** 3: 0 :0 **University Exam. Marks:** 60

**Course Objectives**

1. To acquire the knowledge in measurement of information and errors.
2. T study the generation of various code methods.
3. To study the various application of codes.

**Course Outcomes:** On completion of this course student will be able to

1. Learning the measurement of information and errors.
2. Obtain knowledge in designing Linear Block Codes and Cyclic codes.
3. Construct tree and trellies diagrams for convolution codes
4. Design the Turbo codes and Space time codes and also their applications

**UNIT – I**

**Coding for Reliable Digital Transmission and storage:** Mathematical model of Information, A Logarithmic Measure of Information, Average and Mutual Information and Entropy, Types of Errors, Error Control Strategies.

**Linear Block Codes:** Introduction to Linear Block Codes, Syndrome and Error Detection, Minimum Distance of a Block code, Error-Detecting and Error-correcting Capabilities of a Block code, Standard array and Syndrome Decoding, Probability of an undetected error for Linear Codes over a BSC, Hamming Codes. Applications of Block codes for Error control in data storage system

**UNIT - II**

**Cyclic Codes:** Description, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, Decoding, Cyclic Hamming Codes, Shortened cyclic codes, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes.

**UNIT – III**

**Convolutional Codes:** Encoding of Convolutional Codes, Structural and Distance Properties, maximum likelihood decoding, Sequential decoding, Majority- logic decoding of Convolution codes. Application of Viterbi Decoding and Sequential Decoding, Applications of Convolutional codes in ARQsystem.

**UNIT – IV**

**Turbo Codes:** LDPC Codes- Codes based on sparse graphs, Decoding for binary erasure channel, Log-likelihood algebra, Brief propagation, Product codes, Iterative decoding of product codes, Concatenated convolutional codes- Parallel concatenation, The UMTS Turbo code, Serial concatenation, Parallel concatenation, Turbo decoding

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**UNIT - V**

**Space-Time Codes:** Introduction, Digital modulation schemes, Diversity, Orthogonal space-Time Block codes, Alamouti's schemes, Extension to more than Two Transmit Antennas, Simulation Results, Spatial Multiplexing : General Concept, Iterative APP Preprocessing and Per-layer Decoding, Linear Multilayer Detection, Original BLAST Detection, QL Decomposition and Interface Cancellation, Performance of Multi – Layer Detection Schemes, Unified Description by Linear Dispersion Codes.

**TEXT BOOKS:**

1. Error Control Coding- Fundamentals and Applications –Shu Lin, Daniel J.Costello,Jr, PrenticeHall, Inc.
2. Error Correcting Coding Theory-Man Young Rhee, McGraw-Hill,1989.

**REFERENCES:**

1. Digital Communications-Fundamental and Application - Bernard Sklar, PE.
2. Digital Communications- John G. Proakis, 5th ed. TMH, 2008.
3. Error Correction Coding – Mathematical Methods and Algorithms – Todd K.Moon, Wiley India,2006.
4. Information Theory, Coding and Cryptography – Ranjan Bose, 2nd Edition, TMH, 2009.

Course Outcomes-Program outcomes-Program Specific Outcomes(CO-PO-PSO)Mappin

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PS03 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | M | | L | | H | M | |
| CO2 | H | M | M | | | L | H | H | |
| CO3 | H | M | M | | | | L | L | |
| CO4 | H | M | L | | | | H | M | H |

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## 24MECT10: MOBILE COMPUTING
**(Professional Elective –II)**

**Credits:** 3
**L: T: P:** 3: 0 :0

**Sessional Marks:** 40
**University Exam. Marks:** 60

**Course Objectives:** The objectives of the course Mobile Computing are

1. To learn the fundamental technologies that help in the networking of wirelessdevices.
2. To study the cellular architectures of GSM, GPRS, SMS.
3. To have an exposure about emerging technologies like Blue tooth, WiMAX etc.
4. To impart knowledge about Mobile Application Development using Palm OS, Symbian, OS, J2ME etc. and to know the Network, Transport functionalities of Mobile Communication.

**Course Outcomes:**

1. Understand fundamental technologies underpinning wireless networking, including GSM, GPRS, and SMS.
2. Analyze and explain the cellular architectures and applications of GSM, GPRS, and SMS.
3. Explore emerging technologies like Bluetooth and WiMAX, understanding their functionality and applications.
4. Develop mobile applications using platforms like Palm OS, Symbian OS, and J2ME.

**UNIT – I:**

**Introduction to Mobile Computing Architecture:** Mobile Computing, dialog control, networks, middleware and gateways, application and services, developing mobile computing applications, security in mobile computing, architecture for mobile computing, three tier architecture, design considerations for mobile computing, mobile computing through internet, making existing applications mobile-enabled.

**UNIT – II:**

**Cellular Technologies–GSM, GPRS, CDMA AND 3G:** Bluetooth, Radio frequency identification, Wireless Broadband, mobile IP, Internet protocol version 6 (IPv6), Java card, PLNM interfaces, GSM addresses and identifiers, network aspects in GSM, Mobile computing over SMS, Short Message Services (SMS), GPRS network architecture, GPRS network operations, data services in GPRS, applications for GPRS, limitations of GPRS, CDMA versus GSM, third generation networks,applications on3G.

**UNIT – III:**

**Wireless Application Protocol (WAP) and Wireless LAN:** WAP, MMS, wireless LANadvantages, IEEE 802.11 standards, wireless LAN architecture, mobility in wireless LAN.

**Intelligent and Internetworking:** Introduction, fundamentals of call processing, intelligence in thenetworks, SS#7 signaling, IN Conceptual Model (INCM), Soft switch, programmable networks,technologies and interfaces for IN.

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**UNIT – IV:**

**Client Programming, PLAMOS, SYMBIAN OS, WINCE Architecture:** Introduction, moving beyond the desktop, a peek under the hood: hardware overview, mobile phones, PDA, design constraints in applications for handheld devices, palm OS architecture, application development, Symbian OS architecture, Applications for Symbian, different flavors of windows CE, windows CE architecture. **J2ME:** Java in the handset, the three-prong approach to JAVA everywhere, JAVA 2 micro edition (J2ME) technology, programming for CLDC, MIDLet, Optional packages.

**UNIT – V:**

**Voice Over Internet Protocol and Convergence:** Voice over IP, H.323 Framework for voice over IP, Session Initiation Protocol, Comparison between H.323 and SIP, Real Time protocols, Convergence Technologies, Call Routing, IP multimedia subsystem (IMS), Mobile VoIP.

**Security Issues in Mobile Computing:** Introduction, information security, security techniques and algorithms, security protocols, trust, security models, security frameworks for mobile environment.

**TEXT BOOKS:**

1. Asoke K. Talukder, Roopa R Yavagal, "Mobile Computing- Technology, Applications andService Creation", 2nd edition, Tata McGraw Hill, New Delhi, 2009.
2. Jochen Schiller, "Mobile Communications, 2nd Edition, Pearson Education, New Delhi,2008.

**REFERENCE BOOKS:**

1. Vieri Vanghi, Aleksander Damnjanovic, "The CDMA 2000 system for MobileCommunications", Pearson Education, New Delhi, 2007.
2. Frank Adelstein, "Fundamentals of Mobile and Pervasive Computing", McGraw Hill, NewDelhi,2008.

**Course Outcomes-Program Outcomes -Program Specific Outcomes (CO-PO-PSO) Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PS01 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | | | | | | L | | |
| CO2 | H | H | | | | | M | | |
| CO3 | H | | H | M | | | | | |
| CO4 | | H | | L | H | M | | | |

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## 24MECT11: IOT AND ITS APPLICATIONS
**(Professional Elective –II)**

**Credits:** 3 **Sessional Marks:** 40
**L: T: P:** 3: 0 :0 **University Exam. Marks:** 60

**Course Outcomes:** At the end of this course, students will be able to

- Understand the concept of IOT and M2M
- Study IOT architecture and applications in various fields
- Study the security issues in IOT
- Study the privacy issues in IOT.

**UNIT- I**

IoT & Web Technology The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT RelatedStandardization, Recommendations on Research Topics.

**UNIT- II**

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value
chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

**UNIT- III**

IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

**UNIT- IV**

IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil andGas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

**UNIT- V**

Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues,

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**TEXTBOOKS**


1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
2. Francis da Costa, "Rethinking the Internet of Things: A Scalable Approach to ConnectingEverything", 1st Edition, Apress Publications, 2013.
3. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media, 2011.


**Course Outcomes-Program Outcomes -Program Specific Outcomes (CO-PO-PSO) Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PS01 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | | | | | | L | | |
| CO2 | H | H | | | | | M | | |
| CO3 | H | | H | M | | | | | |
| CO4 | | H | | L | H | M | | | |

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## 24MBST01: Research Methodology and IPR

**Credits – 3**
**L:T:P :: 3:0:0**

**Sessional Marks:** 40
**University Exam Marks:** 60

**Course Objectives**

1. To gain familiarity in order to obtain insights into selected area of research.
2. To acquaint procedures and techniques used to find the results of a research problem.
3. To familiarize methods for data analysis and design.
4. To know the steps to collect information about IPR.
5. To implement IPR protection strategies and other facilities provided by R &D in case of new innovation.

**Course Outcomes**

After completion of the course, students will be able to

**CO1**: Understand the research problem formulation
**CO2**: Analyze research related information
**CO3**: Follow research ethics
**CO4**: Understand that today's world is controlled by computer, information technology but tomorrow world will be ruled by ideas, concept and creativity.
**CO5**: Understand that when IPR would take such important place in growth of individuals and nation, it is needless to emphasis the need of information about intellectual property rights to be promoted among students in general and engineering in particular.
**CO6**: Understand that IPR protection provides an incentive to inventors for further research work and investment in R&D, which leads to creation of new and better products, and intern brings about economic growth and social benefits.

**UNIT – I**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem, Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

**UNIT – II**

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research propósal, a presentation and assessment by a review committee

**UNIT – III**

Design and Analysis of Experiments: Introduction to ANOVA with examples; Factorial design: 2n design; Taguchi method: Introduction and application of taguchi method for optimization of process.

**UNIT – IV**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

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**UNIT – V**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases, Geographical Indications.

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc, Traditional knowledge Case Studies, IPR and IITs.

**Textbooks**

1. Melville, S., and W. Goddard. "Research Methodology-An Introduction for Science & Engineering Students.l Cape Town: Juta & Co Ltd." (1996).

**Reference Books**

1. Goddard, Wayne, and Stuart Melville. Research methodology: An introduction. Juta and Company Ltd, 2004.
2. Kumar, Ranjit. "Research methodology: A step-by-step guide for beginners." 2018: 1-528.
3. Halbert, Debora J. Resisting intellectual property. Routledge, 2006.
4. Asimow, Morris. "Introduction to design." 1962.
5. Merges, Robert P., Peter Seth Menell, and Mark A. Lemley. "Intellectual property in the new technological age." 2003.
6. Ramappa, T. "Intellectual Property Rights Under WTO." S. Chand 3 2008: 272-282.

