JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India
R25 M.Tech ELECTRONICS & COMMUNICATION ENGINEERING
COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

Vision and Mission of the University

VISION

The University is primarily promoting quality of education in the areas of Science, Technology, Engineering and Mathematics (STEM) as four academic pillars of education, to excel in teaching, learning, research, consultancy and placements through innovative practices with global perspective.

MISSION

Design an Industry relevant curriculum from time to time with a Global perspective Promoting quality education by embracing ICT delivery mechanism with continuous pedagogy through e-learning mechanism Spread across for industry collaborations with a focus to pre-training and placements for technology transfer to society Establishing centers of excellence to promote research and innovations in multidisciplinary areas to bring in patent culture and consultancy practices International Collaborations for student outreach Facilitating international students to study in JNTUK to infuse cross culture learning practices.

Vision and Mission of the Institute

Vision and Mission of the Department

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

I - Semester

S. No.	Course Name	Teaching Scheme			Credits
		L	T	P	
1	Mathematical Foundation for Communication Engineering	3	1	0	4
2	Digital Data Communications	3	1	0	4
3	IoT & its Communication Protocols	3	1	0	4
4	**Elective I** 1. Satellite Communication 2. Optical Communication & Networks 3. Software Defined Radio	3	0	0	3
5	**Elective II** 1. Wireless LANs and PANs 2. Mobile Networks 3. Network Security & Cryptography	3	0	0	3
6	Digital Data Communications Laboratory	0	1	2	2
7	Internet of Things Lab	0	1	2	2
8	Seminar – 1	0	0	2	1
	Total Credits	**15**	**5**	**6**	**23**

List of Professionals Elective Courses in I Semester (Electives-I&II)

S. No	Course Title
1	Satellite Communication
2	Optical Communication & Networks
3	Software Defined Radio
4	Wireless LANs and PANs
5	Mobile Networks
6	Network Security & Cryptography

@Minimum 2/3 themes per elective

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II - Semester

S. No.	Course Code	Name of the Subject	Teaching Scheme			Credits
			L	T	P	
1.	Core 4	Mobile Cellular Communication (Including 5G & B5G)	3	1	0	4
2.	Core 5	Detection and Estimation Theory	3	1	0	4
3.	Core 6	Computer Networks	3	1	0	4
4.	Prog. Specific Elective	**Elective III** 1. Cognitive Radio 2. OFDM & MIMO Techniques 3. Smart Antennas and Beam forming Techniques	3	0	0	3
5.	Prog. Specific Elective	**Elective IV** 1. Information Theory and Coding 2. EMI/EMC 3. Radio and Navigational Aids	3	0	0	3
6.	Lab 3	Advanced Communications Lab	0	1	2	2
7.	Lab 4	Computer Networks Lab	0	1	2	2
8.		Seminar-2	0	0	2	1
Total Credits			**15**	**5**	**6**	**23**

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

S. No	Course Title
1	Cognitive Radio
2	OFDM & MIMO Techniques
3	Smart Antennas and Beam forming Techniques
4	Information Theory and Coding
5	EMI/EMC
6	Radio and Navigational Aids

@Minimum 2/3 themes per elective

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III - Semester

S. No.	Subject	Teaching Scheme			Credits
		L	T	P	
1.	Research Methodology and IPR/ Swayam 12-week MOOC course – RM&IPR	3	0	0	3
2.	Summer Internship / Industrial Training (8-10 weeks) *	-	-	-	3
3.	Comprehensive Viva#	-	-	-	2
4.	Dissertation Part – A$	0	0	20	10
5.	**Total**	**3**	**0**	**20**	**18**

*Student attended during summer / year break and assessment will be done in 3rd sem.
Comprehensive viva can be conducted courses completed up to second sem.
$ Dissertation – Part A, internal assessment

M.Tech (COMMUNICATION SYSTEMS) IV - Semester

S. No.	Course Code	Subject	Teaching Scheme			Credits
			L	T	P	
1	Dissertation	Dissertation Part – B%	--	--	32	16
	Total Credits		--	--	32	**16**

% External Assessment

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

Course Outcomes:

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

1. Apply statistical methods including point estimation, confidence intervals, and hypothesis testing to real-world data scenarios.
2. Model and analyse stochastic systems using random processes, random walks, and Markov chains.
3. Solve engineering and scientific problems using numerical techniques such as Newton-Raphson, interpolation methods, and Runge-Kutta for differential equations.
4. Perform optimization tasks with or without constraints using gradient-based techniques and understand the role of Lagrange multipliers.
5. Use wavelet transforms to analyse signals and data with applications in compression and resolution enhancement.

COURSE OBJECTIVES:

1. Understand foundational concepts of probability, sampling distributions, estimation, and hypothesis testing for statistical data analysis.
2. Develop analytical skills to handle random processes and Markov chains essential in stochastic modelling and simulation.
3. Acquire computational techniques for solving numerical problems involving interpolation, root finding, ODEs, and eigen value problems.
4. Explore mathematical optimization through multivariable calculus, constrained optimization techniques, and numerical methods.
5. Introduce wavelet transform concepts and their application to multi-resolution analysis in data and signal processing.

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.

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 Runga-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. Gibert Strang," Linear Algebra and its applications", Thomson Learning Inc, 4th Edition.

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.

