



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (A)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
ACCREDITED BY NAAC A+**

**Programme Structure
R25 M. Tech (C&CE) Structure
M. Tech (Computers and Communication Engineering) I – Semester**

S. No.	Course Code	Course Title	L	T	P	C
1	Program Core -1	Mathematical Foundations for Communication Engineering	3	1	0	4
2	Program Core-2	Computer Networks	3	1	0	4
3	Program Core-3	Embedded Systems Design	3	1	0	4
4	Program Elective- 1	1. Advanced Digital Signal Processing 2. Satellite Navigation Systems / GPS 3. Wireless Communication and networks 4. Software Defined Radio	3	0	0	3
5	Program Elective- 2	1. Mobile Computing 2. Machine Learning and Applications 3. Data Structures and Algorithms 4. Advanced Computer Architecture	3	0	0	3
6	Laboratory- 1	Computer Networks Lab	0	1	2	2
7	Laboratory- 2	Embedded System Design Lab	0	1	2	2
8		Seminar-I	0	0	2	1
		TOTAL	15	5	6	23

List of Professional Elective Courses in I Semester (Electives – I & II)

S.No.	Course Code	Course Title
1		Advanced Digital Signal Processing
2		Satellite Navigation Systems / GPS
3		Wireless Communication and networks
4		Software Defined Radio
5		Mobile Computing
6		Machine Learning and Applications
7		Data Structures and Algorithms
8		Advanced Computer Architecture

@Minimum 2/3 of themes per elective

BOS Members

1. Dr.B.Leeala Kumari

B. Leeala Kumari

5. Prof.G.Sasibhushana Rao

G. Sasibhushana Rao

2. Prof.B.T.Krishna

B.T. Krishna

6. Prof.S.Anuradha

S. Anuradha

3. Prof.U.V.Ratna Kumari

U.V. Ratna Kumari

7. Dr.M.Chakravarthy

M. Chakravarthy

4. Prof.V.Sumalatha

8. Mr.V.Sandeep

V. Sandeep



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Programme Structure

R25 M. Tech (C&CE) Structure

MTech (Computers and Communication Engineering) II – Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1	Program Core-4	Advanced Communication Systems	3	1	0	4
2	Program Core-5	Internet of Things and its applications	3	1	0	4
3	Program Core-6	Information Theory and Coding	3	1	0	4
4	Program Elective- 3	1. Optical communications and networks 2. Smart Antennas 3. Network security and cryptography 4. Image and video Processing	3	0	0	3
5	Program Elective- 4	1. Artificial Intelligence 2. Embedded Real Time Operating Systems 3. Cloud Computing 4. Data Science	3	0	0	3
6	Laboratory- 3	Advanced Communications Lab	0	1	2	2
7	Laboratory- 4	Internet of Things Lab	0	1	2	2
8		Seminar-I	0	0	2	1
		TOTAL	15	5	6	23

List of Professional Elective Courses in II Semester (Electives III & IV)

S.No.	Course Code	Course Title
1		Optical communications and networks
2		Smart Antennas
3		Network security and cryptography
4		Image and video Processing
5		Artificial Intelligence
6		Embedded Real Time Operating Systems
7		Cloud Computing
8		Data Science

@Minimum 2/3 themes per elective

BOS Members

- | | | | |
|--------------------------|-------------------|----------------------------|----------------------|
| 1. Dr.B.Leeala Kumari | 13. Leeala Kumari | 5. Prof.G.Sasibhushana Rao | 14. Sasibhushana Rao |
| 2. Prof.B.T.Krishna | B.T. Krishna | 6. Prof.S.Anuradha | S. Anuradha |
| 3. Prof.U.V.Ratna Kumari | U.V. Ratna Kumari | 7. Dr.M.Chakravarthy | M. Chakravarthy |
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Programme Structure
R25 M. Tech (C&CE) Structure
M. Tech (Computers and Communication Engineering) III – Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1		Research Methodology and IPR / Swayam 12weekMOOCcourse– RM&IPR	3	0	0	3
2		Summer Internship/Industrial Training (8-10 weeks)*	-	-	-	3
3		Comprehensive Viva [#]	-	-	-	2
4		Dissertation Part– A ^{\$}	-	-	20	10
		TOTAL	3	-	20	18

*Student attended during summer/ year break and assessment will be done in 3rdSem.

Comprehensive viva can be conducted courses completed up to second sem.

\$ Dissertation – Part A, internal assessment

M. Tech(Computers and Communication Engineering) IV–Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1		Dissertation Part– B [%]	-	-	32	16
		TOTAL	-	-	32	16

%External Assessment

BOS Members

- | | | | |
|--------------------------|-------------------------|----------------------------|----------------------------|
| 1. Dr.B.Leeala Kumari | <i>B. Leeala Kumari</i> | 5. Prof.G.Sasibhushana Rao | <i>G. Sasibhushana Rao</i> |
| 2. Prof.B.T.Krishna | <i>B.T. Krishna</i> | 6. Prof.S.Anuradha | <i>S. Anuradha</i> |
| 3. Prof.U.V Ratna Kumari | <i>U.V Ratna Kumari</i> | 7. Dr.M Chakravarthy | <i>M. Chakravarthy</i> |
| 4. Prof.V.Sumalatha | | 8. Mr.V Sandeep | <i>V. Sandeep</i> |

12/9/2025

71.

PG- Bos Meeting - R25 Regulation (C&CE)

Time: 11:30 Am.

A Bos Meeting is conducted for PG R25 Regulation for C&CE on 12/9/2025.

The following is the PG (C&CE) R25 Meeting Minutes:

1. The Course structure of R25 PG M.Tech (C&CE) is finalised from the Bos panel members both External & Internal.
 2. Syllabus for M.Tech (C&CE) for R25 Regulation is discussed and syllabus for ITCT is modified and finalised according to the suggestion by the Bos Members, POs are defined & Co-PO Mapping is initiated.
- ONLINE LINK: <https://meet.google.com/nje-sxmc-vey>.

Bos Members Name:-

1. Dr. B. Leelakumari — Chairperson - B. Leelakumari
2. Dr. B.T. Krishna — ONLINE - Internakem. B.T. Krishna
3. Dr. U.V. Patnakumari — ONLINE - Internal Mem U V Patnakumari
4. Dr. V. Sumalatha — ONLINE - External Online
5. Dr. G. Subbushana Rao — ONLINE - External
6. Dr. S. Anuradha — ONLINE - External
7. Dr. M. Chakravarthy — ONLINE - External
8. Mr. Valluri Sandeep — ONLINE - External



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I-Semester	MATHEMATICAL FOUNDATIONS FOR COMMUNICATION ENGINEERING	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1. To introduce foundational concepts in probability, statistics, and hypothesis testing.
2. To develop understanding of stochastic processes and their applications.
3. To equip students with numerical methods for solving mathematical problems.
4. To explore optimization techniques for constrained and unconstrained problems.
5. To familiarize students with wavelet transforms and multi-resolution analysis.

Unit I: Probability and Statistics

Sampling distributions, Estimation of parameters (point estimation – unbiasedness & minimum variance, basics of interval estimation – confidence interval for mean), Testing of hypotheses (one and two sample tests for mean), Linear regression, Introduction to non-linear regression, optimization techniques viz., Meta-heuristic algorithms namely Genetic Algorithm, Particle Swarm Optimization, and Ant Colony Optimization algorithms, etc.

Unit II: Stochastic process

Random processes, Random Walk, Markov process with special emphasis on Markov chain

Unit III: Numerical Analysis

Introduction to Interpolation formulae [Bessel's & Sterling's], Roots of transcendental equations [Bisection, Regula-Falsi & Newton-Raphson] Solutions of simultaneous non-linear equations [Newton's method], Numerical solution of Ordinary Differential equation [Modified Euler's method, fourth order Runge-Kutta method], Matrix Eigen value and Eigen vector problems.

Unit IV: Optimization Technique

Calculus of several variables, Implicit function theorem, Nature of singular points, Necessary and sufficient conditions for optimization, Constrained Optimization, Lagrange multipliers, Gradient method – steepest descent method.

Unit V: Wavelet Transform

Resolution problems, Multi-resolution analysis, Continuous & discrete wavelet transform

TEXT BOOKS:

1. A. Papoulis and S. Unnikrishnan Pillai, "Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill. (Indian Edition is available).
2. Gilbert Strang, "Linear Algebra and its applications", Thomson Learning Inc, 4th Edition.



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REFERENCE BOOKS:

1. H.Stark and J. Woods, 'Probability and Random Processes with Applications to Signal Processing,' Third Edition, Pearson Education. (Indian Edition is available).
2. Steven M. Kay, "Intuitive Probability and Random Process using MATLAB", Springer Publications.
3. Todd K Moon, Wynn C. Stirling" Mathematical Methods and Algorithms for Signal Processing, Prentice Hall.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Apply statistical methods for estimation and hypothesis testing.
2. Analyze and model stochastic processes including Markov chains.
3. Solve equations and differential problems using numerical techniques.
4. Optimize multivariable functions using analytical and numerical methods.
5. Implement wavelet transforms for signal and data analysis.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	M	H	M	M
CO2	H	L	H	H	M	M
CO3	M	L	H	H	M	H
CO4	M	L	H	H	M	H
CO5	M	L	H	H	M	H



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I- Semester	COMPUTER NETWORKS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1. Understand internet architecture, access networks, and switching techniques.
2. Learn IPv6, routing protocols, NAT, and network management standards.
3. Study transport and application layer protocols including secure variants.
4. Explore MAC techniques, routing algorithms, and transport performance.
5. Introduce advanced topics like IP Multicasting, VoIP, optical and secure networking.

UNIT I: The internet architecture, Access Networks, the network Core, Peer-to-Peer Networks, Content Distribution Networks, Delay Tolerant Networks, Circuit Switching vs. Packet switching, Packet switching Delays and congestion, Client/Server and Peer-to-Peer Architectures, MAC and LLC, Virtual LAN, Asynchronous Transfer Mode (ATM)

UNIT II: Network Address Translator, Internet Control Message Protocol, SNMP, CIDR, IPv6, Routing Protocol Basics in advanced networks, Routing Information Protocol (RIP), Interior Gateway Routing Protocol (IGRP), Switching Services, Spanning Tree Protocol (STP), Standard Network Management Protocol.

UNIT III: TCP and Mobile TCP, TCP Tahoe and TCP Reno, High speed TCP, Coexistence of UDP and TCP flows, HTTP and HTTPS, FTP and SFTP, Domain Name Service, TCP and UDP sockets

UNIT IV: Access Methods - Pure ALOHA - Slotted ALOHA. Carrier Sense Multiple Access (CSMA) - Carrier Sense Multiple Access with Collision Detection - Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) - Idle Signal Casting Multiple Access - Packet Reservation Multiple Access - IEEE 802.3 - IEEE 802.4 - IEEE 802.5 - IEEE 802.11 - FDDI - SONET. Routing: Network-Layer Routing, Least-Cost-Path algorithms, Non-Least-Cost-Path algorithms, Intradomain Routing Protocols, Interdomain Routing Protocols, Congestion Control at Network Layer. Logical Addressing: IPv4 Addresses, IPv6 Addresses - Internet Protocol: Internetworking, IPv4, IPv6, Transition from IPv4 to IPv6. Transport and End-to-End Protocols: Transport Layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Mobile Transport Protocols, performance evaluation of TCP protocol.