**Course Outcomes – Program Outcomes – Program Specific Outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | - | - | M | - | L | H | M | L |
| CO2 | - | - | M | H | - | L | M | L | H |
| CO3 | - | L | H | - | - | M | H | M | L |
| CO4 | - | - | - | L | H | M | M | H | L |
| CO5 | - | H | - | M | - | L | L | M | H |
| CO6 | H | - | - | - | L | H | L | H | M |

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## 24MECP01: WIRELESS COMMUNICATION AND NETWORKS LAB

**Credits:** 2 **Sessional Marks:** 40

**L: T: P:** 0: 0 :4 **University Exam. Marks:** 60

**Course Outcomes:** At the end of this course, students will be able to

1. Implement the advanced digital modulation techniques.
2. Design Convolutional encoder and decoder for error control coding techniques.
3. Calculate path loss for Free space, Okumura and Hata models for outdoor propagation.
4. Comprehend Cellular concepts of GSM and CDMA networks.
5. Simulate RAKE receiver for CDMA with MATLAB.

**List of Experiments:**

1. FSK Modulation and Demodulation technique.
2. QPSK Modulation and Demodulation technique.
3. DQPSK Modulation and Demodulation technique
4. 8-QAM Modulation and Demodulation technique.
5. Implementation of Convolutional Encoder and Decoder.
6. Simulation of the following Outdoor Path loss propagation models
   a. Free Space Propagation model b. Okumura model
   b. Hata model
7. Simulation of Adaptive Linear Equalizer using MAT LAB software.
8. Measurement of call blocking probability for GSM & CDMA networks using Netsimsoftware.
9. Study of GSM handset for various signalling and fault insertion techniques (Major GSMhandset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).
10. Study of transmitter and receiver section in mobile handset and measure frequency band signal and GMSK modulating signal.
11. Simulation of RAKE Receiver for CDMA communication using MAT LAB software.
12. Simulate and test various types of PN codes, chip rate, spreading factor and processing gain on performance of DSSS in CDMA.
13. Simulate and test the 3G Network system features using GSM AT Commands. (Features of 3G Communication system: Transmission of voice, video calls, SMS, MMS, TCP/IP, HTTP, GPS)
14. Modeling of communication system using Simulink.

**Note:** 1. Experiments 1 to 5 need to be simulated using MATLAB and NS Tools free downloaded version and test with hardware.

2. Minimum 10 experiments has to be done

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## 24MECP02: AD-HOC WIRELESS NETWORKS LAB

**Credits:** 2
**L: T: P:** 0: 0 :4

**Sessional Marks:** 40
**University Exam. Marks:** 60

List of experiments

1. Evaluate the performance of various LAN Topologies
2. Evaluate the performance of Drop Tail and RED queue management schemes
3. Evaluate the performance of CBQ and FQ Scheduling Mechanisms
4. Evaluate the performance of TCP and UDP Protocols
5. Evaluate the performance of TCP, New Reno and Vegas
6. Evaluate the performance of AODV, DSR and DSDV routing protocols
7. Evaluate the performance of IEEE 802.11 and IEEE 802.15.4
8. Capturing and Analysis of TCP and IP Packets
9. Simulation and Analysis of ICMP and IGMP Packets
10. Analyze the Protocols SCTP , ARP, NetBIOS, IPX VINES
11. Analysis of HTTP, DNS and DHCP Protocols
12. Analysis of OFDM Spectrum
13. Analysis CDMA Downlink
14. MAC protocols

**Note:1.** For Experiments 1 to 7 Performance may be evaluated through simulation by using the parameters Throughput, Packet Delivery Ratio, Delay etc.
2.Minimum of 10 Experiments have to be conducted
3. All the Experiments may be Conducted using Network Simulation software like NS-2/ NSG-2.1/ Wire SHARK/ SDR etc.

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# I Year

# II Semester

# Syllabus

## 24MECT04: ADVANCED COMMUNICATIONS AND NETWORKS

**Credits:** 3
**L: T: P:** 2: 1 :0

**Sessional Marks:** 40
**University Exam. Marks:** 60

**Course Outcomes** at the end of the course, students will be able to

1. Learn Sequence Spread Spectrum
2. Obtain Knowledge in MIMO Systems
3. Able to construct Wireless LAN's 802.11 X /802.15 X
4. Design Wireless MAN's / IEEE802.16 X

**Course Outcomes** at the end of the course, students will be able to

1. Learn Sequence Spread Spectrum.
2. Obtain Knowledge in MIMO Systems
3. Construct wireless LAN's 802.11 X/ 802.15 X
4. Design Wireless MAN's / IEEE 802.16 X

**UNIT - I**

**Spread Spectrum Communications:** Spreading sequences- Properties of Spreading Sequences, Pseudo- noise sequence, Gold sequences, Kasami sequences, Walsh Sequences, Orthogonal Variable Spreading Factor Sequences, Barker Sequence, Complementary Codes

**Direct sequence spread spectrum:** DS-CDMA Model, Conventional receiver, Rake Receiver, Synchronization in CDMA, Power Control, Soft handoff, Multiuser detection – Optimum multiuser detector, Liner multiuser detection.

**UNIT - II**

**Orthogonal Frequency Division Multiplexing:** Basic Principles of Orthogonality, Single vs Multicarrier Systems, OFDM Block Diagram and Its Explanation, OFDM Signal Mathematical Representation, Selection parameter for Modulation, Pulse shaping in OFDM Signal and Spectral Efficiency, Window in OFDM Signal and Spectrum, Synchronization in OFDM, Pilot Insert in OFDM Transmission and Channel Estimation, Amplitude Limitations in OFDM, FFT Point Selection Constraints in OFDM, CDMA vs OFDM, Hybrid OFDM.

**UNIT - III**

**MIMO Systems:** Introduction, Space Diversity and System Based on Space Diversity, Smart Antenna system and MIMO, MIMO Based System Architecture, MIMO Exploits Multipath, Space – Time Processing, Antenna Consideration for MIMO, MIMO Channel Modelling, MIMO Channel Measurement, MIMO Channel Capacity, Cyclic Delay Diversity (CDD), Space Time Coding, Advantages and Applications of MIMO in Present Context, MIMO Applications in 3G Wireless System and Beyond, MIMO-OFDM

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**UNIT - IV**

**Wireless LANs/IEEE 802.11x:** Introduction to IEEE802.11x Technologies, Evolution of wirelessLANs, IEEE 802.11 Design Issues, IEEE 802.11 Services, IEEE 802.11 MAC Layer operations, IEEE

802.11 Layer1, IEEE 802.11 a/b/g Higher Rate Standards, Wireless LAN Security, ComputingWireless Technologies, Typical WLAN Hardware

**UNIT - V**

**Wireless PANs/IEEE 802.15x:** Introduction to IEEE 802.15x Technologies: Wireless PAN Applications and Architecture, IEEE 802.15.1 Physical Layer Details, Bluetooth Link Controllers Basics, Bluetooth Link Controllers Operational States, IEEE 802.15.1 Protocols and Host Control Interface. Evaluation of IEEE 802.15 Standards

**Broad Band Wireless MANs/IEEE 802.16x:** Introduction to WMAN/IEEE 802,16x Technology, IEEE

802.16 Wireless MANs, IEEE 802.16 MAC Layer Details, IEEE 802.16 Physical Layer Details, IEEE

802.16 Physical Layer Details for 2-11 GHz, IEEE 802.16 Common System Operations.

**TEXT BOOKS:**

1. Gary J. Mullett, "Introduction to Wireless Telecommunications Systems and Networks",CENGAGE
2. Upena Dalal, "Wireless Communication", Oxford University Press, 2009.

**REFERENCES:**

1. Ke-Lin Du & M N S Swamy, "Wireless Communication System", Cambridge University Press,2010
2. Gottapu Sasibhusan Rao, "Mobile Cellular Communication", PEARSON.

**Course Outcomes-Programs Outcomes –Program Specific Outcomes-(CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | L | M | H | | | | H | L | |
| CO2 | H | M | | L | | | H | L | |
| CO3 | H | M | | L | | | M | M | L |
| CO4 | H | | L | | | M | H | M | |
| CO5 | H | M | L | | | | H | L | |
| CO6 | | | | | | | | | |

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## 24MECT05: WIRELESS SENSOR NETWORKS

Credits:3
L: T: P: 2: 1: 0

Session Marks:40
University Exam Marks:60

**Course Objectives:**

The objectives of this course are to make the student

1. To understand the basic WSN technology and supporting protocols.
2. To understand the medium access control protocols and address physical layer issues.
3. To learn key routing protocols for sensor networks and main design issues.
4. To understand the Sensor management, sensor network middleware, operating system.

**Course Outcomes:**

At the end of this course the student will be able to

**CO1**: Understand and explain common wireless sensor node architectures.
**CO2**: Be able to carry out simple analysis and planning of WSNs.
**CO3**: Demonstrate knowledge of MAC protocols developed for WSN.
**CO4**: Understand and explain mobile data-centric networking principles.

**UNIT -I:**

Introduction to Sensor Networks, unique constraints and challenges- characteristic requirements and required mechanisms, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks- Terrestrial WSN, Underground WSN, Underwater WSN, Multimedia WSN and Mobile WSN.

**UNIT -II**

Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks

**UNIT -III**

Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol,IEEE 802.15.4 standard and ZigBee.

**UNIT -IV**

Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.

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**UNIT -V**

Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication. Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC.

**TEXT BOOKS:**

1. Ad-Hoc Wireless Sensor Networks- C. Siva Ram Murthy,B. S. Manoj, Pearson.
2. Principles of Wireless Networks – Kaveh Pah Laven and P. Krishna Murthy, 2002, PE.

**REFERENCE BOOKS:**

1. Wireless Digital Communications – Kamilo Feher, 1999, PHI.
2. Wireless Communications-Andrea Goldsmith, 2005 Cambridge University Press.
3. Mobile Cellular Communication – Gottapu Sasibhushana Rao, Pearson Education, 2012.
4. Wireless Communication and Networking – William Stallings, 2003, PHI.

**Course Outcomes-Program Outcomes -Program Specific Outcomes (CO-PO-PSO) Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO 1 | H | M | | | L | | H | M | L |
| CO 2 | | H | M | L | L | | M | H | L |
| CO 3 | | L | M | H | | | M | H | L |
| CO 4 | | M | H | L | | | L | M | H |

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## 24MECT12: DIGITAL IMAGE AND VIDEO PROCESSING
**(Professional Elective –III)**

**Credits:** 3 **Sessional Marks:** 40
**L: T: P:** 3: 0 :0 **University Exam. Marks:** 60

**Course Objectives**

1. The student will be able to understand the quality improvement methods of Image.
2. To study the basic digital image and video filter operations.
3. Understand the fundamentals of Image Compression.
4. Understand the Representation of video, principles and methods of motion estimation.

**Course Outcomes:** On completion of this course student will be able to

1. Learn the image representation, and fundamental processing steps of an image.
2. Know the different enhancement techniques in both spatial and frequency domains.
3. Understand the importance of compression and different compression techniques.
4. Learn the representation, modeling and motion estimation of Video.

**UNIT – I**

**Fundamentals of Image Processing and Image Transforms:** Basic steps of Image Processing System Sampling and Quantization of an image, Basic relationship between pixels.

**Image Segmentation:** Segmentation concepts, Point, Line and Edge Detection, Thresholding, Region based segmentation.

**UNIT – II**

**Image Enhancement:** Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters.

Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Selective filtering.

**UNIT – III**

**Image Compression:** Image compression fundamentals - Coding Redundancy, Spatial and Temporal redundancy, Compression models: Lossy & Lossless, Huffman coding, , Bit plane coding, Transform coding, Predictive coding, Wavelet coding, Lossy Predictive coding, JPEG Standards.

**Color Image Processing**:RGB, YUV, HIS:Color transformation-formulation, color components

**UNIT - IV**

**Basic Steps of Video Processing:** Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations.

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**UNIT – V**

**Motion Estimation:** Optical flow, General Methodologies, Pixel Based Motion Estimation, Block- Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Video coding.

**TEXT BOOKS:**

1. Digital Image Processing – Gonzaleze and Woods, 4th Ed., Pearson, 2018.
2. Digital Video Processing – M. Tekalp, Prentice Hall International.

**REFERENCE BOOKS:**

1. Video Processing and Communication – Yao Wang, Joem Ostermann and Ya–quin Zhang. 1st Ed., PH Int.
2. Digital Image Processing – S. Jayaraman, S. Esakkirajan, T. Veera Kumar –TMH, 2009.

Course Outcomes-Program outcomes-Program Specific Outcomes(CO-PO-PSO)Mappin

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PS03 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | L | | M | | | M | H | |
| CO2 | | M | H | | L | | | H | M |
| CO3 | | H | | | M | L | M | L | H |
| CO4 | H | | M | L | | | L | H | |

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## 24MECT13: NETWORK SECURITY AND CRYPTOGRAPHY
## (Professional Elective –III)

**Credits:** 3
**L: T: P:** 3: 0 :0

**Sessional Marks:** 40
**University Exam. Marks:** 60

**Course Objectives:** The main objectives of the course are:

1. To acquire the knowledge on wireless networks, protocols and standards.
2. To familiarize the students to understand and analyze the network layer solutions for wireless networks.
3. To interpret the students about wireless LAN and wireless PAN
4. To acquire knowledge on IEEE Standard protocols.

**Course Outcomes:**

At the end of this course the student will be able to

CO1: Understand about the protocols and wireless 4G systems.
CO2: Known how to differentiate the wired and wireless networks .
CO3: Obtain the knowledge on IEEE standards for Wireless LAN.
CO4: Analyse the protocols on wireless PANs.

**UNIT- I:**

**Security:** Need of security, security services, Attacks, OSI Security Architecture, one-time passwords, Model for Network security, Classical Encryption Techniques like substitution ciphers, Transposition ciphers, Cryptanalysis of Classical Encryption Techniques.

**UNIT- II**

**Number Theory:** Introduction, Fermat's and Euler's Theorem, The Chinese Remainder Theorem, Euclidean Algorithm, Extended Euclidean Algorithm, and Modular Arithmetic.

**UNIT- III**

**Private-Key (Symmetric) Cryptography:** Block Ciphers, Stream Ciphers, RC4 Stream cipher, Data Encryption Standard (DES), Triple DES ,Advanced Encryption Standard (AES), RC5, IDEA, Linear and Differential Cryptanalysis.

**UNIT- IV**

**Public-Key (Asymmetric) Cryptography:** RSA, Key Distribution and Management, Diffie-Hellman Key Exchange, Elliptic Curve Cryptography, Message Authentication Code, hash functions, message digest algorithms: MD5, Secure Hash algorithm, RIPEMD-160, HMAC.

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**UNIT- V**

**Authentication and System Security:** IP and Web Security Digital Signatures, Digital Signature Standards, Authentication Protocols, Kerberos, IP security Architecture, Encapsulating Security Payload, Key Management, Web Security Considerations, Secure Socket Layer, Secure Electronic Transaction Intruders, Intrusion Detection, Password Management, Worms, viruses, Trojans, Virus Countermeasures, Firewalls, Trusted Systems.

**TEXT BOOKS:**


1. William Stallings, "Cryptography and Network Security, Principles and Practices",, PearsonEducation, 3rd Edition.
2. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security, Private Communication in a Public World", Prentice Hall, 2nd Edition


**REFERENCES:**


1. Christopher M. King, Ertem Osmanoglu, Curtis Dalton, "Security Architecture, DesignDeployment and Operations", RSA Pres,
2. Stephen Northcutt, Leny Zeltser, Scott Winters, Karen Kent, and Ronald W. Ritchey, "InsideNetwork Perimeter Security", Pearson Education, 2nd Edition
3. Richard Bejtlich, "The Practice of Network Security Monitoring: Understanding IncidentDetection and Response", William Pollock Publisher, 2013.


**Course Outcomes-Program Outcomes -Program Specific Outcomes (CO-PO-PSO) Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | L | M | L | | | M | H | L |
| **CO2** | H | L | H | | | | M | H | L |
| **CO3** | M | | H | L | | M | M | H | L |
| **CO4** | L | H | M | M | | | M | H | L |

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## 24MECT14: MIMO COMMUNICATIONS
**(Professional Elective –III)**

**Credits:** 3 **Sessional Marks:** 40
**L: T: P:** 3: 0 :0 **University Exam. Marks:** 60

**Course Objectives:**

1. Understand the impact of fading on wireless communication and explore techniques to mitigate its effects.
2. Examine the capacity and information rates of various MIMO channels under different conditions.
3. Investigate space-time coding techniques to enhance transmit diversity and performance in wireless communications.
4. Understand the development and application of concatenated codes and iterative decoding techniques for improved error correction and explore space-time coding strategies for MIMO.

**Course Outcomes:**

Students will be able to:

1. Analyze error and outage probabilities in fading channels and apply diversity techniques to improve communication performance.
2. Calculate and compare the capacity of coherent and non-coherent MIMO channels in noisy and fading environments.
3. Implement and evaluate the performance of space-time block and trellis codes, such as the Alamouti scheme and orthogonal/quasi-orthogonal codes.
4. Design and analyze concatenated codes for AWGN and MIMO channels, including turbo coded modulation for MIMO systems. Evaluate the capacity and information rates of MIMO.

**UNIT - I**

**Fading Channels and Diversity Techniques:** Wireless channels – Error/Outage probability over fading channels – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications.

**UNIT - II**

**Capacity and Information Rates of MIMO Channels:** Capacity and Information rates of noisy, AWGN and fading channels – Capacity of MIMO channels – Capacity of non-coherent MIMO channels – Constrained signaling for MIMO communications.

**UNIT - III**

**Space-Time Block and Trellis Codes:** Transmit diversity with two antennas: The Alamouti scheme –Orthogonal. and Quasi-orthogonal space-time block codes – Linear dispersion codes – Generic space-time trellis codes – Basic space-time code design principles – Representation of space-time trellis codes for PSK constellation – Performance analysis for space-time trellis codes – Comparisonof space-time block and trellis codes.

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**UNIT - IV**

**Concatenated Codes and Iterative Decoding**: Development of concatenated codes – Concatenated codes for AWGN and MIMO channels – Turbo coded modulation for MIMO channels – Concatenated space-time block coding.

**UNIT - V**

**Space-Time Coding for Frequency Selective Fading Channels**: MIMO frequency-selective channels – Capacity and Information rates of MIMO FS fading channels – Space-time coding and Channel detection for MIMO FS channels – MIMO OFDM systems.

**TEXT BOOKS:**


1. Tolga M. Duman and Ali Ghrayeb, "Coding for MIMO Communication systems", John Wiley& Sons, West Sussex, England, 2007.
2. A. B. Gershman and N.D. Sidiropoulus, "Space-time processing for MIMO Communications", Wiley, Hoboken, NJ, USA, 2005.


**REFERENCES:**


1. E.G. Larsson and P. Stoica, "Space-time block coding for Wireless communications",Cambridge University Press, 2003.
2. M. Janakiraman, "Space-time codes and MIMO systems", Artech House, 2004.
3. H. Jafarkhani, "Space-time coding: Theory & Practice", Cambridge University Press, 2005.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | H | L | | | H | M | |
| CO2 | H | M | M | L | | | M | H | |
| CO3 | M | H | | | | | M | L | H |
| CO4 | H | M | M | | | | | L | M |

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## 24MECT15: COGNITIVE RADIO
## (Professional Elective –IV)

**Credits:** 3
**L: T: P:** 3: 0 :0

**Sessional Marks:** 40
**University Exam. Marks:** 60

**Course Objectives**

- Understand the concept of the digital dividend and the architecture of cognitive radios.
- Grasp the fundamentals of spectrum sensing and the detection of spectrum holes.
- Develop skills in optimization techniques for dynamic spectrum allocation.
- Explore the concept of spectrum trading and research challenges in cognitive radio networks.

**Course Outcomes:** At the end of this course, students will be able to:

- Understand the fundamental concepts of cognitive radio networks.
- Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
- Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
- Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimization techniques for better spectrum exploitation.

**UNIT-I**

**Introduction to Cognitive Radios:** Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

**UNIT-II**

**Spectrum Sensing:** Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).

**UNIT-III**

**Optimization Techniques of Dynamic Spectrum Allocation:** Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming.

**Unit-IV**

**Dynamic Spectrum Access and Management:** Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

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**UNIT-V**

**Spectrum Trading:** Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), and classification of auctions (single auctions, double auctions, concurrent, sequential). Research Challenges in Cognitive Radio: Network layer and transport layer issues, cross layer design for cognitive radio networks.

**REFERENCES:**


1. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management inCognitive Radio Networks", Cambridge University Press, 2009.
2. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd.,2009.
3. Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
4. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems",Springer, 2007.
5. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless CommunicationSystems" Springer, 2009.
6. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | L | M | H | L | | | M | H | |
| CO2 | H | H | M | L | | | H | L | |
| CO3 | L | H | | | | | M | H | H |
| CO4 | H | M | | | | | | H | M |

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## 24MECT16: TECHNOLOGY DEVELOPMENTS
## (Professional Elective –IV)

**Credits:** 3 **Sessional Marks:** 40
**L: T: P:** 3: 0 :0 **University Exam. Marks:** 60

**Course Objectives:** The objectives of the course 4G Technologies are

- To know about Second Generation, Third Generation Cellular technologies.
- To study the Evolution Generation (2.5G) technology platforms.
- To study various 4G technologies like OFDM, MC-CDMA etc.
- To understand UWB wireless channels, channel modelling for micro, picocells.

**Course Outcomes:** At the end of the course, the students will be able to

- Explain and compare Second , improved version of 2G technology and Third Generation technologies, their architectures.
- Define 4G technologies, their applications in modern wireless communication systems.
- Differentiate various multiple access schemes used in 4G systems.
- Demonstrate the knowledge about UWB wireless channels.

**UNIT – I**

**2G Technology: Second Generation(2G):** Overview, Enhancements over 1G Systems, Integration with Existing 1G Systems, GSM, IS-136 System Description, IS-95 System Description, iDEN (Integrated Dispatch Enhanced Network),CDPD.