UNIT-V: Explaining IP Multicasting, VOIP, Unified Communication, Virtual Networking, Data center Networking, Introduction to Optical Networking, SONET /SDH Standard, Next generation cellular networks, Secure Socket Layer, IP Sec, TLS, Kerberos, Domain name system Protection.

TEXTBOOKS:

1. Computer Networking: A Top-Down Approach, 6/e, James F. Kurose and Keith W. Ross, Pearson Education, 2012.
2. Larry L. Peterson and Bruce S. Davie, Computer Networks: A systems approach, Morgan Kaufman, 5th Edition, 2012
3. Data Communications and Networking, Behrouz A. Forouzan, Fourth Edition, Tata McGrawHill



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REFERENCE BOOKS:

1. High Speed Networks and Internets – Performance and Quality of Service, William Stallings, Second Edition, Pearson Education.
2. TopDown Network Design, Priscilla Oppenheimer, Second Edition, Pearson Education
3. William Stallings, Data and Computer Communication, Prentice Hall of India.
4. S. Keshav, An Engineering Approach to Computer Networking, Pearson Education.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Explain network architectures, switching, and peer-to-peer communication models.
2. Configure IP addressing, routing protocols, and manage networks using SNMP/STP.
3. Analyze TCP/UDP behaviors, and implement application-level protocols securely.
4. Apply MAC protocols, routing techniques, and evaluate transport performance.
5. Describe modern networking trends including VoIP, SDN, and network security protocols.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	M
CO2	M	L	H	H	M	H
CO3	H	M	H	H	M	H
CO4	H	L	H	H	M	H
CO5	M	M	H	H	H	H



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I Semester	EMBEDDED SYSTEM DESIGN	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1. To introduce the fundamentals, classification, and characteristics of embedded systems.
2. To explore the core components of embedded systems including processors, memory, and interfaces.
3. To understand embedded firmware components and design approaches.
4. To study ARM processor architecture, instruction sets, and programming model.
5. To provide practical exposure to Raspberry Pi programming, communication protocols, and sensor interfacing.

UNIT I

Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

UNIT II

Typical Embedded System: Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.

UNIT III

Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

UNIT IV

ARM: ARM design philosophy, data flow model and core architecture, registers, program status register, instruction pipeline, interrupts and vector table, operating modes and ARM processor families. Instruction Sets: Data processing instructions, addressing modes, branch, load, store instructions, PSR instructions, and conditional instructions.

UNIT V

Raspberry Pi: Raspberry Pi board and its processor, Programming the Raspberry Pi using Python, Communication facilities on Raspberry Pi (I2C, SPI, UART), Interfacing of sensors and actuators.

TEXT BOOKS:

1. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.
2. A. N. Sloss, D. Symes, and C. Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Elsevier, 2008.
3. S. Monk, "Programming the Raspberry Pi" McGraw-Hill Education, 2013.

REFERENCE BOOKS:

1. Steve Furber, "ARM system-on-chip architecture", Addison Wesley, 2000.
2. Embedded Systems - Raj Kamal, TMH.
3. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.



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COURSE OUTCOMES:

After successful completion of the course, students will be able to:

1. **Describe** the structure, classification, and purpose of embedded systems and their quality attributes.
2. **Analyse** embedded system components such as processors, memory types, sensors, actuators, and interfaces.
3. **Explain** embedded firmware building blocks and **apply** suitable design approaches.
4. **Demonstrate** knowledge of ARM architecture and instruction sets relevant to embedded programming.
5. **Develop** simple embedded applications using Raspberry Pi and **interface** sensors and communication peripherals.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	M
CO2	M	L	H	H	M	H
CO3	H	M	H	H	M	H
CO4	H	L	H	H	M	H
CO5	H	M	H	H	M	H



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I Semester	ADVANCED DIGITAL SIGNAL PROCESSING (PE-1)	L	T	P	C
		3	0	0	3

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

1. Know the concept of multi rate signal processing and derive the Expression for sampling rate conversion by a rational factor I/D
2. Know the conditions for perfect reconstruction of 2 channels QMF. Design the single and two stage multi rate structures from the given specifications.
3. Know the classifications of non-parametric methods and compare the performance of non-parametric methods. Derive the statistical properties (i.e. mean, variance) of non- parametric power spectrum estimations.
4. Derive the reflection coefficients of Lattice realization. Know the forward prediction error and back ward prediction error and advantages of Lattice structures
5. Derive the properties of Auto-correlation and Cross correlation. Understand the Non- parametric and Parametric power spectrum estimation methods

UNIT I

Review of DFT, FFT, IIR Filters and FIR Filters: Multi Rate Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design & Implementation for sampling rate conversion.

UNIT II

Applications of Multi Rate Signal Processing: Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrow Band Low Pass Filters, Implementation of Digital Filter Banks, Subband Coding of Speech Signals, Quadrature Mirror Filters, Trans-multiplexers, Over Sampling A/D and D/A Conversion.

UNIT III

Non-Parametric Methods of Power Spectral Estimation: Estimation of spectra from finite duration observation of signals, Non-parametric Methods: Bartlett, Welch & Blackman-Tukey methods, Comparison of all Non-Parametric methods.

UNIT IV

Implementation of Digital Filters: Introduction to filter structures (IIR & FIR), Frequency sampling structures of FIR, Lattice structures, Forward prediction error, Backward prediction error, Reflection coefficients for lattice realization, Implementation of lattice structures for IIR filters, Advantages of lattice structures.

UNIT V

Parametric Methods of Power Spectrum Estimation: Autocorrelation & Its Properties, Relation between auto correlation & model parameters, AR Models - Yule-Walker Burg Methods, MA & ARMA models for power spectrum estimation, Finite word length effect in IIR digital Filters – Finite word-length effects in FFT algorithms.

TEXT BOOKS:

1. Digital Signal Processing: Principles, Algorithms & Applications - J.G.Proakis&D. G.Manolakis, 4thEd. PHI.
2. Discrete Time Signal Processing - Alan V Oppenheim & R. W Schaffer, PHI.
3. DSP – A Practical Approach – Emmanuel C. Ifeacher, Barrie. W. Jervis, 2 Ed., Pearson Education.



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REFERENCE BOOKS:

1. Modern Spectral Estimation: Theory & Application – S. M. Kay, 1988, PHI.
2. Multi Rate Systems and Filter Banks – P.P. Vaidyanathan – Pearson Education.

After successful completion of this course, the student will be able to:

1. **Apply** the concepts of multirate signal processing for decimation, interpolation, sampling rate conversion, and design of filters.
2. **Analyze** applications of multirate systems including phase shifters, filter banks, subband coding, and oversampling-based A/D–D/A conversion.
3. **Evaluate** power spectral density using non-parametric methods (Bartlett, Welch, Blackman–Tukey) and compare their performance.
4. **Design and implement** digital filters using various structures (FIR, IIR, lattice, frequency sampling) and assess their advantages.
5. **Model and estimate** power spectra using parametric approaches (AR, MA, ARMA models) and examine finite word-length effects in digital filters and FFT algorithms.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	H	L	H	H	M	H
CO3	H	M	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	H	M	H



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I Semester	SATELLITE NAVIGATION SYSTEMS (PE-1)	L	T	P	C
		3	0	0	3

Course Objectives:

The objectives of this course are to:

1. Provide a strong foundation in the principles of satellite communication and orbital dynamics.
2. Familiarize students with the subsystems of satellites and ground station requirements.
3. Develop the ability to design and analyze satellite link budgets under realistic conditions.
4. Introduce modulation and multiple access techniques employed in satellite systems.
5. Explore advanced applications of satellite communication including navigation, internet, broadcasting, and small satellite technologies.

UNIT I

Introduction and Orbital Dynamics: Overview of Satellite Communication, Historical background and current State, Kepler's three laws of planetary motion, orbit of satellite, Orbital elements, look angle determination, Placement of GEO satellite, orbital perturbation and orbital effects on Communication System performance.

UNIT II

Space and Ground Segment: Satellite subsystems: Attitude and orbit control system, Telemetry, Tracking, Commands and Monitoring, Power system, Communication system, Satellite antennas, Reliability. Equipment for the Earth station, small earth station antennas.

UNIT III

Satellite Link Budget: Basic transmission theory, system noise temperature and G/T ratio, down link design, up-link design, overall carrier-to-noise ratio (CNR), effect of interferences and atmospheric attenuation.

UNIT IV

Modulation and Multiple Access Techniques: Digital modulation techniques, Frequency division multiple access, time division multiple access, code division multiple access, practical demand access systems, random access, multiple access with on-board processing Satellite .Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communication system (satellite telephony) using LEO. Modulation and Multiple Access Schemes used in satellite communication. Typical case studies of VSAT, DBS-TV satellites and few recent communication satellites launched by NASA/ ISRO. GPS.

UNIT V

Advanced Satellite Systems: Applications of Satellite Communication, Small satellites, Satellite television, Satellite internet, Satellite navigation system.



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TEXTBOOKS:

1. T. Pratt, J. Alluntt, Satellite Communications, Wiley, 3rd. Edn.
2. G.D. Gordon and W.L. Morgan, Principles of Communication Satellites, John Wiley & Sons, Inc.
3. Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition, 2010.
4. S. K. Raman, "Fundamentals of Satellite Communication", Pearson Education India, 2011.

REFERENCE BOOKS:

1. T T Ha, Digital Satellite Communications, McGraw Hill
2. William W Wu, Elements of Digital Satellite Communication, John Willey and Sons

Course Outcomes:

After successful completion of this course, the student will be able to:

1. Demonstrate understanding of orbital dynamics, satellite placement, and their impact on communication performance.
2. Explain the functions of satellite subsystems and ground segment equipment.
3. Design satellite links by calculating link budgets, system noise temperature, and carrier-to-noise ratios.
4. Compare and apply suitable modulation and multiple access techniques for different satellite communication systems.
5. Analyze and evaluate advanced satellite communication applications such as GPS, VSAT, DBS-TV, internet, and small satellites.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	M
CO2	M	L	H	H	M	M
CO3	H	M	H	H	M	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H



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I - Semester	Wireless Communication and networks (PE-1)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To introduce the cellular system design concepts including frequency reuse, interference management, and handoff strategies.
2. To understand large-scale radio wave propagation models and their impact on wireless system performance.
3. To study small-scale fading, multipath propagation effects, and statistical models for channel behaviour.
4. To explore equalization and diversity techniques for improving signal quality in wireless environments.
5. To provide an overview of wireless networks and standards such as IEEE 802.11, IEEE 802.16, and wireless PANs.

UNIT- I

The Cellular Concept-System Design Fundamentals: Introduction, Frequency Reuse, Interference and system capacity – Co channel Interference and system capacity, Channel planning for Wireless Systems, Adjacent Channel interference, Power Control for Reducing interference, Improving Coverage &

Capacity in Cellular Systems- Cell Splitting, Sectoring, Channel Assignment Strategies, Handoff Strategies- Prioritizing Handoffs, Practical Handoff Considerations, Trunking and Grade of Service

UNIT- II

Mobile Radio Propagation: Large-Scale Path Loss: Introduction to Radio Wave Propagation, Free Space Propagation Model, Relating Power to Electric Field, Basic Propagation Mechanisms, **Reflection:** Reflection from Dielectrics, Brewster Angle, Reflection from perfect 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 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 Fading Channels-Clarke's model for



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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, Non-linear 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 -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, HiperLan, 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. Mobile Cellular Communication – Gottapu Sasibhushana Rao, Pearson Education, 2012.

REFERENCE BOOKS:

1. Principles of Wireless Networks – KavehPahLaven and P. Krishna Murthy, 2002, PE
2. Wireless Digital Communications – KamiloFeher, 1999, PHI.

Wireless Communication and Networking – William Stalling

After successful completion of this course, the student will be able to:

1. **Explain** the fundamental concepts of cellular system design including frequency reuse, interference, power control, and handoff strategies.
2. **Analyze** large-scale propagation models (Okumura, Hata, Walfisch-Bertoni, etc.) and indoor/outdoor radio wave propagation mechanisms.
3. **Evaluate** small-scale fading, multipath propagation, Doppler effects, and apply statistical models for fading channel characterization.
4. **Apply** equalization techniques, adaptive algorithms, and diversity methods (space, frequency, time, RAKE) to mitigate channel impairments.
5. **Compare and assess** different wireless networking standards (IEEE 802.11, IEEE 802.16, WLAN, WPAN, HiperLAN, WLL) for practical communication applications.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	M
CO2	H	L	H	H	M	M
CO3	H	M	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	H	H	H



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I Semester	SOFTWARE DEFINED RADIO(PE-1)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To introduce the concepts, characteristics, and evolution of software radios.
2. To explore radio frequency implementation issues and RF front-end design.
3. To understand digital signal generation and synthesis techniques.
4. To study multirate signal processing methods and their applications in receivers.
5. To examine data conversion techniques and performance enhancement strategies.

UNIT- I:

Introduction to Software radio concepts: Introduction, need, characteristics, benefits and design principles of Software Radios. Traditional radio implemented in hardware (first generations of 2G cell phones), Software controlled radio (SCR), Software defined radio (SDR), Ideal software radio (ISR), Ultimate software radio (USR)

UNIT -II:

Radio frequency implementation issues: The purpose of RF Front-End, Dynamic range, RF Receiver Front-End Topologies, Enhanced Flexibility of the RF Chain with Software Radios, Importance of Components to Overall performance, Transmitter Architecture and their issues, Noise and Distortion in RF Chain.

UNIT- III:

Digital generation of signals: Introduction, Comparison of Direct Digital Synthesis with Analog Signal Synthesis, Approaches to Direct Digital Synthesis, Analysis of Spurious Signals, Spurious components due to Periodic Jitter.

UNIT – IV:

Multirate Signal Processing: Introduction, Sample Rate Conversion Principles, Polyphase Filters, Digital Filter Banks, Timing Recovery in Digital receivers Using Multirate Digital Filters.

UNIT – V:

A/D & D/A Conversion: Introduction, Parameters of Ideal Data Converters, Parameters of Practical data Converters, Techniques to improve Data Converter performance, JTRS.

TEXT BOOKS and REFERENCE BOOKS:

1. Jeffery H. Reed, “Software Radio, (A modern approach to radio engineering)”, PHI PTR, 2002
2. John J. Roupheal, “RF and Digital Signal Processing for Software Defined Radio” Elsevier, Newness Publications.
3. C. Richard Johnson, Jr., and William A. Sethares, Telecommunication Breakdown, Prentice Hall, ISBN 0-13-143047-5, 2004



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COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Explain the design principles and types of software radios from SCR to USR.
2. Analyse RF front-end architectures and assess their impact on system performance.
3. Compare digital and analogy signal synthesis methods and evaluate spurious effects.
4. Apply multirate signal processing techniques for timing recovery and filtering.
5. Evaluate A/D and D/A converter parameters and techniques for performance.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	M
CO2	H	L	H	H	M	H
CO3	H	M	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	H	M	H



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I- Semester	Mobile Computing (PE-2)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. **Introduce** the fundamental concepts of network security including attacks, services, and mechanisms, and establish a foundational security model for internetworks.
2. **Explore** classical and modern encryption techniques including symmetric block ciphers such as DES, 3DES, and AES-like algorithms to understand cryptographic strength and design.
3. **Understand** the principles and algorithms of public key cryptography, including RSA, Diffie-Hellman, and elliptic curve cryptography, supported by essential number theory concepts.
4. **Examine** the role and construction of message authentication codes (MACs), hash functions, and digital signatures to ensure data integrity and authenticity in communication.
5. **Analyse** the architecture and mechanisms for IP and web security including protocols like SSL/TLS, IPSec, and secure email systems, and understand security threats such as viruses, worms, and the role of firewalls in defending systems.

UNIT I: Introduction: Attacks, Services and Mechanisms, Security attacks, Security services, A Model for Internetwork security. Classical Techniques: Conventional Encryption model, Steganography, Classical Encryption Techniques.

Modern Techniques: Simplified DES, Block Cipher Principles, Data Encryption standard, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and Modes of operations.

UNIT II: Triple DES, International Data Encryption algorithm, Blowfish, RC5, CAST-128, RC2, Characteristics of Advanced Symmetric block ciphers.

Conventional Encryption: Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation.

UNIT III: Public Key Cryptography: Principles, RSA Algorithm, Key Management, Diffie-Hellman Key exchange, Elliptic Curve Cryptography.

Number Theory: Prime and relatively prime numbers, Modular arithmetic, Fermat's and Euler's theorems, Testing for primality, Euclid's Algorithm, the Chinese remainder theorem, Discrete logarithms.

UNIT IV: Message Authentication and Hash Functions: Authentication requirements and functions, Message Authentication, Hash functions, Security of Hash functions and MACs. Hash and Mac Algorithms. MD File, Message digest Algorithm, Secure Hash Algorithm, RIPEMD-160, HMAC. Digital signatures and Authentication protocols: Digital signatures, Authentication Protocols, Digital signature standards. Authentication Applications: Kerberos, X.509 directory Authentication service. Electronic Mail, Security: Pretty Good Privacy, S/MIME.



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UNIT V: IP Security: Overview, Architecture, Authentication, Encapsulating Security Payload, Combining security Associations, Key Management. **Web Security:** Web Security requirements, Secure sockets layer and Transport layer security, Secure Electronic Transaction. Intruders, Viruses and Worms Intruders, Viruses and Related threats. Fire Walls: Fire wall Design Principles, Trusted systems.

TEXTBOOKS:

1. Cryptography and Network Security: Principles and Practice - William Stallings, Pearson Education.
2. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.

REFERENCE BOOKS:

1. Fundamentals of Network Security by Eric Maiwald (Dreamtech press)
2. Network Security - Private Communication in a Public World by Charlie Kaufman, Radia Perlman and Mike Speciner, Pearson/PHI.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Explain the basic concepts of network security including types of attacks, security services, classical encryption techniques, and modern block cipher principles such as DES.
2. Analyze and compare various modern symmetric encryption algorithms such as Triple DES, IDEA, Blowfish, RC5, and evaluate key distribution techniques and random number generation methods.
3. Apply public key cryptographic algorithms such as RSA, Diffie-Hellman, and Elliptic Curve Cryptography, and demonstrate number theory concepts used in cryptography like modular arithmetic, primality testing, and discrete logarithms.
4. Evaluate the effectiveness of message authentication codes, hash functions (SHA, MD5, HMAC), and digital signature protocols for data integrity and authentication in applications like Kerberos, PGP, and S/MIME.
5. Demonstrate understanding of IP and Web security architectures, identify threats from intruders, viruses, worms, and explain the principles of firewall design and trusted systems.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	M
CO2	H	M	H	H	M	H
CO3	H	M	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	H	H	H



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I Semester	Machine Learning (PE-2)	L	T	P	C
		3	0	0	3

Course Objectives

The objectives of this course are to:

1. Introduce the fundamental principles of machine learning, including tasks, models, and features.
2. Provide knowledge of different learning paradigms such as supervised, unsupervised, and regression.
3. Develop understanding of various machine learning techniques such as tree-based, rule-based, linear, distance-based, and kernel methods.
4. Familiarize students with probabilistic models, feature engineering, and ensemble learning strategies.
5. Prepare students to apply machine learning algorithms for solving real-world data-driven problems.

UNIT I:

The ingredients of machine learning, Tasks: the problems that can be solved with machine learning, **Models:** the output of machine learning, **Features,** the workhorses of machine learning, **Binary classification and related tasks:** Classification, Scoring and ranking, Class probability estimation

UNIT II:

Beyond binary classification: Handling more than two classes, Regression, Unsupervised and descriptive learning, **Concept learning:** The hypothesis space, Paths through the hypothesis space, Beyond conjunctive concepts

UNIT III:

Tree models: Decision trees, Ranking and probability estimation trees, Tree learning as variance reduction, **Rule models:** Learning ordered rule lists, Learning unordered rule sets, Descriptive rule learning, First-order rule learning

UNIT IV:

Linear models: The least-squares method, The perceptron: a heuristic learning algorithm for linear classifiers, Support vector machines, obtaining probabilities from linear classifiers, Going beyond linearity with kernel methods, **Distance Based Models:** Introduction, Neighbours and exemplars, Nearest Neighbours classification, Distance Based Clustering, Hierarchical Clustering.