**The Evolution Generation (2.5G):** What Is 2.5G?, Enhancements over 2G, Technology Platforms, General Packet Radio Service, (GPRS), Enhanced Data Rates for Global Evolution (EDGE),High- Speed Circuit Switched Data (HSCSD), CDMA 2000 (1XRTT),WAP, SMS, Migration Path from 2G to 2.5G to 3G.

**UNIT – II**

**Third Generation (3G):** Overview, Introduction, Universal Mobile Telecommunications Service (UMTS), UMTS Services, The UMTS Air Interface, Overview of the 3G PP Release 1999 Network Architecture, Overview of the 3GPP Release 4 Network Architecture, Overview of the 3G PP Release 5 All-IP Network Architecture, Overview CDMA 2000, TD- CDMA, TD-SCDMA, Commonality Between WCDMA, CDMA2000, TD-CDMA and TD- SCDMA.

**UNIT – III**

**4G Technology:** Fundamentals of 4G, Advantages and Applications of 4G, Technology path, IMS, Convergent Devices, Advanced Broadband Wireless Access, Multimedia (Mobile TV), Business Requirements.

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**OFDM:** Timing and frequency offset in OFDM, Fading channel estimation for OFDM signals, Space-Time coding with OFDM signals, Layered Space-Time coding for MIMO OFDM, PAPR Reduction of OFDM signals.

**UNIT – IV**

**MC-CDMA:** Signal Structure, Downlink Signal, Uplink Signal, Spreading Techniques, Detection Techniques, Pre- Equalization, Combined Equalization, Soft Channel Decoding Flexibility in System design, Performance Analysis, MC-DS-CDMA, Signal Structure, Downlink Signal, Uplink Signal, Spreading, Detection Techniques, Performance Analysis.

Hybrid Multiple Access Schemes: Orthogonal Frequency Division Multiple Access (OFDMA), Single - Carrier FDMA (SC-FDMA), OFDMA with Code Division Multiplexing (SS-MC-MA).

**UNIT – V**

**UWB:** Ultra-Wide Band Radio, The UWB channel, Coded UWB schemes, Multiuser detection in UWB radio, UWB with space–time processing.

**Channel Modelling and Measurements for 4G:** Macrocellular environments (1.8 GHz), urban spatial radio channels in macro/microcell (2.154 GHz), MIMO channels in microcell and picocell environments (1.71/2.05 GHz), Outdoor mobile channel (5.3 GHz), Microcell channel (8.45 GHz), Wireless MIMO LAN environments (5.2GHz).

**TEXT BOOKS:**


1. Clint Smith, P.E., Daniel Collins, "3G Wireless Networks", 2nd ed., McGraw-Hill, 2007.
2. Savo G. Glisic, "Advanced Wireless Communications: 4G Cognitive and Cooperative Broadband Technology", 2nd ed., University of Oulu, Finland, John Wiley & Sons, Ltd, 2007.
3. K. Fazel, S. Kaiser, "Multi□Carrier and Spread Spectrum Systems: From OFDM and MC□CDMA to LTE and WiMAX", 2nd ed., John Wiley & Sons, Ltd, 2008.


**REFERENCE BOOKS:**


1. Upena Dalal, "Wireless Communication", Oxford University Press, 2009.
2. Simon R. Saunders, Alejandro Aragon-Zavala, "Antennas and Propagation for Wireless Communication Systems", 2nd ed., 2008.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | | M | L | M | H | M | | L |
| CO2 | L | M | H | M | H | H | M | | M |
| CO3 | L | | | L | M | H | L | | |
| CO4 | H | | M | H | M | H | L | M | L |

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## 24MECT17: ADVANCED DIGITAL SIGNAL PROCESSING
**(Professional Elective –IV)**

**Credits:** 3
**L: T: P:** 3: 0 :0

**Sessional Marks:** 40
**University Exam. Marks:** 60

**Course Outcomes:** At the end of this course, students will be able to

- To understand theory of different filters and algorithms
- To understand theory of multirate DSP, solve numerical problems and write algorithms
- To understand theory of prediction and solution of normal equations
- To know applications of DSP at block level.

Course Objectives:

- To understand multi rate filter banks such as two channel QMF banks.
- To understand different non-parametric techniques for power spectral estimation.
- To understand various designing techniques and realisation methods of digital filters.
- To understand different parametric techniques for power spectral estimation.

**UNIT - I**

Overview of DSP, Characterization in time and frequency, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design &structures, design techniques of linear phase FIR filters,IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, parallel realization of IIR.

**UNIT- II**

Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in subband coding.

**UNIT- III**

Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

**UNIT- IV**

Adaptive Filters, Applications, Gradient Adaptive Lattice, Minimum mean square criterion, LMS algorithm, Recursive Least Square algorithm

**UNIT- V**

Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum- Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation.

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## 24MHMT06: Entrepreneurship Development

**Credits – 3**
**L:T:P :: 3:0:0**

**Sessional Marks: 40**
**University Exam Marks:60**

### Course Objectives

1. To grasp the essential characteristics, functions, types, ethics, and social responsibilities of an entrepreneur, and the importance and role of entrepreneurship in economic development, as well as the impact of the MSMED Act 2006.
2. To explore India's start-up revolution, trends, imperatives, benefits, key players in the ecosystem, and examples of business incubators, rural entrepreneurship, social entrepreneurship, and women entrepreneurship through case studies of prominent Indian entrepreneurs.
3. To identify opportunities, conduct market surveys, create business plans, assess financial viability, manage bookkeeping, accounting, costing, pricing, and working capital, and apply management principles in business.
4. To comprehend different company structures, job roles, negotiation skills, financial risk assessment, and business plan preparation.
5. To design effective business models by understanding customer segmentation, value proposition, channels, customer relationships, key partners, activities, revenue streams, cost structures, and social business models.

### Course Outcomes

At the end of the course, student will be able to

**CO1:** Explain the key characteristics, functions, and types of entrepreneurship and the significance of ethics and social responsibilities in entrepreneurial ventures.

**CO2:** Analyze the various Indian models of entrepreneurship and evaluate the contributions of key Indian entrepreneurs to economic development

**CO3:** Develop comprehensive business plans by identifying opportunities, conducting market surveys, and assessing financial viability and working capital management.

**CO4:** Evaluate company structures and job roles, and demonstrate negotiation skills, financial risk assessment, and business plan preparation

**CO5:** Create innovative business models that address customer segmentation, value propositions, and social business considerations, and optimize revenue streams and cost structures.

### UNIT – I

Entrepreneur and Entrepreneurship: Characteristics, Functions, Types, Ethics and Social Responsibilities of an Entrepreneur. Entrepreneurship: Importance, Growth and Role of Entrepreneurship in Economic Development, EDPs in India. MSMED Act 2006.

### UNIT – II

Indian Models in entrepreneurship: Overview of entrepreneurship. India's start up revolution, Trends, imperatives, benefits; the players involved in the ecosystem, Business incubators, Rural entrepreneurship. Social entrepreneurship, women entrepreneurship, Cases of Tata, Birla, Kirloskar and many large and small entrepreneurs of India.

### UNIT – III

Soft skills for entrepreneurs, Planning, Whom to approach, Opportunity identification, Market survey, Production programme, Business plan, Financial of project report, Assessing financial viability, Bookkeeping and Accounting and financial statements, Costing and Pricing of Produce,

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Working Capital Management, Marketing, Management, Applied management in Business, Learning from Existing Business, Legal requirements

## UNIT – IV

Company Structure and Job roles, Understanding company structure, understanding job role, Developing negotiations skill, Add Wizard & Market makers skill, Financial Risk assessment, Business plan preparation.

## UNIT – V

Designing and configuration Business Models, Introduction to business models, Designing/Understanding customer segmentation and value preposition, choosing channels, Customer relationship to serve customer, key partners and key activities of the business model, choosing revenue streams and cost structures, social business model.

**Textbooks**

1. Vasant Desai: The Dynamics of Entrepreneurial Development and Management (Himalaya Publishing House)
2. Dr. S.S.Khanka: Entrepreneurial Development (S.Chaned)
3. K. Nagarajan: Project Management (New Age international Publishers)
4. Poornima M. Charantimath: Entrepreneurship Development ( Tata McGraw Hill)

**Web References**

1. http://eagri.org/eagri50/ARM402/index.html
2. http://pioneerinstitute.net/activities/6188-entrepreneurship.development-cell.html
3. http://www.sreewarangal.ac.in/centre-for-entrepreneurship.php
4. http://fredericodeigh.wrodpress.com/2012/10/12/introduction-to-entrepreneurship-developement/
5. http://ncert.nic.ic/ncerts/l/lebs213.pdf

**Course Outcomes – Program Outcomes – Program Specific Outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | - | - | L | - | M | H | M | L |
| CO2 | L | H | - | - | M | - | M | H | L |
| CO3 | - | L | H | - | - | M | L | M | H |
| CO4 | - | - | M | H | - | L | H | L | M |
| CO5 | M | - | - | - | H | L | M | H | L |

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**TEXTBOOKS:**

1. J. G. Proakis and D.G. Manolakis, "Digital signal processing: Principles, Algorithm andApplications", 4th Edition, Prentice Hall, 2007.
2. N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks –Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999.

**REFERENCES:**

1. Bruce W. Suter, "Multirate and Wavelet Signal Processing",1st Edition, Academic Press,1997.
2. M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & Sons Inc.,2002.
3. S. Haykin, "Adaptive Filter Theory", 4th Edition, Prentice Hall, 2001.
4. D. G. Manolakis, V. K. Ingle and S. M. Kogon, "Statistical and Adaptive Signal Processing",McGraw Hill, 2000

Course Outcomes-Program outcomes-Program Specific Outcomes(CO-PO-PSO)Mapping

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PS03 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | L | H | M | L |
| CO2 | M | H | | L | | | M | M | H |
| CO3 | | | M | H | L | | | H | L |
| CO4 | M | H | | | | L | H | | M |

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## 24MECP03: ADVANCED COMMUNICATIONS AND NETWORKS LAB

**Credits:** 2
**L: T: P:** 0: 0 :4

**Sessional Marks:** 40
**University Exam. Marks:** 60

**List of Experiments:**

1. Implementation of Matched Filters.
2. Optimum receiver for the AWGN channel.
3. Design FIR (LP/HP/BP) filter using Window method.
4. Measurement of effect of Inter Symbol Interference.
5. Generation of constant envelope PSK signal wave form for different values of M.
6. Simulation of PSK system with M=4
7. Simulation of DPSK system with M=4
8. Design of FSK system
9. Simulation of correlation type demodulation for FSK signal
10. BPSK Modulation and Demodulation techniques
11. QPSK Modulation and Demodulation techniques
12. DQPSK Modulation and Demodulation techniques
13. 8-QAM Modulation and Demodulation techniques
14. DQAM Modulation and Demodulation techniques
15. Verification of Decimation and Interpolation of a given signal
16. Power spectrum estimation using AR models

**Note:**Minimum of ten Experiments are to be performed.

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## 24MECS01: ADVANCED SIGNAL SIMULATION LAB

**Credits-2** **Sessional Marks: 40**

**L:T:P: 0:0:4** **University Exam Marks: 60**

### LIST OF EXPERIMENTS

1. Bilinear Transformations
2. Impulse Invariant Transformations
3. Filter function operation
4. Design of low pass Filter and High pass filter
5. Design and Analysis of Butterworth Low pass filter, High pass filter and Band pass Filter with second and third orders.
6. Design and testing of Chebysev Type 1 Low Pass Filter, High Pass Filter and Band pass Filter with second and third orders.
7. Design and testing of Chebysev Type 2 Low Pass Filter, High Pass Filter and Band Pass Filter with second and third orders.
8. Comparison of FIR and IIR Low Pass Filter Characteristics.
9. Comparison of FIR and IIR High Pass Filter Characteristics.
10. Comparison of FIR and IIR Band Pass Filter Characteristics.