UNIT V:

Probabilistic models: The normal distribution and its geometric interpretations, Probabilistic models for categorical data, Discriminative learning by optimising conditional likelihood Probabilistic models with hidden variables, **Features:** Kinds of feature, Feature transformations, Feature construction and selection. Model ensembles: Bagging and random forests, Boosting

Text Books:

1. Machine Learning: The art and science of algorithms that make sense of data, 1st Edition, Peter Flach, Cambridge, 2012
2. Machine Learning, 1st Edition, Tom M. Mitchell, MGH, 2017



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Reference Books:

1. Understanding Machine Learning: From Theory to Algorithms, 3rd Edition, Shai Shalev-Shwartz, Shai Ben-David, Cambridge, 2015
2. Machine Learning in Action, 1st Edition, Peter Harington, Cengage, 2012

Course Outcomes (COs):

After successful completion of this course, the student will be able to:

1. Explain the basic concepts, models, and tasks of machine learning including classification, scoring, and ranking.
2. Apply supervised, unsupervised, regression, and concept learning approaches to solve practical problems.
3. Construct and analyze models such as decision trees, rule-based systems, linear classifiers, kernel methods, and clustering techniques.
4. Evaluate probabilistic models, feature transformations, and ensemble learning techniques for improved performance.
5. Design and implement machine learning solutions for real-world applications.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	M
CO2	H	M	H	H	M	H
CO3	H	M	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	H	H	H



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I Semester	Data Structures and Algorithms (PE-2)	L	T	P	C
		3	0	0	3

The objectives of this course are to:

1. Introduce the fundamental concepts, tasks, and models in machine learning.
2. Provide knowledge of different learning paradigms such as supervised, unsupervised, regression, and concept learning.
3. Develop understanding of various machine learning techniques including tree-based, rule-based, linear, kernel, and distance-based methods.
4. Familiarize students with probabilistic models, feature engineering, and ensemble approaches for performance enhancement.
5. Enable students to apply machine learning methods for solving real-world classification, prediction, and decision-making problems.

UNIT I: Introduction, Classification of Data Structure, concept of Data Types, Algorithm, importance of Algorithm Analysis, Complexity of an algorithm, Asymptotic Analysis and Notations. (Ref-1)

Searching-Linear and Binary, Search Methods, **Sorting**-Bubble Sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort. (Text-1)

UNIT II:

Singly Linked Lists, Doubly Linked Lists, Circular Lists-Algorithms.

Stacks and Queues: Algorithm Implementation using Linked Lists and its applications (Text-1)

UNIT III:

Trees- Binary trees, Properties, Representation and Traversals (DFT, BFT), Expression Trees (Infix, prefix, postfix).

Search Trees- Binary Search Trees, Definition, ADT, Implementation, **Operations**-Searching, Insertion, Deletion.

Search Trees- AVL Trees, Definition, Height of AVL Tree, Operations-, Insertion, Deletion and Searching (Text-1)

UNIT IV:

Hashing: Hash Functions, Collision Resolution-Separate Chaining, **Open Addressing**-Linear Probing, Quadratic Probing, Double Hashing.

Priority queues- Definition, Insertion, Deletion.

Introduction to Red-Black and Splay Trees, B-Trees, Comparison of Search Trees. (Text-1)

UNIT V:

Graphs-Basic Concepts, Storage structures, Traversal Algorithms, shortest path algorithms: Minimum Spanning Trees, Prim's Algorithm. Kruskal's Algorithm, Dijkstra's algorithm, Warshall's Algorithm, Applications of Graphs (Text-2)

Text Books:

1. Data Structures and Algorithm Analysis, 3/e, Mark Allen Weiss, Pearson
2. Data Structures Using C, 2/e, Reema Thareja, OXford



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Reference Books:

1. A simplified Approach to Data Structures, Vishal Goyal, Lalit Goyal, Pawan kumar, SPD, Data Structures: A Pseudo Code Approach, 2/e, Richard F. Gilberg, Behrouz A. Forouzan and Cengage, 2005.

After successful completion of this course, the student will be able to:

1. Explain the basic concepts, models, and tasks of machine learning including classification, scoring, and ranking.
2. Apply supervised, unsupervised, regression, and concept learning approaches to solve practical problems.
3. Construct and analyze models such as decision trees, rule-based systems, linear classifiers, kernel methods, and clustering techniques.
4. Evaluate probabilistic models, feature transformations, and ensemble learning techniques for improved performance.
5. Design and implement machine learning solutions for real-world applications.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	M
CO2	H	M	H	H	M	H
CO3	H	M	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	H	H	H



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I Semester	Advanced Computer Architecture (PE-2)	L	T	P	C
		3	0	0	3

The objectives of this course are to:

1. Provide fundamental knowledge of computer design principles, instruction sets, and performance evaluation.
2. Develop an understanding of pipelining, instruction-level parallelism, and memory hierarchy design.
3. Introduce software techniques for exploiting ILP and compiler-level optimizations.
4. Familiarize students with multiprocessors, thread-level parallelism, and synchronization mechanisms.
5. Expose students to interconnection networks, cluster design, and advanced processor architectures such as Intel IA-64.

UNIT I Fundamentals of Computer Design:

Fundamentals of Computer design, changing faces of computing and task of computer designer, Technology trends, Cost price and their trends, measuring and reporting performance, quantitative principles of computer design, Amdahl's law. Instruction set principles and examples- Introduction, classifying instruction set- memory addressing-type and size of operands, operations in the instruction set.

UNIT II Pipelines:

Introduction, basic RISC instruction set, Simple implementation of RISC instruction set, Classic five stage pipe line for RISC processor, Basic performance issues in pipelining, Pipeline hazards, Reducing pipeline branch penalties.

Memory Hierarchy Design:

Introduction, review of ABC of cache, Cache performance, Reducing cache miss penalty, Virtual memory.

Instruction Level Parallelism - The Hardware Approach:

Instruction-Level parallelism, Dynamic scheduling, Dynamic scheduling using Tomasulo's approach, Branch prediction, high performance instruction delivery- hardware based speculation.

UNIT III ILP Software Approach:

Basic compiler level techniques, static branch prediction, VLIW approach, Exploiting ILP, Parallelism at compile time, Cross cutting issues -Hardware verses Software.

UNIT IV Multi Processors and Thread Level Parallelism:

Multi Processors and Thread level Parallelism- Introduction, Characteristics of application domain, Systematic shared memory architecture, Distributed shared – memory architecture, Synchronization

UNIT V Inter Connection and Networks:

Introduction, Interconnection network media, Practical issues in interconnecting networks, Examples of inter connection, Cluster, Designing of clusters.

Intel Architecture:

Intel IA- 64 ILP in embedded and mobile markets Fallacies and pit falls



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TEXT BOOKS:

1. John L. Hennessy, David A. Patterson, Computer Architecture: A Quantitative Approach, 3rd Edition, An Imprint of Elsevier.

REFERENCE BOOKS:

1. John P. Shen and Miikko H. Lipasti, Modern Processor Design : Fundamentals of Super Scalar Processors
2. Computer Architecture and Parallel Processing ,Kai Hwang, Faye A. Briggs., MC Graw Hill.,
3. Advanced Computer Architecture - A Design Space Approach, Dezso Sima, Terence Fountain, Peter Kacsuk ,Pearsoned.

Course Outcomes (COs):

After successful completion of this course, the student will be able to:

1. **Explain** the fundamentals of computer design, instruction set architecture, and performance evaluation techniques.
2. **Analyze** pipeline implementation, hazards, memory hierarchy design, and hardware techniques for instruction-level parallelism.
3. **Apply** compiler-level methods such as static branch prediction, VLIW, and software optimizations for exploiting ILP.
4. **Evaluate** multiprocessor architectures, thread-level parallelism, and synchronization issues in parallel systems.
5. **Compare and assess** interconnection networks, cluster architectures, and advanced processor designs including Intel IA-64.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	M
CO2	H	L	H	H	M	H
CO3	H	M	H	H	M	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H



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I Semester	Computer Networks Lab	L	T	P	C
		0	1	2	2

COURSE OBJECTIVES:

1. To provide practical exposure to data link layer framing and error detection mechanisms.
2. To implement and analyze network layer routing algorithms and protocols.
3. To simulate transport layer operations such as flow control, congestion control, and error recovery.
4. To understand and apply basic security techniques like encryption and decryption in networking.
5. To explore and analyze real network traffic and behavior using tools like Wireshark, Nmap, and NS2.

List of Experiments

1. Implement the data link layer framing methods such as character, character-stuffing and bit stuffing.
2. Write a program to compute CRC code for the polynomials CRC-12, CRC-16 and CRC CCIP
3. Develop a simple data link layer that performs the flow control using the sliding window protocol, and loss recovery using the Go-Back-N mechanism.
4. Implement Dijkstra's algorithm to compute the shortest path through a network
5. Take an example subnet of hosts and obtain a broadcast tree for the subnet.
6. Implement distance vector routing algorithm for obtaining routing tables at each node.
7. Implement data encryption and data decryption
8. Write a program for congestion control using Leaky bucket algorithm.
9. Write a program for frame sorting technique used in buffers.
10. Wireshark
 - i. Packet Capture Using Wire shark.
 - ii. Starting Wire shark
 - iii. Viewing Captured Traffic
 - iv. Analysis and Statistics & Filters.
11. How to run Nmap scan
12. Operating System Detection using Nmap
13. Do the following using NS2 Simulator
 - i. NS2 Simulator-Introduction
 - ii. Simulate to Find the Number of Packets Dropped



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- iii. Simulate to Find the Number of Packets Dropped by TCP/UDP
- iv. Simulate to Find the Number of Packets Dropped due to Congestion.
- v. Simulate to Compare Data Rate & Throughput.
- vi. Simulate to Plot Congestion for Different Source/Destination
- vii. Simulate to Determine the Performance with respect to Transmission of Packets

COURSE OUTCOMES:

1. Implement framing, CRC, and flow control mechanisms at the data link layer.
2. Simulate and analyze routing algorithms such as Dijkstra's and Distance Vector.
3. Develop programs for congestion control and buffering techniques.
4. Apply encryption and decryption for secure data transmission.
5. Use Wireshark and Nmap to monitor, capture, and analyze network behaviour.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	H
CO2	H	L	H	H	M	H
CO3	H	M	H	H	M	H
CO4	H	M	H	H	H	H
CO5	H	M	H	H	H	H



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I Semester	Embedded System Design Lab	L	T	P	C
		0	1	2	2

COURSE OBJECTIVES:

1. To provide hands-on experience with ARM Cortex-M microcontroller programming.
2. To develop embedded applications using GPIO, timers, interrupts, and serial communication.
3. To explore advanced interfacing techniques including ADC, PWM, LCD, and SD card integration.
4. To implement wireless communication using BLE and Wi-Fi for smart system applications.
5. To design and deploy embedded systems capable of real-time monitoring and control.

EXPERIMENTS USING ARM CORTEX-M MICROCONTROLLER

(NUCLEO board -F429ZI):

1. Program to configure and control General Purpose Input / Output (GPIO) port pins.
2. Program to demonstrate Serial communication. Transmission from Kit and reception from PC using Serial Port on IDE environment use debug terminal to trace the program.
3. Program to demonstrate Time delay program using built in Timer / Counter feature on IDE environment.
4. Program to demonstrate a simple interrupt handler and setting up a timer.
5. Program to Displaying a message in a 2-line x 16 Characters LCD display and verify the result in debug terminal.
6. Program to demonstrate ADC interfacing.
7. Generation of PWM Signal with the objective of introducing the practical application of timers and fundamental principles of control theory.
8. To integrate a micro-SD card with the computing system for the purpose of storing event logs conveniently on the SD card.
9. To establish a connection between the two computing systems using Bluetooth Low Energy (BLE), with the objective of monitoring pertinent information from one system and facilitating gate control through the other system.
10. To enhance the smart home system by enabling it to host a web page through Wi-Fi connectivity, thereby allowing users to access information using a smartphone or PC.