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## 24MECC01: Term Paper cum Seminar

**Credits – 2** | **Sessional Marks: 40**
**L:T:P :: 0:0:4** | **University Exam Marks:60**

**Course Objectives**

1. Equip students with the ability to conduct in-depth research, analyze complex ideas, and synthesize information from diverse sources.
2. Focus on improving students' ability to articulate their research findings clearly and effectively through written communication.
3. Prepare students to effectively communicate their research and ideas in a structured and persuasive manner during seminars.
4. Inculcate a strong sense of academic integrity and adherence to ethical standards in research and reporting.
5. Encourage students to integrate knowledge and methods from multiple disciplines to enrich their research perspectives and outcomes.

**Course Outcomes**

At the end of the course, student will be able to

**CO1:** Students will exhibit a deep understanding of the chosen topic, showing mastery over the content, methodologies, and theories involved (CO1: Understand).

**CO2:** Students will competently apply appropriate research methods to their chosen topics, demonstrating the ability to collect, analyze, and interpret data (CO2: Apply).

**CO3:** Students will produce a well-structured term paper that clearly communicates research objectives, processes, analysis, and conclusions (CO3: Create).

**CO4:** Students will deliver persuasive and well-organized presentations that effectively communicate the significance of their research findings to an audience (CO4: Evaluate).

**CO5:** Students will actively participate in scholarly discourse, demonstrating the ability to engage critically with peers, respond to feedback, and refine their perspectives based on constructive criticism.

**Rubrics for Evaluation:**

1. **Content (40%)**
   - **Depth of Research (20%)**
     - **Excellent (A)**: Exhibits comprehensive and thorough research with extensive sources beyond course material.
     - **Good (B)**: Shows adequate research with some sources beyond the basic course material.
     - **Satisfactory (C)**: Meets basic research expectations with minimal external sources.
     - **Poor (D)**: Research is underdeveloped or lacks depth with very few or no external sources.
   - **Clarity and Relevance (20%)**
     - **Excellent (A)**: The paper is exceptionally clear and directly relevant to the topic; all arguments are well supported.
     - **Good (B)**: The paper is clear with minor ambiguities; most arguments are supported.
     - **Satisfactory (C)**: Some sections are unclear or not completely relevant; some arguments lack support.

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- **Poor (D)**: The paper lacks clarity and relevance; arguments are poorly supported or absent.

2. **Organization (20%)**
   - **Structure (10%)**
     - **Excellent (A)**: Exceptionally well-organized, logical flow that enhances the clarity of the paper.
     - **Good (B)**: Well-organized, with a clear structure that occasionally lacks smooth transitions.
     - **Satisfactory (C)**: Organization is apparent but not maintained throughout the paper.
     - **Poor (D)**: Poorly organized, lacks logical flow, making it hard to follow.
   - **Formatting and Style (10%)**
     - **Excellent (A)**: Impeccable formatting and professional style; follows academic standards precisely.
     - **Good (B)**: Minor errors in formatting and style; mostly follows academic standards.
     - **Satisfactory (C)**: Some inconsistent formatting and stylistic choices; generally follows academic standards.
     - **Poor (D)**: Frequent errors in formatting and style; does not adhere to academic standards.

3. **Presentation (20%)**
   - **Delivery (10%)**
     - **Excellent (A)**: Engaging, confident presentation style; excellent eye contact and body language; speaks clearly at an appropriate pace.
     - **Good (B)**: Generally clear and confident; minor issues with eye contact, body language, or pace.
     - **Satisfactory (C)**: Somewhat clear but lacks confidence; noticeable issues with eye contact, body language, or pace.
     - **Poor (D)**: Unclear, unconfident delivery; poor eye contact, body language; inappropriate pace.
   - **Use of Visual Aids (10%)**
     - **Excellent (A)**: Visual aids are professionally crafted, enhance the presentation, and are completely relevant.
     - **Good (B)**: Visual aids are well-prepared and relevant with minor issues in design or relevance.
     - **Satisfactory (C)**: Visual aids are used but do not significantly enhance the presentation or have design issues.
     - **Poor (D)**: Visual aids are poorly prepared or irrelevant to the presentation.

4. **Understanding and Interaction (20%)**
   - **Question Handling (10%)**
     - **Excellent (A)**: Answers all questions with depth and clarity, demonstrating a strong understanding of the topic.
     - **Good (B)**: Answers most questions correctly but may lack depth in some responses.
     - **Satisfactory (C)**: Struggles with some questions; responses lack depth or clarity.
     - **Poor (D)**: Unable to answer questions adequately; shows poor understanding of the topic.

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- **Engagement and Discussion (10%)**
  - **Excellent (A)**: Actively engages the audience, stimulating discussion and thought.
  - **Good (B)**: Generally engages the audience but with limited discussion.
  - **Satisfactory (C)**: Limited engagement with the audience, minimal discussion.
  - **Poor (D)**: Does not engage the audience or stimulate discussion.

**Course Outcomes – Program Outcomes – Program Specific Outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | - | L | - | - | M | H | L |
| CO2 | M | L | H | - | - | - | H | M | L |
| CO3 | L | H | M | - | - | - | L | H | M |
| CO4 | - | M | L | H | - | - | M | L | H |
| CO5 | - | - | M | L | H | - | H | M | L |

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## 24MECT20: ADVANCED EMBEDDED SYSTEMS
(OPEN ELECTIVE -I)

**Credits:** 3 **Sessional Marks:** 40
**L: T: P:** 3: 0 :0 **University Exam. Marks:** 60

**Course Objectives**

Students completing this course will be well positioned to

1. Familiarize about the basic functions of embedded systems.
2. Inculcate the basic architecture of general purpose processors and its applications.
3. Gain interface between analog and digital blocks, also Software aspects of embedded systems.
4. Develop different State Machine and Concurrent Process Models.
5. Learn Evolution of complication and synthesis, Verification and reuse of intellectual property cores.

**Course Outcomes**

At the end of this course students will demonstrate the ability to

CO1. To understand the embedded system concepts and technologies of embedded systems.
CO2. To analyze the general process of embedded system development.
CO3. To apply Interfacing between analog and digital blocks and apply Software aspects of embedded systems.
CO4. To create finite state machine and analyze Communication and Synchronization among processes.

**UNIT I**

**Introduction** The concept of embedded systems design, Examples of embedded systems Design challenge, Processor technology, IC technology, Design technology. RT-Level combinational logic, Sequential logic (RT-Level), Custom single purpose processor design (RT-Level), Optimizing custom single purpose processors.

**UNIT II**

**General Purpose Processors** Basic architecture, Development environment, Application specific system depth, Set processors (ASIPs). Embedded Memories.

**UNIT III**

**Technoligical aspects of embeddes systems** Interfacing between analog and digital blocks, signal conditioning, digital signal processing. System interfacing, interfacing with external systems, user interfacing. Design tradeoffs due to process compatibility, thermal considerations, etc., Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

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**UNIT IV**

**State Machine and Concurrent Process Models** Introduction, Models Vs languages, Finite State Machine with Data path model (FSMD), using State Mahines, Program State Machine (PSM), Concurrent Process Model, Concurrent Processes, Communication among processors, Synchronization among processes, Implementation, Data flow model.

**UNIT V**

**Introduction Automation** The parallel evolution of complication and synthesis, Logic, RT, Behavioral synthesis, System synthesis and hardware/software code sign, Verification of hardware/software co-simulation, Reuse of intellectual property cores, Embedded microcontroller cores.

**Text Books**

1. Embedded Systems Design – A unified Hardware/Software introduction by Frank Vahid, Tony, D. Givargis, John Wiley & Sons. Inc. 2002.
2. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole,2000.

**Reference books**

1. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
2. V.K.Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
3. David Simon, "An Embedded Sostware Primer", Addison Wesley,2000.

**Course Outcomes-Program Outcomes – Program Specific Outcomes – (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| CO1 | H | | L | | | |
| CO2 | L | M | H | M | L | |
| CO3 | | | | M | H | |
| CO4 | | L | M | H | | |
| CO5 | | | M | L | | H |

| PSO1 | PSO2 | PSO3 |
|---|---|---|
| H | | |
| | M | H |
| L | M | H |
| | L | H |
| L | H | M |

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Semester: I – II

M.Tech(AI&DS) – R24

## 24MCST05: Prompt Engineering
## (Professional Core for CSE & Open Elective – I for ECE, EEE, ME)

Credits – 3
L:T:P :: 3:0:0

Sessional Marks: 40
University Exam Marks:60

### Course Objectives

1. To introduce students to the fundamental concepts and architecture of Large Language Models (LLM) and the functionality of LLM prompts, including their components and types.
2. To provide a comprehensive understanding of prompt engineering, emphasizing its importance in AI communications and exploring techniques to enhance prompt effectiveness.
3. To delve into advanced topics and best practices in prompt engineering, including template-based forms, language nuances, and iterative refinement for improved performance.
4. To demonstrate the practical applications of AI, particularly ChatGPT, in creating and promoting content such as podcasts and educational materials.
5. To equip students with the knowledge and skills to effectively use ChatGPT and its APIs, understanding their functionalities, customizable parameters, and practical use cases.

### Course Outcomes

At the end of the course, student will be able to

**CO1:** Understand and create effective LLM prompts, utilizing few-shot learning models and defining personality in prompts to enhance their effectiveness.

**CO2:** Craft and refine prompts, leveraging effective verbs, tone nuances, and progressive experimentation to achieve high-quality AI communications.

**CO3:** Apply advanced prompt engineering techniques, including template-based forms and iterative testing, while addressing ethical considerations and common challenges.

**CO4:** Use AI tools like ChatGPT to create and promote content, such as podcasts and educational materials, and generating strategic questions for client engagements.

**CO5:** Master the use of ChatGPT APIs, understand key parameters, interaction methods, and limitations, enabling them to integrate and utilize these APIs effectively in various applications.

### UNIT – I

Introducing LLM Prompts, how LLM Prompt works, Architecture, LLM Training, Types of LLM Prompts, Components of an LLM Prompts, Few shot learning training models wit example prompts, Finding your voice-defining personality in prompts, Using patterns to enhance prompt effectiveness, Mix and Match –Strategic combinations for enhanced prompts, Exploring LLM parameters, The challenges and limitations of using LLM prompts.

### UNIT – II

Introduction to Prompt Engineering: Definition of Prompt Engineering, Importance of Prompt Engineering in AI Communications, Overview of the Different Types of Prompts, Understanding the Foundation of Prompt Engineering, Power Up Your Prompts With Effective Verbs, Elevate Your Prompts with Nuances of Tone, Progressive Experimentation for Refining Prompts, Key attributes Goo prompt writing.

### Unit – III

Advanced topics in Prompt Engineering: Deep dive into advanced topics, Template based forms. Best Practices Prompt Engineering: Understanding of nuances of Language & tone, Testing & Iterating Prompts or improved performance, incorporating feedback form AI models to refine prompts, Enhancing reliability of responses.

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Challenges in Prompt Engineering: Addressing common challenges and pitfalls, Strategies for improving the Prompt Effectiveness, Ethical Considerations in Prompt Engineering

## Unit – IV

Creating and Promoting a Podcast Using ChatGPT and Other Practical Examples: Crafting podcast questions for celebrity guests, Preparing podcast questions with everyday guests, Identify topics, ideas, and potential guest speakers for your podcast, Using AI to promote a podcast, Identifying insightful interview questions, Sharpening interview skills with AI-generated responses, Generating strategic questions for client engagements with AI

Applications of LLM in Education: Creating course materials with ChatGPT, Creating handouts and other materials, creating quizzes, Creating rubrics, Creating cloze comprehension tests

## Unit – V

Introduction to ChatGPT: What Is ChatGPT, Output Formats, Generated By ChatGPT, Use Cases for ChatGPT, Differences between ChatGPT and Web Search

Practical guide to CHATGPT API's: API's and their functionalities, API interaction methods, Key customizable API parameters, Impact of temperature & Max tokens, API Limitations & Considerations, Mastering ChatGPT API's

**Textbooks**

1. Mizrahi, Gilbert. Unlocking the Secrets of Prompt Engineering: Master the Art of Creative Language Generation to Accelerate Your Journey from Novice to Pro. United Kingdom: Packt Publishing, 2024.
2. Bhat, Harish. Demystifying Prompt Engineering: AI Prompts at Your Fingertips: A Step-By-Step Guide. United States: Harish Bhat, 2023.

**Course Outcomes -- Program Outcomes – Program Specific Outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | - | - | M | - | L | H | L | M |
| CO2 | - | - | M | H | - | L | M | H | L |
| CO3 | - | M | - | H | - | L | H | L | M |
| CO4 | H | - | - | L | M | L | M | H | - |
| CO5 | - | H | - | M | - | L | L | M | H |

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## 24MEET12: NEURAL NETWORK AND FUZZY LOGIC
(PROFESSIONAL ELECTIVE –III)

Credits - 3
L: T: P:: 3:0:0

Sessional Marks: 40
University Exam Marks: 60

**Course Objectives:**

1. To know the Importance of AI techniques in engineering applications
2. To familiarize with the concepts of Artificial Neural networks and Biological Neural Network.
3. To study the ANN approach in various Electrical Engineering problems.
4. To impart knowledge on Fuzzy Logic and Its use in various Electrical Engineering Applications

**Course Outcomes:**

At the end of this course, students will be able to

CO1. Discuss the concepts of Artificial Neural networks
CO2. Acquire the adequate knowledge about feedback networks.
CO3. Explain the learning rules and control applications of Neural Networks.
CO4. Understand the concept of fuzziness, fuzzy set theory and gain the comprehensive Knowledge of fuzzy logic control and adaptive fuzzy logic
CO5. Design of fuzzy systems for real time applications

### UNIT I

Biological neuron Vs artificial neuron, structure and activation functions – Neural network architectures –learning methods, stability and convergence .Single layer networks –Mcculloh–pitts neuron model, Perceptron training and algorithm, delta learning, Windrow-Hoff learning rules, limitations, Adeline and modification.

### UNIT II

Multilayer networks, architectures and modeling, BP algorithm, radial basis functions. Unsupervised Learning-Winner take all learning, out star learning, Counter propagation networks, self-organizing networks-Kohonen.

### UNIT III

Grossberg, Hamming NET, MAXNET, Hopfield networks, recurrent and associative memory, BAM and ART architectures Fuzzy sets and systems – geometry of fuzzy sets theorems – fuzzy and neural function estimators

### UNIT IV

Measures of Fuzziness – Classical measures of uncertainty – measures of Dissonance –confession specificity – knowledge base defuzzification.

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## UNIT-V

Application to load forecasting, load flow, fault detection-unit commitments, LF control – economic dispatch, Neuro-Fuzzy controllers.

**Text Books:**

1. Jacek M Jurada, "Introduction to artificial Neural Systems", Jaico Publications.
2. S.Rajashekaran , G.A.VijayaLakshmiPai,"Neural Networks, Fuzzy Logic and Genetic Algorithm Synthesis and applications".PHI,2013.

**Reference Books:**

1. Hans-JurgenZimmermann,"Fuzzy Set TheoryanditsApplications" ,4th,Kluwer AcademicPublishers,2006.
2. S.N. Sivanandam& S.N. Deepa ,"Principles of soft Computing", 3rdEdition,Wiley India Pvt.Ltd,2018.

**Course Outcomes-Program outcomes- Program specific outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | - | - | L | M | - | H | - | - |
| CO2 | H | - | - | L | M | - | H | - | - |
| CO3 | H | - | - | L | M | - | H | - | - |
| C04 | H | - | - | L | M | - | H | - | - |
| C05 | - | H | - | L | M | - | - | H | - |

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# 24MMET19: INDUSTRIAL ROBOTICS

**Credits: 3** **Sessional Marks: 40**

**L: T: P: 3:0:0** **University Exam Marks: 60**

## Course Objectives

**To expose the students to the following**

1. To introduce students to Robotics Engineering as a discipline and expose them to the multifaceted world of robots.
2. To apply the principles and concepts learned in the course to design a robotic system
3. To build and test a fully functional robotic system that meets the specific requirements
4. To study the various kinematics and inverse kinematics of robots.
5. To present their projects in the fields of robotics.

## Course Outcomes

**After successful completion of course the student should be able to**

CO1. Gain knowledge of basic mechanical designing, electrical wiring, robotic sensors and actuators, PCB design and communication protocols.

CO2. Gain an understanding of the theoretical background necessary to understand advanced robotic technologies and their specific applications.

CO3. Demonstrate proficiency in design, construction, and operation of robotic systems.

CO4. Develop problem-solving skills by applying principles of robotics engineering to real-world problems

CO5. Communicate effectively about robotics engineering technologies, their workings and potential applications.

## UNIT I

**Introduction to Robotics:** Types of robots, Degrees of freedom of robots, Robot configurations and concept of workspace, Overview of robot subsystems, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

## UNIT II

Rigid-body motions and twists, Rotations and angular velocities, Homogenous transformation matrices and its Twists.

## UNIT III

## UNIT III

Robot subsystems: Sensors and Actuators; Image Processing and Computer Vision , Robotic Control Systems.

## UNIT IV

**Introduction to Robo Analyzer :** DH Parameters Visualization , Forward Kinematics; Inverse Kinematics; Forward Dynamics; Inverse Dynamics ,Building Virtual Robot Module.

## UNIT V

**Robotics Applications** : The advanced robotics applications, including automation systems, robotic arm design and control, robot-vehicle interaction, and collaborative robots, robotic inspection and safety considerations.

## TEXT BOOKS:


1. S. K. Saha, "Introduction to Robotics", Tata McGraw Hill Education Pvt. Ltd., New Delhi.

2. R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw-Hill Publishing Company Ltd.

3. J. J. Graig, "Introduction to Robotics – Mechanics and Control", 2nd edition, Pearson Education, Inc.

4. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, "ROBOTICS – Control, Sensing, Vision, and Intelligence", McGraw-Hill Book Company.


## REFERENCES:


1. Saeed Niku, "Introduction to Robotics – Analysis, Control, Applications", John Wiley & Sons. 2. Mohsen Shahin poor, Harper and Row, "A Robot Engineering Textbook", New York

3. Roboert J. Schilling, "Fundamentals of Robotics – Analysis & Control", Prentice-Hall of India Pvt. Ltd.

4. S. R. Deb and S. Deb, "Robotics Technology and Flexible Automation", Second Edition, Tata McGraw Hill Education Pvt, Ltd., New Delhi


**Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | | | | M | | | M | M | M |
| CO2 | M | H | | | | | | | M | |
| CO3 | | M | M | | | | | M | M | L |
| CO4 | M | M | H | H | H | | | | | |
| CO5 | | | H | | H | | | | | M |

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## 24MBST02: English for Research Paper Writing
## (Open Elective – I)

**Credits – 3**
**L:T:P :: 3:0:0**

**Sessional Marks: 40**
**University Exam Marks: 60**

**Course Objectives**

1. To develop students' ability to plan and structure their academic writing, ensuring clarity, coherence, and conciseness.
2. To enhance students' skills in avoiding ambiguity, redundancy, and plagiarism while effectively paraphrasing and citing sources.
3. To guide students through the process of writing key sections of a research paper, including the abstract, introduction, literature review, methods, results, discussion, and conclusion.
4. To equip students with the necessary skills to write clear, concise, and impactful titles, abstracts, and introductions for academic papers.
5. To provide students with practical strategies and useful phrases to ensure their academic writing is well-organized, properly structured, and meets the standards for first-time submission.

**Course Outcomes**

At the end of the course, student will be able to

**CO1:** Apply effective planning and structuring techniques in academic writing to produce clear, concise, and coherent sentences and paragraphs.

**CO2:** Identify and eliminate ambiguity, redundancy, and plagiarism in academic writing, ensuring clarity and originality in their work.

**CO3:** Demonstrate proficiency in writing key sections of a research paper, including the abstract, introduction, literature review, methods, results, discussion, and conclusion.

**CO4:** Develop well-crafted titles, abstracts, and introductions that accurately represent the content and significance of their research.

**CO5:** Utilize useful phrases and strategies to enhance the quality of their academic writing, ensuring it meets the standards for first-time submission.

### UNIT – 1

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

### UNIT – 2

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

### UNIT – 3

Review of the Literature, Methods, Results, Discussion, Conclusions and the Final Check.

### UNIT – 4

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

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## UNIT – 5

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions, useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

**Reference Books**


1. Goldbort, Robert. Writing for science. Yale university press, 2006.
2. Day, Robert A., and Bárbara Gastel. "How to Write and Publish a Scientific Paper: Cambridge University Press. ISBN: 978-1-107-67074-7." (2012).
3. Highman, N. "Handbook of Writing for the Mathematical Sciences, SIAM." Highman's book (1998).
4. Wallwork, Adrian. English for writing research papers. Springer, 2016.