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COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Configure and control GPIO pins for digital input/output operations.
2. Implement serial communication and debug embedded applications using IDE tools.
3. Utilize timers and interrupts for time-based and event-driven programming.
4. Interface peripherals such as LCD, ADC, PWM, and SD card with the microcontroller.
5. Develop wireless communication systems using BLE and Wi-Fi for smart home applications.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	H	H	M	H
CO2	H	M	H	H	M	H
CO3	H	L	H	H	M	H
CO4	H	M	H	H	M	H
CO5	H	M	H	H	H	H



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I Semester	Seminar-1	L	T	P	C
		0	0	2	1





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II Semester	Advanced Communication Systems	L	T	P	C
		3	1	0	4

Course Objectives:

1. To provide a comprehensive understanding of the evolution of mobile communication technologies from 1G to 5G, including standards, regulations, and spectrum utilization.
2. To introduce students to propagation channels and the challenges associated with 5G communication environments, particularly mmWave and MIMO systems.
3. To develop knowledge of advanced transmission and modulation techniques such as OFDM, GFDM, FBMC, UFMC, and multiple access techniques suitable for 5G.
4. To explain the concepts and mechanisms of device-to-device (D2D) and machine-to-machine (M2M) communication in 5G networks, including radio resource management.
5. To impart a deep understanding of millimeter-wave communications and Massive MIMO technologies, including beamforming, channel estimation, interference management, and spatial modulation.

UNIT 1:

Overview of 5G Broadband Wireless Communications: Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro) , An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G.

UNIT 2:

The 5G wireless Propagation Channels: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, Channel Models for mmWave MIMO Systems.

UNIT 3:

Transmission and Design Techniques for 5G: Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), nonorthogonal multiple accesses (NOMA).

UNIT 4

Device-to-device (D2D) and machine-to-machine (M2M) type communications – Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multihop and multi-operator D2D communications.

UNIT 5

Millimeter-wave Communications – spectrum regulations, deployment scenarios, beamforming, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM)



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Textbooks:

1. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.
2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks", Cambridge University Press.

References

1. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.
2. Amitabha Ghosh and Rapeepat Ratasuk "Essentials of LTE and LTE-A", Cambridge University Press

Course Outcomes:**After successful completion of this course, the student will be able to:**

1. Analyze the evolution, requirements, and spectrum regulations for 5G communication systems.
2. Evaluate different channel models, propagation scenarios, and challenges in 5G wireless propagation.
3. Apply and compare various modulation and multiple access techniques used in 5G systems.
4. Demonstrate understanding of D2D and M2M communications and their role in 5G broadband connectivity.
5. Assess and design techniques for mmWave communications and Massive MIMO, addressing practical issues such as imperfect CSI, pilot contamination, and mobility management.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	L	L
CO2	H	L	H	H	M	L
CO3	H	L	H	H	L	M
CO4	M	M	H	L	M	M
CO5	H	L	H	H	M	M



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II- Semester	Internet of Things and its applications	L	T	P	C
		3	1	0	4

Course Objectives:

By the end of this course, the student will be able to:

1. Understand the fundamental networking technologies and cloud computing concepts related to IoT.
2. Explore and familiarize with various IoT hardware platforms such as Raspberry Pi, Arduino, ARM Cortex, and Intel Galileo.
3. Learn IoT architectures, communication protocols, and security aspects for building scalable IoT systems.
4. Acquire skills in IoT application development using web, databases, and mobile platforms.
5. Analyze real-world IoT case studies and advanced applications in smart homes, industries, and infrastructure.

UNIT I:

The IoT Networking Core: Technologies involved in IoT Development: Internet/Web and Networking Basics, OSI Model, Data transfer referred with OSI Model, IP Addressing, Point to Point Data transfer, Point to Multi Point Data transfer & Network Topologies, Sub-netting, Network Topologies referred with Web, Introduction to Web Servers, Introduction to Cloud Computing.

UNIT II:

IoT Platform Overview: Overview of IoT supported Hardware platforms such as Raspberry Pi, ARM Cortex Processors, Arduino and Intel Galileo boards.

Network Fundamentals: Overview and working principle of Wired Networking equipment – Routers, Switches; Overview and working principle of Wireless Networking equipment – Access Points, Hubs etc.

Linux Network Configuration Concepts: Networking configurations in Linux, Accessing Hardware & Device Files interactions.

UNIT III:**IoT Architecture:**

History of IoT, M2M – Machine to Machine, Web of Things, IoT protocols. Applications: Remote Monitoring & Sensing, Remote Controlling, Performance Analysis.

The Architecture: The Layering concepts, IoT Communication Pattern, IoT Protocol Architecture, The 6LoWPAN. Security aspects in IoT.

UNIT IV:**IoT Application Development:**

Application Protocols. Back-end Application Designing: Apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB Object type Database, HTML, CSS & jQuery for UI Designing, JSON library for data processing, Security & Privacy during development. Application Development for Mobile Platforms: Overview of Android / iOS App Development tools.



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UNIT V:**Case Study & Advanced IoT Applications:**

IoT applications in home, infrastructures, buildings, security, industries, home appliances, and other IoT electronic equipment. Use of Big Data and Visualization in IoT, Industry 4.0 concepts. Sensors and Sensor Nodes and interfacing using any embedded target boards (Raspberry Pi / Intel Galileo / ARM Cortex / Arduino).

TEXTBOOKS:

1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
2. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers
3. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann

REFERENCES:

1. The Internet of Things: From RFID to the Next-Generation Pervasive Network ed Lu Yan, Yan Zhang, Laurence T. Yang, Huansheng Ning
2. Internet of Things (A Hands-on-Approach), Vijay Madisetti, Arshdeep Bahga
3. Designing the Internet of Things, Adrian Mc Ewen (Author), Hakim Cassimally
4. Asoke K Talukder and RoopaR Yavagal, "Mobile Computing," Tata Mc Graw Hill, 2010.

Course Outcomes:

After successful completion of this course, the student will be able to:

1. Apply networking fundamentals, OSI model concepts, IP addressing, and subnetting in IoT system design.
2. Demonstrate working knowledge of IoT hardware platforms and networking equipment for IoT deployment.
3. Analyze IoT architectures, communication patterns, and protocols including 6LoWPAN with emphasis on security.
4. Develop IoT applications using backend servers, databases, and mobile platforms ensuring privacy and security.
5. Evaluate and implement IoT solutions in real-time domains such as smart homes, industries, and infrastructure using big data and visualization techniques.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	L	H	H	M	M
CO2	M	L	H	H	M	H
CO3	H	M	H	H	H	M
CO4	H	H	H	M	H	H
CO5	H	M	H	M	H	H



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II Semester	Information Theory and Coding	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1. Introduce core concepts of information theory including entropy and mutual information.
2. Teach lossless source coding algorithms like Huffman, Arithmetic, and LZW.
3. Explain channel capacity and its evaluation for various communication channels.
4. Explore the fundamentals of video and speech coding techniques.
5. Provide knowledge of error control coding for reliable data transmission.

UNIT-I: Information Source, Symbols, and Entropy, Mutual information, information Measures for Continuous Random Variable, Joint and Conditional Entropy, Relative Entropy, Applications Based on information Theoretic Approach.

UNIT-II: Source coding: Source Coding Theorem, Kraft inequality, Shannon-Fano Codes, Huffman Codes, Run Length Code, Arithmetic Codes, Lempel-Ziv-Welch Algorithm, Universal Source Codes, Prefix Codes, Variable Length Codes, Uniquely Decodable Codes, instantaneous Codes, Shannon's Theorem, Shannon Fano Encoding Algorithm, Shannon's Noiseless Coding Theorem, Shannon's Noisy Coding Theorem.

UNIT-III: Communication channel: Channel and its Capacity, Continuous and Gaussian Channels, Discrete Memory-Less Channels, Symmetric Channel, Binary Erasure Channel, Estimation of Channel Capacity, Noiseless Channel, Channel Efficiency, Shannon's Theorem on Channel Capacity, MIMO Channels, Channel Capacity with Feedback.

UNIT-IV: Video and speech coding: Video Coding Basics, Quantization, Symbol Encoding, Intraframe Coding, Predictive Coding, Transform Coding, Sub-band Coding, Vector Quantization, Interframe Coding, Motion Compensated Coding, Image Compression, Jpeg, LZ78 Compression, Dictionary Based Compression, Statistical Modelling, Speech Coding, Psycho-Acoustic Modelling, Time Frequency Mapping Quantization, Variable Length Coding, Multichannel Correlation and Irrelevancy, Long Term Correlation, Pre-Echo Control, Bit Allocation.

UNIT-V: Error control coding: Overview of Field, Group, Galois Field, Types of Codes, Hamming Weight, Minimum Distance Based Codes, Error Detection and Error Correction Theorems, Maximum Likelihood Decoder, Map Decoder, Linear Block Codes and Their Properties, Equivalent Codes, Generator Matrix and Parity Check Matrix, Systematic Codes, Cyclic Codes, Convolution Codes and Viterbi Decoding Algorithm, Iterative Decoding, Turbo Codes and Low Density-Parity-Check Codes, Asymptotic Equipartition Property, Bch Codes, Generator Polynomials, Decoding of Bch Codes, Reed Solomon Codes, Trellis Codes, Space Time Coding.

TEXTBOOKS:

1. T.M. Cover and J.A. Thomas, Elements of Information Theory, John Wiley & Sons.
2. Todd K. Moon, Error Correction coding, John Wiley, 2005



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REFERENCE BOOKS:

1. Shu lin/ Daniel J. Costello Jr., Error Control Coding, Prentice Hall series in computer applications in electrical engineering series (2/e) 2005.
2. Ranjan Bose, Information Theory, coding and cryptography (2/e), McGraw Hill.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Understand and compute entropy, mutual information, and related measures.
2. Apply and analyze source coding algorithms for efficient data compression.
3. Evaluate channel capacity and efficiency in communication systems.
4. Implement and compare video/speech coding and multimedia compression techniques.
5. Design and analyze error control codes for error detection and correction.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	L	L
CO2	H	M	H	H	M	M
CO3	H	L	H	H	M	L
CO4	H	M	H	M	H	H
CO5	H	L	H	H	M	M



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II Semester	Optical communications and networks(PE-3)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Introduce the fundamentals of optical fiber communication, including transmission link components, light propagation, and fiber structures.
2. Understand the principles and performance of optical sources and detectors used in optical communication systems.
3. Explain the structure and function of optical communication systems, including digital systems and modern high-speed links.
4. Familiarize students with components and technologies used in fiber optic networks and their architectures.
5. Explore coherent communication systems, detection techniques, and the role of demodulation and noise management in optical receivers.