**Course Outcomes – Program Outcomes – Program Specific Outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | - | M | L | - | - | - | - | L |
| CO2 | M | H | - | - | - | L | L | - | - |
| CO3 | - | M | H | L | - | - | - | L | - |
| CO4 | L | - | M | - | H | - | M | - | - |
| CO5 | - | L | - | H | M | - | - | M | - |

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# II Year

# I Semester

## 24MECT24: COMMUNICATION NETWORKS
(OPEN ELECTIVE - II)

**Credits:** 3
**L: T: P:** 3: 0 :0

**Sessional Marks:** 40
**University Exam. Marks:** 60

**Course Outcomes:** Students completing this course will be well positioned to

- Understand advanced concepts in Communication Networking.
- Design and develop protocols for Communication Networks.
- Understand the mechanisms in Quality of Service in networking.
- Optimise the Network Design

**Course Outcomes**

At the end of this course students will demonstrate the ability to

CO1. To impart knowledge on the fundamental principles of network services and layered architecture.
CO2. To develop an understanding of ISDN and B-ISDN technologies
CO3. To equip students with the skills needed to design and optimize ATM networks
CO4. To provide insights into advanced TCP/IP networks and interconnection technologies

**UNIT- I**

NETWORK SERVICES & LAYERED ARCHITECTURE: Traffic characterization and quality of service, Network services, High performance networks, Network elements, Basic network mechanisms, layered architecture.

**UNIT- II**

ISDN & B-ISDN: Over view of ISDN, ISDN channels, User access, ISDN protocols, Brief history of B-ISDN and ATM, ATM based services and applications, principles and building block of B-ISDN, general architecture of B-ISDN, frame relay.

**UNIT- III**

ATM NETWORKS: Network layering, switching of virtual channels and virtual paths, applications of virtual channels and connections.

QOS parameters, traffic descriptors, ATM service categories, ATM cell header, ATM layer, ATM adaptation layer.

**UNIT- IV**

INTERCONNECTION NETWORKS: Introduction, Banyan Networks, Routing algorithm & blocking phenomenon, Batcher-Banyan networks, crossbar switch, three stage class networks.

REARRANGEABLE NETWORKS: Rearrangeable class networks, folding algorithm, bens network, looping algorithm.

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**UNIT- V**

TCP/IP NETWORKS: History of TCP/IP, TCP application and Services, Motivation, TCP, UDP, IP services and Header formats, Internetworking, TCP congestion control, Queue management: Passive & active, QOS in IP networks: differentiated and integrated services.

**TEXTBOOKS**

1. William Stallings, "ISDN & B-ISDN with Frame Relay", PHI.
2. Leon Garcia widjaja, "Communication Networks", TMH, 2000.
3. N. N. Biswas, "ATM Fundamentals", Adventure books publishers, 1998.

**Course Outcomes-Program Outcomes – Program Specific Outcomes – (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | L | | | | | H | | H |
| CO2 | L | M | H | M | | L | L | M | H |
| CO3 | | | M | | H | | | | |
| CO4 | | L | M | | H | | | | |
| CO5 | | M | | L | H | | L | H | M |

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Semester: I – I

M.Tech(AI&DS) – R24

## 24MCST06: Soft Computing
## (Professional Elective – I for CSE & Open Elective – II for ECE, EEE, ME)

**Credits – 3**
**L:T:P :: 3:0:0**

**Sessional Marks: 40**
**University Exam Marks:60**

### Course Objectives

1. To provide a comprehensive understanding of soft computing, its evolution, types, and applications, with a foundational knowledge of machine learning and neural networks.
2. To explore various neural network architectures, learning methods, and applications, with a focus on backpropagation networks and associative memory networks.
3. To introduce the concepts of unsupervised learning and adaptive resonance theory (ART), including classical ART networks, their features, algorithms, and real-world applications.
4. To provide an understanding of fuzzy sets, fuzzy relations, fuzzy logic, and inference systems, emphasizing their operations, properties, and applications in decision-making processes.
5. To explore the history, principles, and applications of genetic algorithms (GA), including the creation of offspring, genetic modeling, and comparison with traditional algorithms, along with hybrid systems and evolutionary computing.

### Course Outcomes

At the end of the course, student will be able to

**CO1:** Differentiate between soft computing and hard computing, understand the features and applications of soft computing, and have a basic understanding of machine learning principles.

**CO2:** Understand neural network architectures, learning methods, and the backpropagation algorithm, along with practical applications in various domains.

**CO3:** Acquire knowledge in unsupervised learning techniques, specifically adaptive resonance theory, and will be able to illustrate and apply ART1 and ART2 models to relevant applications.

**CO4:** Work with fuzzy sets, fuzzy relations, and fuzzy logic systems, understand their operations and properties, and apply fuzzy inference and decision-making techniques in real-world scenarios.

**CO5:** Implement genetic algorithms, understand their working principles and genetic modelling techniques, compare GA with traditional methods, and apply hybrid systems and evolutionary computing in solving complex problems.

### UNIT – I

Introduction to Soft Computing: soft computing vs. hard computing, evolution of soft computing, features and types of soft computing, applications of soft computing, basics of machine learning. Neural networks: Basic concepts of Neural Networks, Model of Artificial Neuron, Neural Network Architectures, Characteristics of neural networks

### UNIT – II

Back Propagation Networks and Associative Memory Networks: Learning Methods, Early neural network architectures, Application domains. Back propagation network (BPN), Back propagation Learning, Applications of BPN, Parameter selection, Variations of Back propagation Algorithms, Auto correlators, hetero correlators: Kosko's discrete Bi-direction associative memory (BAM),Exponential BAM, Application of Character Recognition.

### UNIT – III

Unsupervised Learning and Adaptive Resonance Theory: Adaptive Resonance Theory (ART),

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Classical ART Networks, Simplifies ART Architecture, Features, algorithms and Illustration of ART1 and ART2 model, Related Applications.

## UNIT – IV

Fuzzy Sets, Fuzzy Relations, Fuzzy Logic And Inference: Fuzzy versus Crisp, Crisp Sets, Fuzzy sets, Membership functions, fuzzy set operations, properties of Fuzzy sets, Crisp Relations, Fuzzy relations – Fuzzy Cartesian product, Operations of Fuzzy Relations. Crisp Logic, Predicate Logic, Fuzzy Logic, Fuzzy Quantifiers, Fuzzy Inference, Fuzzy knowledge and rule-based system, fuzzy decision making, Defuzzification, and application of fuzzy logic

## UNIT – V

Genetic Algorithms: History of Genetic Algorithm, Basic concepts, Creation of offspring, working principles, encoding, fitness function, reproduction, Genetic modeling: Inheritance operator, crossover, inversion & deletion, mutation operator, Bitwise operator, Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional method, Hybrid systems, evolutionary computing, Genetic Algorithm based on Backpropagation networks - Implementation and comparison on performance of traditional algorithms with Genetic Algorithm

**Textbooks**

1. Rajasekaran, Sundaramoorthy, and GA Vijayalakshmi Pai. Neural networks, fuzzy systems and evolutionary algorithms: Synthesis and applications. PHI Learning Pvt. Ltd., 2017.
2. Fuzzy Logic With Engineering Applications, 3rd Ed. India: Wiley India Pvt. Limited, 2011.
3. Sivanandam, S. N.Deepa. Principles of Soft Computing, 3rd Ed. India: Wiley India Pvt. Limited, 2018.

**Reference Books**

1. Jang, Jyh-Shing Roger., Sun, Chuen-Tsai., Mizutani, Eiji. Neuro-fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence. United Kingdom: Prentice Hall, 1997.
2. Kosko, Bart. Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence. United States: Prentice Hall, 1992.
3. Klir, George J.., Yuan, Bo. Fuzzy Sets and Fuzzy Logic: Theory and Applications. India: Pearson, 2015.
4. Rich, Elaine. Artificial Intelligence 3E (Sie). India: Tata McGraw-Hill Publ., 2019.
5. Haykin, Simon. Neural networks and learning machines, 3/E. Pearson Education India, 2009.
6. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. Deep learning. MIT press, 2016.

**Web References**

1. https://onlinecourses.nptel.ac.in/noc20_cs17/preview
2. https://www.coursera.org/learn/cnns-and-rnns
3. https://www.udemy.com/topic/fuzzy-log

**Course Outcomes – Program Outcomes – Program Specific Outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | - | - | M | - | L | H | M | L |
| CO2 | - | - | M | H | - | L | H | L | M |
| CO3 | - | - | - | H | M | L | H | M | L |
| CO4 | H | - | - | - | M | L | M | H | L |
| CO5 | - | H | - | M | - | L | L | H | M |

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# 24MEET17 SOLAR ENERGY UTILIZATION

Credits - 3
L: T: P:: 3:0:0

Sessional Marks:40
University Exam Marks:60

**Course Objectives**

1. Understand the various typesofsolar collectors and solar radiation
2. Learn the present application of solar energy in different fields
3. Explain the concept of solar thermal power generation and solar economics
4. Understand Construction and working conceptsof Photo-voltaic cell
5. Study the different concepts of Energy Storages.

**Course Outcomes**

At the end of this course, students will demonstrate the ability to

CO1. acquire knowledge on different solar collectors and their performance
CO2. attain the knowledge on different applications of solar energy
CO3. understand the solar thermal power generation and the performance characteristics
CO4. analyze the performance characteristicsof photovoltaic cell
CO5. understand the energy Storage and its applications

## UNIT I

Solar radiation, availability, measurement and estimation; Isotropic and anisotropic models; empirical relations, solar collectors and types: flat plate, concentrating solar collectors, advanced collectors and solar concentrators, Selective coatings.

## UNIT II

Solar water heating, solar cooking, solar drying, Solar distillation and solar refrigeration. Active and passive heating and cooling of buildings, Solar Chimney, Solar drying.

## UNIT III

Solar thermal power generation, Home lighting systems, Solar lanterns, Industrial process heat systems, Solar thermal power generation and sterling engine, Solar economics.

## UNIT IV

Photo-voltaic cell – characteristics- cell arrays-power electric circuits for output of solarpanels-choppers-inverters-batteries-charge regulators, Construction concepts.

## UNIT V

Energy Storage - Sensible, latent heat and thermo-chemical storage-pebble bed etc. materialsfor phase change-Glauber's salt-organic compounds. Solar ponds.

### Text Books


1. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2ndEdition, Taylor & Francis, 2000, Indian reprint, 2003
2. Edward E. Anderson, "Fundamentals for solar energy conversion", Addison WesleyPubl. Co., 1983.
3. Duffie J. A and Beckman, W .A., "Solar Engineering of Thermal Process", John Wiley.1991.
4. G. N. Tiwari and M. K. Ghosal, "Fundamentals of Renewable energy Sources", NarosaPublishing House, New Delhi, 2007


### Reference Books


1. Energy Studies, Second Edition, by W. Shepherd and D. W. Shepherd. Imperial CollegePress London, 2004.
2. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hil, New Delhi, 1996.
3. M. S. Sodha, N. K. Bansal, P. K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive .
4. M. A. S. Malik, G. N. Tiwari, A. Kumar and M.S. Sodha, Solar Distillation. Pergamon P.


**Course Outcomes-Program outcomes-Program specific outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | - | - | - | H | M | - | H | - |
| CO2 | H | - | - | L | - | M | H | - | - |
| CO3 | H | - | - | L | - | M | M | H | - |
| C04 | H | - | - | L | - | M | H | - | - |
| C05 | H | - | - | L | - | M | M | H | - |

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## 24MMET20: COMPUTER INTEGRATED MANUFACTURING

Credits –3 | Sessional Marks: 40
L:T:P :: 3:0:0 | University Exam Marks: 60

**Course Objectives:**
To expose the students to the following

To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

**Course Outcomes**
After successful completion of course the student should be able to

CO1 Explain the basic concepts of CAD, CAM and computer integrated manufacturing systems
CO2: Summarize the production planning and control and computerized process planning
CO3: Differentiate the different coding systems used in group technology
CO4: Explain the concepts of flexible manufacturing system (FMS) and automated guided vehicle (AGV) system
CO5: Classification of robots used in industrial applications

### UNIT I

**INTRODUCTION :** Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerized elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

### UNIT II

**PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING :**Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

### UNIT III

**CELLULAR MANUFACTURING :** Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

## UNIT IV

**FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) :**Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

## UNIT V

**INDUSTRIAL ROBOTICS :** Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

## TEXT BOOKS:

1. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.

2. Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

## REFERENCES:

1. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" Chapman & Hall, London, 1995.

2. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India.

3. Rao. P, N Tewari &T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, 2000.

**Course Outcomes - Program Outcomes - Program Specific Outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | | | | M | | | M | M | M |
| CO2 | M | H | | | | | | | M | |
| CO3 | | M | M | | | | | M | M | L |
| CO4 | M | M | H | H | H | | | | | |
| CO5 | | | H | | H | | | | | M |

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## 24MHMT07: BUSINESS ANALYTICS
## (Open Elective – II)

**Credits – 3** **Sessional Marks: 40**
**L:T:P :: 3:0:0** **University Exam Marks: 60**

**Course Objectives**

1. To introduce students to the basics of R programming, including data structures, descriptive statistics, and foundational statistical tests and distributions.
2. To equip students with the skills necessary for effective data visualization, emphasizing the creation of meaningful and informative charts and graphs using R.
3. To develop students' abilities in exploratory data analysis, focusing on data preparation, handling big data, and implementing automation in data analytics.
4. To provide an understanding of advanced data analytics techniques, including prediction analysis, clustering, machine learning, and text mining using R.
5. To familiarize students with forecasting techniques and their applications in business, including time series analysis, regression forecasting, and Monte Carlo simulation.

**Course Outcomes**

At the end of the course, student will be able to

**CO1:** Apply fundamental R programming commands and perform basic statistical analyses.
**CO2:** Design and implement effective visualizations for data-driven decision-making using R.
**CO3:** Conduct exploratory data analysis, including data cleaning and big data management, to prepare datasets for advanced analysis.
**CO4:** Utilize advanced data analytics techniques such as clustering, decision trees, machine learning, and text mining to derive insights from data.
**CO5:** Implement forecasting models and simulations to predict future trends and analyze risks in various business scenarios.

### UNIT – I

**INTRODUCTION TO R :** Basic commands of R using R console and R studio, Data structures using R, Descriptive Statistics: Measure of Central Tendency and Measure of Dispersion, Binomial, Poisson and Normal Distribution, Chi-square test, ANOVA and Co-variance.

### UNIT – II

**DATA VISUALIZATION FOR MANAGERS:** Visualization Imperative – Message to Charts – Visual Perception – Grammar for Graphics (using R) – Component level design of tables and graphs – Storytelling using Visualization.

### UNIT – III

**EXPLORATORY DATA ANALYSIS**: Data mugging / scraping/ sampling/ cleaning – handling big data – automation of data analytics solutions – Non-linear optimization models.

### UNIT – IV

**DATA ANALYTICS:** Best practices in data analytics and business intelligence – Prediction Analysis - Clustering – Decision tree – Machine learning - Neural networks – Associations / market basket analysis – Text Mining using R.

## UNIT – V

**FORECASTING TECHNIQUES:** Qualitative and Judgemental Forecasting, Statistical Forecasting, models, forecasting models for stationary Time Series, Forecasting Models for Time Series with a Linear Trend. Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables. Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation using Analytic Solver Platform, New-product development model, Newsvendor modes, overbooking model, Cash budget model – Customer management model – Marketing Mix Model.

### Reference Books

1. Prasad, R. N., and Seema Acharya. Fundamentals of business analytics (with cd). John Wiley & Sons, 2011.
2. Asllani, Arben. Business analytics with management science models and methods. FT Press, 2014.
3. Hodeghatta, Umesh R., and Umesha Nayak. Business analytics using R-a practical approach. Apress, 2016.
4. Schniederjans, Marc J., Dara G. Schniederjans, and Christopher M. Starkey. Business analytics principles, concepts, and applications: what, why, and how. Pearson Education, 2014.
5. James Evans. Business Analytics. Pearson Education 2021.

**Course Outcomes – Program Outcomes – Program Specific Outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | H | - | - | - | L | - | - |
| **CO2** | H | M | - | L | - | - | - | L | - |
| **CO3** | M | H | - | - | L | - | - | - | L |
| **CO4** | H | - | M | - | - | L | M | - | - |
| **CO5** | - | M | - | H | - | - | - | M | - |

## 24MECV01: Comprehensive Viva

**Credits – 2**
**L:T:P :: 0:0:0**

**Sessional Marks: 40**
**University Exam Marks: 60**

### Course Objectives

To assess the overall knowledge of the student in the Computer Science and Engineering acquired over 3 semesters of study in the postgraduate program.

### Course Outcomes

At the end of the course, student will be able to

**CO1:** Demonstrate Knowledge in the program domain.
**CO2:** Present his views cogently and precisely.
**CO3:** Exhibit professional etiquette suitable for career program

### Course Outcomes – Program Outcomes – Program Specific Outcomes (CO-PO-PSO) Mapping

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | - | H | - | L | - | M | - | L |
| CO2 | L | H | - | - | - | M | - | - | H |
| CO3 | - | - | L | M | - | H | - | L | - |

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## 24MECJ01: Dissertation Phase – I

**Credits – 10** **Sessional Marks: 100**

**Course Objectives**

1. Enable students to conduct independent and original research on a topic relevant to their field of study, utilizing advanced methodologies and technologies.
2. Deepen students' understanding and expertise in a specific area of technology, enhancing their skills in specialized domains.
3. Train students to effectively communicate complex research findings through a well-structured dissertation and oral presentations.
4. Instill a strong sense of ethics and responsibility in conducting and reporting research.
5. Encourage innovation and creative problem solving through challenging research questions that contribute to technological advancements.

**Course Outcomes**

At the end of the course, student will be able to

**CO1:** Students will be proficient in designing, executing, and managing a substantial research project that contributes new knowledge or understanding to the field of technology.

**CO2:** Students will demonstrate deep knowledge and expert understanding in their chosen research area, applying complex concepts to solve specific problems.

**CO3:** Students will be able to communicate their research effectively, both in written format and orally, to a scholarly audience.

**CO4:** Students will conduct all aspects of their research according to strict ethical standards and demonstrate integrity in their scientific inquiry.

**CO5:** Students will develop innovative solutions or enhancements in their specific area of research, demonstrating creativity and the ability to overcome significant challenges

**Rubrics for Evaluation**

1. **Research Quality (40%)**
   - **Originality and Innovation (20%)**
     - **Excellent (A)**: Demonstrates significant originality and innovation; introduces new methods, ideas, or approaches.
     - **Good (B)**: Shows some original elements and attempts at innovation.
     - **Satisfactory (C)**: Follows existing models with little new input; some minor novel aspects.
     - **Poor (D)**: Lacks originality; largely derivative of existing work.
   - **Depth and Scope of Research (20%)**
     - **Excellent (A)**: Research is comprehensive and detailed; explores the subject matter deeply with broad implications.
     - **Good (B)**: Adequate depth and scope; covers necessary aspects without significant insights beyond the basics.
     - **Satisfactory (C)**: Research meets minimum criteria but lacks depth; scope is limited.
     - **Poor (D)**: Research is superficial; key aspects are poorly covered or missing.

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2. **Methodology (20%)**
   - **Appropriateness and Execution (20%)**
     - **Excellent (A)**: Methodology is perfectly suited to the research questions; flawlessly executed.
     - **Good (B)**: Methodology is appropriate; execution has minor flaws that do not seriously impede outcomes.
     - **Satisfactory (C)**: Methodology is mostly appropriate; some execution errors that affect results.
     - **Poor (D)**: Methodology is poorly chosen or executed; major flaws in application.

3. **Analysis and Interpretation (20%)**
   - **Clarity and Depth of Analysis (10%)**
     - **Excellent (A)**: Analysis is exceptionally clear and insightful; demonstrates deep understanding.
     - **Good (B)**: Analysis is clear with some insightful observations.
     - **Satisfactory (C)**: Analysis is adequate but lacks depth or insight.
     - **Poor (D)**: Analysis is unclear or incorrect; lacks depth.
   - **Interpretation and Conclusions (10%)**
     - **Excellent (A)**: Conclusions are well-founded, insightful, and clearly derived from data.
     - **Good (B)**: Conclusions are logical but lack some insight or direct connection to data.
     - **Satisfactory (C)**: Some conclusions are logical; others are not well-supported by data.
     - **Poor (D)**: Conclusions are not supported by data or analysis; illogical.

4. **Writing Quality and Presentation (10%)**
   - **Coherence and Organization (5%)**
     - **Excellent (A)**: Work is exceptionally well-organized and coherent; professional presentation.
     - **Good (B)**: Generally well-organized; minor issues in coherence or presentation.
     - **Satisfactory (C)**: Organization is lacking in areas; some issues in presentation.
     - **Poor (D)**: Poor organization and presentation; difficult to follow.
   - **Quality of Writing (5%)**
     - **Excellent (A)**: Writing is clear, concise, and well-structured with appropriate academic style.
     - **Good (B)**: Writing is mostly clear with some errors in style or structure.
     - **Satisfactory (C)**: Writing is adequate but may be unclear or improperly structured.
     - **Poor (D)**: Writing is poor, unclear, and frequently incorrect; lacks academic style.

5. **Defense and Oral Examination (10%)**
   - **Defense Preparation and Response (10%)**
     - **Excellent (A)**: Excellently prepared; responses are detailed, thoughtful, and demonstrate deep knowledge.
     - **Good (B)**: Well-prepared; responses are adequate but lack some depth.
     - **Satisfactory (C)**: Adequately prepared; responses lack depth and detail.

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- **Poor (D)**: Poorly prepared; responses are superficial or incorrect.

**Course Outcomes – Program Outcomes – Program Specific Outcomes (CO-PO-PSO) Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | - | L | - | - | M | H | L |
| CO2 | M | L | H | - | - | - | H | M | L |
| CO3 | L | H | M | - | - | - | L | H | M |
| CO4 | - | M | L | H | - | - | M | L | H |
| CO5 | - | - | M | L | H | - | H | M | L |

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