UNIT I:

Overview of optical fiber communications: Elements of an optical fiber transmission link. Optical Fibers: structures, wave guiding, Nature of light, Basic optical laws and definitions, optical fiber modes and configurations (Fiber types, Rays and modes, step index and graded index fibers) mode theory of circular waveguides. (Qualitative Treatment) Fabrication, cabling and installation: Fabrication, fiber optic cables, Installation- placing the cable.

UNIT II:

Optical sources: LEDs, structures, quantum efficiency, modulation capability, Laser diodes: Laser diodes and threshold conditions, external quantum efficiency resonant frequencies, Optical Detectors: Physical principles of photodiodes (pin Photodiode, avalanche, photo diode) comparison of photo detectors, noise in detectors.

UNIT III:

Optical Communication Systems: Block diagrams of optical communication systems, direct intensity modulation, digital communication systems, Laser semiconductor transmitter, Generations of optical fiber link, description of 8 Mb/s optical fiber communication link, description of 2.5 Gb/s optical fiber communication link.

UNIT IV:

Components of fiber optic Networks: Overview of fiber optic networks, Trans receiver, semiconductors optical amplifiers, couplers/splicer's, wavelength division multiplexers and demultiplexers, filters, isolators and optical switches. Fiber Optic Networks: Basic networks, SONET/SDIT, Broad cast and select WDM Networks, wavelength routed networks, optical CDMA Nonlinear effects on network performance.

UNIT V:

Coherent Systems: Coherent receiver, Homodyne and heterodyne detection, noise in coherent receiver, polarization control, Homodyne receiver, Reusability and laser linewidth, heterodyne receiver, synchronous, Asynchronous and self-synchronous demodulation, phase diversity receivers.

TEXTBOOKS:

1. Optical fiber communications – Gerd Keiser, 3 rd Ed. MGH.
2. Fiber Optic Communication Technology – Djafar K. Mynbaev and Lowell L. Scheiner,
3. Optoelectronic devices and systems – S.C. Gupta, PHI, 2005.



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REFERENCE BOOKS:

1. Fiber Optics Communications – Harold Kolimberis (Pearson Education Asia)
2. Optical Fiber Communications and its applications – S.C: Gupta (PHI) 2004.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Explain the fundamental principles of optical fiber communication including waveguiding, fiber types, and mode theory of circular waveguides.
2. Compare and analyze various optical sources (LEDs, laser diodes) and detectors (PIN, APD) in terms of efficiency, modulation capability, and noise performance.
3. Design and interpret the block diagrams of optical communication systems and explain the working of digital systems including 8 Mb/s and 2.5 Gb/s optical links.
4. Evaluate different fiber optic network components such as transceivers, amplifiers, WDM Systems.
5. Demonstrate understanding of coherent optical systems including homodyne/heterodyne detection, polarization effects, and noise handling in coherent receivers.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	L	L
CO2	H	M	H	H	M	M
CO3	H	M	H	H	M	H
CO4	H	M	H	M	H	H
CO5	H	L	H	H	M	M



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II Semester	SMART ANTENNAS AND BEAM FORMING TECHNIQUES(PE-3)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To provide the essential knowledge of the antenna parameters and measurements.
2. To design antenna array using synthesise techniques.
3. To design the single element microstrip antenna and array with feeder network
4. To introduce the types of high impedance surface antennas for various applications.

UNIT -I:

Antenna Fundamentals Radiation Mechanism, antennas used in various applications and selection criteria, Antenna measurements using anechoic chamber - Radiation pattern, Radiation Intensity, Power gain, Directivity, impedance, Radiation efficiency, Polarization

UNIT -II:

Antenna Array Synthesis Fourier Transform - Woodward-Lawson Sampling - Schelkunoff Method-Dolph-Tchebyscheff -Taylor Line Source Method

UNIT-III:

Microstrip Antennas Basic characteristics, feeding methods, Methods of analysis – Transmission line model and cavity model - Design of Rectangular patch, Circular patch –Microstrip antenna array and feed network. Antenna Design Techniques Antenna Design using Artificial Impedance Surface Metamaterial- Electromagnetic Band Gap Defective Ground Structure - High Impedance Surface

UNIT-IV:

Antenna Applications-I: Integrated Antenna for wireless personal communication, mobile communication- Antenna design consideration for MIMO diversity systems - medical therapy

UNIT -V:

Antenna Applications- II: Antenna for Software Defined Radio – Cognitive Radio- Electronic Warfare- Ground penetrating Radar Method of moments (MoM), Finite element method (FEM), Finite difference time domain method

TEXT BOOKS:

1. C.A. Balanis, Antenna Theory: Analysis and Design, 2016, 4th edition, Wiley, India
2. C.A. Balanis, Modern Antenna Handbook, 2012, 1st Edition, Wiley, India.

REFERENCE BOOKS:

1. W.L. Stutzman and G.A. Thiele, Antenna Theory and design, 2012, 3rd Edition, Wiley, India
2. J. D. Kraus, Antennas and Wave propagation, 2012, 4th Edition, McGraw Hill, India.
3. Sanjay Kumar, Saurabh Shukla, Wave Propagation and Antenna Engineering, 2016, 1st Edition PHI, India
4. www.antenna-theory.com



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COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Explain the fundamentals of antenna radiation mechanisms and evaluate antenna parameters such as radiation pattern, gain, directivity, efficiency, and polarization using measurement techniques.
2. Apply antenna array synthesis techniques (Fourier Transform, Schelkunoff, Dolph-Chebyshev, Taylor methods) to design antenna arrays with desired radiation characteristics.
3. Design and analyze microstrip patch antennas using transmission line and cavity models, and apply modern design techniques such as metamaterials, EBG, and HIS structures.
4. Analyze antenna requirements and design considerations for wireless communication, MIMO diversity systems, and medical applications.
5. Evaluate and implement antenna applications for advanced technologies such as software-defined radio, cognitive radio, electronic warfare, and radar using numerical methods (MoM, FEM, FDTD).

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	L	M
CO2	H	L	H	H	M	M
CO3	H	M	H	H	H	H
CO4	H	M	H	M	H	M
CO5	H	M	H	H	H	H



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II Semester	Network security and cryptography(PE-3)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. **Introduce** the fundamental concepts of network security including attacks, services, and mechanisms, and establish a foundational security model for internetworks.
2. **Explore** classical and modern encryption techniques including symmetric block ciphers such as DES, 3DES, and AES-like algorithms to understand cryptographic strength and design.
3. **Understand** the principles and algorithms of public key cryptography, including RSA, Diffie-Hellman, and elliptic curve cryptography, supported by essential number theory concepts.
4. **Examine** the role and construction of message authentication codes (MACs), hash functions, and digital signatures to ensure data integrity and authenticity in communication.
5. **Analyse** the architecture and mechanisms for IP and web security including protocols like SSL/TLS, IPsec, and secure email systems, and understand security threats such as viruses, worms, and the role of firewalls in defending systems.

UNIT I:

Introduction: Attacks, Services and Mechanisms, Security attacks, Security services, A Model for Internetwork security. Classical Techniques: Conventional Encryption model, Steganography, Classical Encryption Techniques.

Modern Techniques: Simplified DES, Block Cipher Principles, Data Encryption standard, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and Modes of operations.

UNIT II:

Triple DES, International Data Encryption algorithm, Blowfish, RC5, CAST-128, RC2, Characteristics of Advanced Symmetric block ciphers.

Conventional Encryption: Placement of Encryption function, Traffic confidentiality, Key distribution, Random Number Generation

UNIT III:

Public Key Cryptography: Principles, RSA Algorithm, Key Management, Diffie-Hellman Key exchange, Elliptic Curve Cryptography.

Number Theory: Prime and relatively prime numbers, Modular arithmetic, Fermat's and Euler's theorems, Testing for primality, Euclid's Algorithm, the Chinese remainder theorem, Discrete Algorithms.

UNIT IV:

Message Authentication and Hash Functions: Authentication requirements and functions, Message Authentication, Hash functions, Security of Hash functions and MACs. Hash and Mac Algorithms. MD File, Message digest Algorithm, Secure Hash Algorithm, RIPEMD-160, HMAC. Digital signatures and Authentication protocols: Digital signatures, Authentication Protocols, Digital signature standards. Authentication Applications: Kerberos, X.509 directory Authentication service. Electronic Mail, Security: Pretty Good Privacy, S/MIME.



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UNIT V:

IP Security: Overview, Architecture, Authentication, Encapsulating Security Payload, Combining security Associations, Key Management. **Web Security:** Web Security requirements, Secure sockets layer and Transport layer security, Secure Electronic Transaction. **Intruders, Viruses and Worms:** Intruders, Viruses and Related threats. **Fire Walls:** Fire wall Design Principles, Trusted systems.

TEXTBOOKS:

1. Cryptography and Network Security: Principles and Practice - William Stallings, Pearson Education.
2. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education.

REFERENCE BOOKS:

1. Fundamentals of Network Security by Eric Maiwald (Dreamtech press)
2. Network Security - Private Communication in a Public World by Charlie Kaufman, Radia Perlman and Mike Speciner, Pearson/PHI.

COURSE OUTCOMES:

After completion of the course, students will be able to:

1. Explain the basic concepts of network security including types of attacks, security services, classical encryption techniques, and modern block cipher principles such as DES.
2. Analyze and compare various modern symmetric encryption algorithms such as Triple DES, IDEA, Blowfish, RC5, and evaluate key distribution techniques and random number generation methods.
3. Apply public key cryptographic algorithms such as RSA, Diffie-Hellman, and Elliptic Curve Cryptography, and demonstrate number theory concepts used in cryptography like modular arithmetic, primality testing, and discrete logarithms.
4. Evaluate the effectiveness of message authentication codes, hash functions (SHA, MD5, HMAC), and digital signature protocols for data integrity and authentication in applications like Kerberos, PGP, and S/MIME.
5. Demonstrate understanding of IP and Web security architectures, identify threats from intruders, viruses, worms, and explain the principles of firewall design and trusted systems.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	L	L
CO2	H	M	H	H	M	M
CO3	H	L	H	H	M	M
CO4	H	M	H	M	H	M
CO5	H	M	H	M	H	H



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II Semester	Image and video Processing(PE-3)	L	T	P	C
		3	0	0	3

The objectives of this course are to:

1. Introduce the fundamentals of digital image processing including sampling, quantization, resolution, and transforms.
2. Develop an understanding of image enhancement, restoration, and segmentation techniques in both spatial and frequency domains.
3. Provide knowledge of image compression methods and standards for efficient storage and transmission.
4. Familiarize students with the basics of video processing, time-varying image formation, and motion estimation methods.
5. Enable students to apply image and video processing algorithms for practical applications in multimedia, medical, and communication systems.

- UNIT I Fundamentals of Image Processing and Image Transforms:** Introduction, Image sampling, Quantization, Resolution, Image file formats, Elements of image processing system, Applications of Digital image processing Introduction, Need for transform, image transforms, Fourier transform, 2 D Discrete Fourier transform and its transforms, Importance of phase, Walsh transform, Hadamard transform, Haar transform, slant transform Discrete cosine transform, KL transform, singular valuedecomposition, Radon transform, comparison of different image transforms
- 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. **Image Restoration:** Introduction to Image restoration, Image degradation, Types of image blur, Classification of image restoration techniques, Image restoration model, Linear and Nonlinear image restoration techniques, Blind deconvolution.
- UNIT III Image Segmentation:** Introduction to image segmentation, Point, Line and Edge Detection, Region based segmentation., Classification of segmentation techniques, Region approach to image segmentation, clustering techniques, Image segmentation based on Thresholding, Edge based segmentation, Edge detection and linking, Hough transform, Active contour **Image Compression:** Introduction, Need for image compression, Redundancy in images, Classification of redundancy in images, image compression scheme, Classification of image compression schemes, Fundamentals of information theory, Run length coding, Shannon – Fano coding, Huffman coding, Arithmetic coding, Predictive coding, Transformed based compression, Image compression standard, Wavelet-based image compression, JPEG Standards.
- 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 2-D 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.

Total

TEXT BOOKS:

1. Digital Image Processing – Gonzalez and Woods, 3rd Ed., Pearson.
2. Video Processing and Communication – Yao Wang, Joem Ostermann and Ya-quin Zhang. 1st Ed., PHInt.
3. S.Jayaraman, S.Esakkirajan and T.VeeraKumar, “Digital Image processing, Tata McGraw Hill publishers, 2009

REFERENCE BOOKS:

1. Digital Image Processing and Analysis-Human and Computer Vision Application with CVIP Tools – Scott Umbaugh, 2nd Ed, CRC Press, 2011.
2. Digital Video Processing – M. Tekalp, Prentice Hall International.
3. Digital Image Processing – S.Jayaraman, S.Esakkirajan, T.Veera Kumar – TMH, 2009.

After successful completion of this course, the student will be able to:

1. **Explain** the fundamental concepts of image formation, sampling, quantization, and various image transforms (DFT, DCT, KL, Wavelet, etc.).
2. **Apply** spatial and frequency domain techniques for image enhancement, filtering, and restoration.
3. **Analyze and compare** different image segmentation methods such as thresholding, clustering, edge detection, and region-based approaches.
4. **Evaluate** image compression techniques including predictive coding, transform coding, and standards like JPEG and wavelet-based schemes.
5. **Implement** video processing concepts such as motion estimation, optical flow, and coding techniques for real-world video application

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	L	M
CO2	H	M	H	H	M	H
CO3	H	M	H	M	M	M
CO4	H	M	H	M	H	H
CO5	H	M	H	M	H	H



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II Semester	Artificial Intelligence (PE-4)	L	T	P	C
		3	0	0	3

UNIT – I: Introduction to AI and Search Methods

Introduction to Artificial Intelligence – definition, scope, and relevance to communication systems. Problem-solving approaches, state space representation, uninformed and informed search strategies (BFS, DFS, A*, heuristic search). Constraint satisfaction problems and applications in routing and resource allocation in communication networks.

UNIT – II: Knowledge Representation and Reasoning

Knowledge representation techniques: propositional logic, predicate logic, inference rules, unification, and resolution. Ontologies and semantic networks. Reasoning under uncertainty: Bayesian networks, fuzzy logic, and probabilistic reasoning. Applications in speech and language processing, and decision-making in wireless systems.

UNIT – III: Machine Learning for AI

Supervised learning: regression, decision trees, support vector machines, neural networks. Unsupervised learning: clustering and dimensionality reduction. Reinforcement learning and Markov decision processes. Applications include modulation classification, channel estimation, anomaly detection in networks, and traffic prediction.

UNIT – IV: Deep Learning and Neural Architectures

Introduction to deep learning architectures: feedforward networks, CNNs, RNNs, LSTMs, and transformers. Feature extraction and representation learning. Case studies in image and speech recognition, IoT sensor data analytics, and cognitive radio. Frameworks and tools: TensorFlow, PyTorch, and Keras.

UNIT – V: AI Applications in Communications and Emerging Trends

AI in wireless communications: spectrum management, resource optimization in 5G/6G, and intelligent IoT systems. Natural Language Processing (NLP) applications in chatbots and virtual assistants. Edge AI and federated learning for distributed communication systems. Ethical considerations, explainable AI, and future research directions in AI for communications.

Textbooks:

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson, 2021.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, MIT Press, 2016.
3. Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press, 4th Edition, 2020.



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REFERENCES

1. Christopher Bishop, *Pattern Recognition and Machine Learning*, Springer, 2007.
2. Mehdi Bennis, Mérouane Debbah, and H. Vincent Poor, *Machine Learning and Wireless Communications*, Cambridge University Press, 2021.
3. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly, 2022.
4. Rajendra Akerkar, *Artificial Intelligence for Business*, Springer, 2019.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Explain the fundamentals of AI and apply search strategies to solve communication-related problems.
2. Apply logical reasoning and probabilistic models to represent and analyze knowledge in uncertain communication environments.
3. Implement supervised, unsupervised, and reinforcement learning algorithms for communication data analysis.
4. Develop AI solutions using deep learning architectures for signal, speech, and image processing.
5. Analyze and design AI-driven applications for wireless networks, IoT, and next-generation communication systems.

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Explain the fundamentals of AI and apply search strategies to solve communication-related problems	H	M	H	M	M	L
CO2: Apply logical reasoning and probabilistic models to represent and analyze knowledge in uncertain communication environments	H	H	H	M	M	L
CO3: Implement supervised, unsupervised, and reinforcement learning algorithms for communication data analysis	M	M	H	H	H	M
CO4: Develop AI solutions using deep learning architectures for signal, speech, and image processing	M	H	H	H	H	M
CO5: Analyze and design AI-driven applications for wireless networks, IoT, and next-generation communication systems	H	H	H	H	H	M



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II Semester	Embedded Real Time Operating Systems (PE-4)	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the definition, characteristics, kernel objects, services, and task scheduling mechanisms of an RTOS.
2. To study task structure, task states, synchronization, inter-task communication, and concurrency in real-time environments.
3. To analyze the role and implementation of semaphores, message queues, pipes, signals, condition variables, and event registers in real-time systems.
4. To examine the handling of exceptions and interrupts, timer services, I/O subsystems, and memory management techniques in embedded real-time systems.
5. To modularize applications for concurrency, perform schedulability analysis, and address common design issues such as deadlocks, priority inversion, and resource management.

- UNIT I** **Introduction to Real-Time Operating Systems:** Defining an RTOS, The scheduler, Kernel Objects and services, Key characteristics of an RTOS.
Task: Defining a Task, Task States and Scheduling, Typical Task Operations, Typical Task Structure, Synchronization, Communication and Concurrency.
- UNIT II** **Semaphores:** Defining Semaphores, Typical Semaphore Operations, Typical Semaphore Use. Message Queues: Defining Message Queues, Message Queue States, Message Queue Content, Message Queue Storage, Typical Message Queue Operations, Typical Message Queue Use. Pipes, Event Registers, Signals and Condition Variables.
- UNIT III** **Exceptions and Interrupts:** Exceptions and Interrupts, Applications of Exceptions and Interrupts, Closer look at exceptions and interrupts, Processing General Exceptions, Nature of Spurious Interrupts. Timer and Timer Services: Real-Time Clocks and System Clocks, Programmable Interval Timers, Timer Interrupt Service Routines. I/O Subsystems: I/O Concepts, I/O Subsystems.
- UNIT IV** **Memory Management:** Dynamic Memory Allocation in Embedded Systems, Fixed-Size Memory Management in Embedded Systems, Blocking vs. Non-Blocking Memory Functions, Hardware Memory Management Units.
Modularizing an Application for Concurrency: An Outside-In Approach to Decompose Applications, Guidelines and Recommendations for Identifying Concurrency, Schedulability Analysis.
- UNIT V** **Synchronization and Communication:** Synchronization, Communication, Resource Synchronization Methods, Critical Section, Common Practical Design Patterns, Specific Solution Design Patterns.
Common Design Problems: Resource Classification, Deadlocks, Priority Inversion.



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Text Books

1. Qing Li, Caroline Yao (2003), “Real-Time Concepts for Embedded Systems”, CMP Books.

Reference Books

1. Albert Cheng, (2002), “Real-Time Systems: Scheduling, Analysis and Verification”, Wiley Interscience.
2. Hermann Kopetz, (1997), “Real-Time Systems: Design Principles for Distributed Embedded Applications”, Kluwer.
3. Insup Lee, Joseph Leung, and Sang Son, (2008) “Handbook of Real-Time Systems”, Chapman and Hall.
4. Krishna and Kang G Shin, (2001), “Real-Time Systems”, McGraw Hill.

Course Outcomes: At the end of the course, student will be able

- CO1** Illustrate real time programming concepts.
- CO2** Apply RTOS functions to implement embedded applications
- CO3** Understand fundamentals of design consideration for embedded applications
- CO4** Describe about the memory units and real time memory applications
- CO5** Discuss communication Common Design Problems

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	L	H	H	M	M
CO2	H	L	H	H	M	H
CO3	M	L	H	H	M	M
CO4	M	L	H	H	L	M
CO5	H	M	H	M	H	M



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II Semester		L	T	P	C
	Cloud Computing(PE-4)	3	0	0	3

Course Objectives:

From the course the student will learn

- The student will also learn how to apply trust-based security model to real-world security problems.
- An overview of the concepts, processes, and best practices needed to successfully secure information within Cloud infrastructures.
- Students will learn the basic Cloud types and delivery models and develop an understanding of the risk and compliance responsibilities and Challenges for each Cloud type and service delivery model.

UNIT-I: Introduction- Network centric computing, Network centric content, peer-to-peer systems, cloud computing delivery models and services, Ethical issues, Vulnerabilities, Major challenges for cloud computing, **Parallel and Distributed Systems-** Introduction, architecture, distributed systems, communication protocols, logical clocks, message delivery rules, concurrency, model concurrency with Petri Nets.

UNIT-II: Cloud Infrastructure- At Amazon, The Google Perspective, Microsoft Windows Azure, Open Source Software Platforms, Cloud storage diversity, Intercloud, energy use and ecological impact, responsibility sharing, user experience, Software licensing, **Cloud Computing-** Applications and Paradigms: Challenges for cloud, existing cloud applications and new opportunities, architectural styles, workflows, The Zookeeper, The Map Reduce Program model, HPC on cloud, biological research.

UNIT-III: Cloud Resource virtualization- Virtualization, layering and virtualization, virtual machine monitors, virtual machines, virtualization- full and para, performance and security isolation, hardware support for virtualization, Case Study: Xen, vBlades, **Cloud Resource Management and Scheduling-** Policies and Mechanisms, Applications of control theory to task scheduling, Stability of a two-level resource allocation architecture, feedback control based on dynamic thresholds, coordination, resource bundling, scheduling algorithms, fair queuing, start time fair queuing, cloud scheduling subject to deadlines, Scheduling Map Reduce applications, Resource management and dynamic application scaling.

UNIT-IV: Storage Systems- Evolution of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems. Google file system., Apache Hadoop, BigTable, Amazon Simple Storage Service(S3), **Cloud Security-** Cloud security risks, security – atop concern for cloud users, privacy and privacy impact assessment, trust, OS security, Virtual machine security, Security risks.

UNIT-V: Cloud Application Development- Amazon Web Services- EC2, instances, connecting clients, security rules, launching, usage of S3 in Java, Installing Simple Notification Service on Ubuntu 10.04, Installing Hadoop on Eclipse, Cloud based simulation of a Distributed trust algorithm, Cloud service for adaptive data streaming, **Google-** Google App Engine, Google Web Toolkit, **MicroSoft-** Azure Services Platform, Windows live, Exchange Online, Share Point Services, Microsoft Dynamics CRM.



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Text Books:

1. Cloud Computing, Theory and Practice, 1st Edition, Dan C Marinescu, MK Elsevier, Morgan Kaufmann, 2013
2. Cloud Computing, A Practical Approach, 1st Edition, Anthony T Velte, Toby J Velte, Robert Elsenpeter, TMH, 2009

Reference Books:

1. Mastering Cloud Computing, Foundations and Application Programming, 1st Edition, Raj Kumar Buyya, Christen vecctiola, S Tammaraiselvi, Morgan Kaufmann, 2013

Course Outcomes:

- CO1** Analyze the Cloud computing setup with it's vulnerabilities and applications using different architectures.
- CO2** Design different workflows according to requirements and apply map reduce programming model.
- CO3** Apply and design suitable Virtualization concept, Cloud Resource Management and design scheduling algorithms.
- CO4** Create combinatorial auctions for cloud resources and design scheduling algorithms for computing clouds
- CO5** Assess cloud Storage systems and Cloud security, the risks involved, its impact and develop cloud application

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	M	H
CO2	H	L	H	H	M	H
CO3	H	L	H	H	M	H
CO4	H	L	H	M	M	H
CO5	H	M	H	M	H	H



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II Semester	Data Science(PE-4)	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the basics of data science and use Python tools to work with communication data.
2. Learn probability and statistics to analyze and model communication system data.
3. Apply machine learning techniques to solve problems in communication systems.
4. Use big data tools to process and analyze large communication datasets.
5. Explore advanced data science applications in modern communication technologies like 5G and IoT.

UNIT – I: Introduction to Data Science

This unit introduces the foundations of data science with emphasis on its applications in communication engineering. It covers different types of data, including structured, semi-structured, and unstructured data, along with methods of data collection, preprocessing, cleaning, normalization, and feature extraction. Students will also study data visualization techniques for analyzing communication datasets such as signal and network data. Practical exposure is given through Python programming tools including NumPy, Pandas, and Matplotlib.

UNIT – II: Probability and Statistics for Data Science

The second unit focuses on probability and statistical methods relevant to communications. Topics include probability distributions, random variables, hypothesis testing, correlation, and covariance. Bayesian methods and regression models—linear, polynomial, and logistic—are covered in detail. Applications in communication systems such as noise modeling, estimation, and data analysis in wireless networks will be highlighted through case studies.

UNIT – III: Machine Learning Fundamentals

This unit provides an introduction to machine learning concepts. It covers supervised learning algorithms such as Support Vector Machines (SVM), Decision Trees, Random Forests, and k-Nearest Neighbors. Unsupervised learning methods such as clustering (k-means, hierarchical, DBSCAN) and dimensionality reduction techniques (PCA, LDA) are also introduced. Basics of neural networks and deep learning are included, with applications such as channel estimation, modulation classification, and signal recognition in communication systems.

UNIT – IV: Big Data Analytics in Communications

The fourth unit emphasizes big data concepts in the context of communication networks. It includes data pipelines, streaming data processing, and distributed frameworks like Hadoop and Spark. Time-series analysis methods are introduced for analyzing large volumes of communication signal and traffic data. Case studies include IoT sensor data analytics, real-time network monitoring, and anomaly detection in large-scale communication infrastructures.



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UNIT – V: Advanced Applications of Data Science in Communications

The final unit explores advanced and emerging applications of data science in communication systems. Topics include cognitive radio and spectrum sensing using ML/DL techniques, data-driven network optimization for 5G/6G, and analytics for speech and image signals in communication scenarios. Predictive maintenance for communication systems is discussed along with research trends in artificial intelligence and machine learning for wireless networks, IoT, and next-generation communication technologies.

Course Outcomes (COs)

After completion of the course, students will be able to:

1. Demonstrate understanding of data science fundamentals and apply preprocessing techniques to communication datasets.
2. Apply probability and statistical models to analyze signal and network data.
3. Implement supervised and unsupervised machine learning algorithms for communication problems.
4. Use big data tools and time-series analytics for large-scale communication datasets.
5. Design and evaluate advanced data science solutions in wireless, IoT, and next-generation communication systems.

Textbooks

1. Joel Grus, *Data Science from Scratch: First Principles with Python*, O'Reilly, 2019.
2. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, 3rd Edition, O'Reilly, 2022.
3. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, *An Introduction to Statistical Learning with Applications in R*, Springer, 2nd Edition, 2021.

References

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, MIT Press, 2016.
2. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly, 2016.
3. Thomas M. Cover, Joy A. Thomas, *Elements of Information Theory*, Wiley, 2nd Edition, 2006.
4. Mehdi Bennis, Mérouane Debbah, and H. Vincent Poor, *Machine Learning and Wireless Communications*, Cambridge University Press, 2021.

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1: Demonstrate understanding of data science fundamentals and apply preprocessing techniques to communication datasets	H	M	H	M	M	L
CO2: Apply probability and statistical models to analyze signal and network data	H	H	H	M	M	L
CO3: Implement supervised and unsupervised machine learning algorithms for communication problems	M	M	H	H	H	M
CO4: Use big data tools and time-series analytics for large-scale communication datasets	M	H	H	H	H	M
CO5: Design and evaluate advanced data science solutions in wireless, IoT, and next-generation communication systems	H	H	H	H	H	M



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II Semester	Advanced Communications Lab	L	T	P	C
		0	1	2	2

COURSE OBJECTIVES:

1. To demonstrate practical implementation of analog and digital modulation techniques.
2. To simulate and analyze communication systems using modern tools and platforms.
3. To apply error control coding methods for reliable data transmission.
4. To understand wireless channel behavior through real-time experiments.
5. To evaluate performance metrics of communication systems using hardware and software tools.

List of Experiments:

- A. Minimum of 10 Experiments have to be conducted.
- B. All Experiments may be Simulated using MATLAB and to be verified using related training kits.
 1. Measurement of Bit Error Rate using Binary Data
 2. Verification of minimum distance in Hamming code
 3. Determination of output of Convolutional Encoder for a given sequence
 4. Determination of output of Convolutional Decoder for a given sequence
 5. Efficiency of DS Spread- Spectrum Technique
 6. Simulation of Frequency Hopping (FH) system
 7. Effect of Sampling and Quantization of Digital Image
 8. Verification of Various Transforms (FT / DCT/ Walsh / Hadamard) on a given Image (Finding Transform and Inverse Transform)
 9. Point, Line and Edge detection techniques using derivative operators.
 10. Implementation of FIR filter using DSP Trainer Kit (C-Code/ Assembly code)
 11. Implementation of IIR filter using DSP Trainer Kit (C-Code/ Assembly code)
 12. Determination of Losses in Optical Fiber
 13. Observing the Waveforms at various test points of a mobile phone using Mobile Phone Trainer
 14. Study of Direct Sequence Spread Spectrum Modulation & Demodulation using CDMA-DSS-BER Trainer
 15. Study of ISDN Training System with Protocol Analyzer
 16. Characteristics of LASER Diode.



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COURSE OUTCOMES:

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

CO1: Demonstrate the measurement and evaluation of error control techniques including Bit Error Rate (BER), Hamming codes, convolutional codes, and spread spectrum systems.

CO2: Apply digital signal processing concepts to implement and analyze FIR/IIR filters, quantization effects, image transforms, and edge detection techniques.

CO3: Analyze and evaluate optical communication parameters including fiber losses and characteristics of optical sources such as LASER diodes.

CO4: Operate and examine modern communication trainers such as Mobile Phone Trainer, DSSS/CDMA systems, ISDN systems, and verify system functionalities through waveform analysis.

CO5: Integrate theoretical knowledge with practical experiments to simulate, test, and interpret results of digital, optical, and wireless communication systems for real-world applications.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	H	L	M
CO2	H	H	H	M	L	M
CO3	H	H	M	H	M	L
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H



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COURSE OUTCOMES:

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

1. **Describe** the architecture of IoT systems and explain the role of physical components such as sensors, actuators, microcontrollers, and transducers.
2. **Develop** basic programs and circuits using Arduino IDE and simulate simple systems using tools like Scratch, S4A, and Tinkercad.
3. **Implement** digital and analog I/O operations and interface Arduino with sensors, actuators, and display modules.
4. **Design** mobile applications using MIT App Inventor and control hardware through custom apps.
5. **Work with** NodeMCU for IoT connectivity and publish sensor data to cloud platforms such as ThingSpeak and Blynk.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	H	M	M	H	L
CO2	L	H	H	L	H	M
CO3	L	H	H	M	H	M
CO4	L	M	H	M	H	H
CO5	M	M	H	H	H	M



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II Semester	SEMINAR-II	L	T	P	C
		0	0	2	2



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III Semester	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To understand the concept of a research problem and methods for its investigation.
2. To develop skills in literature review, plagiarism detection, and research ethics.
3. To learn techniques for technical writing and research proposal preparation.
4. To gain foundational knowledge of Intellectual Property Rights (IPR) and patenting processes.
5. To explore new developments in IPR, including applications in software, biology, and traditional knowledge.

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 proposal, a presentation and assessment by a review committee.

UNIT-III: Nature of Intellectual Property: Patents, Designs, Trademarks 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.

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

UNIT-V:

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.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students".
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

REFERENCES:

1. Ranjit Kumar, 2nd Editio , "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
3. Mayall, "Industrial Design", McGraw Hill,1992.
4. Niebel , "Product Design", McGraw Hill,1974.
5. Asimov, "Introduction to Design", Prentice Hall,1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age",2016.
- 7.T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand,2008



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COURSE OUTCOMES:

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

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	M	M	L	L
CO2	H	H	H	M	M	L
CO3	M	M	M	H	L	H
CO4	M	M	L	H	L	M
CO5	M	M	L	H	M	M



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III Semester	SUMMER INTERNSHIP/INDUSTRIAL TRAINING	L	T	P	C
		0	0	0	3



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III Semester	Comprehensive Viva [#]	L	T	P	C
		0	0	0	2



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III Semester	Dissertation Part– AS	L	T	P	C
		0	0	20	10



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IV Semester	Dissertation Part– B%	L	T	P	C
		0	0	32	16