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I Semester	DIGITAL DATA COMMUNICATIONS	L	T	P	C
		3	1	0	4

COURSE OUTCOMES:

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

1. Analyse and compare digital modulation techniques such as BPSK, QPSK, QAM, and their impact on bandwidth and signal recovery.
2. Demonstrate knowledge of data communication principles, protocol layers, UART/USB interfaces, and network models like OSI and TCP/IP.
3. Apply error detection and correction methods (VRC, CRC, Hamming code) and explain link-layer protocols like bit- and character-oriented ones.
4. Understand and differentiate multiplexing and switching techniques and describe various LAN/MAN technologies and interfacing devices.
5. Explain and evaluate multiple access schemes (FDMA, TDMA, CDMA, OFDM), and random and controlled access protocols such as CSMA and token passing.

COURSE OBJECTIVES:

1. Understand various digital modulation techniques including PSK, QAM, and DPSK, along with bandwidth and synchronization requirements.
2. Introduce the fundamentals of data communication systems, network protocols, transmission media, and interface standards.
3. Explore error detection and correction techniques and study data link layer protocols and control mechanisms.
4. Provide insights into multiplexing techniques, LAN/MAN architectures, and switching methodologies in communication networks.
5. Familiarize students with multiple access techniques and channel access protocols used in modern communication systems.

UNIT -I: Digital Modulation Schemes:

BPSK, QPSK, 8PSK, 16PSK, 8QAM, 16QAM, DPSK – Methods, Band Width Efficiency, Carrier Recovery, Clock Recovery.

UNIT -II: Basic Concepts of Data Communications, Interfaces and Modems:

Data Communication Networks, Protocols and Standards, UART, USB, Line Configuration, Topology, Transmission Modes, Digital Data Transmission, DTE-DCE interface, Categories of Networks – TCP/IP Protocol suite and Comparison with OSI model.

UNIT -III: Error Correction: Types of Errors, Vertical Redundancy Check (VRC), LRC, CRC, Checksum, Error Correction using Hamming code Data Link Control: Line Discipline, Flow Control, Error Control, Data Link Protocols: Asynchronous Protocols, Synchronous Protocols, Character Oriented Protocols, Bit-Oriented Protocol, Link Access Procedures.

UNIT -IV:

Multiplexing: Frequency Division Multiplexing (FDM), Time Division Multiplexing (TDM), Multiplexing Application, DSL. Local Area Networks: Ethernet, Other Ether Networks, Token

Bus, Token Ring, FDDI. Metropolitan Area Networks: IEEE 802.6, SMDS. Switching: Circuit Switching, Packet Switching, Message Switching. Networking and Interfacing Devices: Repeaters, Bridges, Routers, Gateway, Other Devices.

UNIT -V: Multiple Access Techniques:

Frequency- Division Multiple Access (FDMA), Time - Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), OFDM and OFDMA. Random Access, Aloha- Carrier Sense Multiple Access (CSMA)- Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA), Controlled Access- Reservation- Polling- Token Passing, Channelization.

TEXTBOOKS:

1.Data Communication and Computer Networking - B. A.Forouzan, 2nd Ed., 2003, TMH.
2.Advanced Electronic Communication Systems - W. Tomasi, 5th Ed., 2008, PEI.

REFERENCE BOOKS:

1.Data Communications and Computer Networks - Prakash C. Gupta, 2006, PHI.
2.Data and Computer Communications - William Stallings, 8th Ed., 2007, PHI.
3.Data Communication and Tele Processing Systems -T. Housely, 2nd Ed, 2008, BSP.
4.Data Communications and Computer Networks- Brijendra Singh, 2ndEd., 2005, PHI.

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I Semester	IOT AND ITS COMMUNICATION PROTOCOLS	L	T	P	C
		3	1	0	4

COURSE OUTCOMES:

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

1. Understand the fundamental components and architecture of iot systems
2. Interpret and apply various iot reference architectural views
3. Analyze data link and network layer protocols used in iot communication
4. Evaluate transport and session layer protocols for their suitability in iot applications
5. Assess iot service layer and security protocols to ensure interoperability and secure

Communication

COURSE OBJECTIVES:

1. Introduce the core architecture and technologies of IoT**,** including devices, gateways, networking, data management, and services.
2. Familiarize students with IoT reference architectures, views, and the design constraints encountered in real-world implementations.
3. Understand data link and network layer protocols that support communication in IoT systems, including both traditional and IoT-specific protocols.
4. Explore transport and session layer protocols essential for reliable and efficient data transfer in IoT communication models.
5. Explain service layer and security protocols used in IoT systems, emphasizing interoperability and secure communication.

UNIT-I: Introduction: IoT architecture outline, standards - IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics

UNIT-II: IoT Reference Architecture: Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints

UNIT-III: IoT Data Link Layer & Network Layer Protocols: PHY/MACLayer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4,IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP

UNIT-IV: IoT Transport & Session Layer Protocols: Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT

UNIT-V:IoT Service Layer Protocols & Security Protocols: Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC802.15.4, 6LoWPAN, RPL, Application Layer

TEXTBOOKS:

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications ,2016
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2015

REFERENCE BOOKS:

1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things",ISBN 978-3-642 19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

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I Semester	SATELLITE COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

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

1. Explain the architecture, applications, advantages, and limitations of satellite communication and identify appropriate frequency bands.
2. Perform orbital analysis by applying Kepler's laws and calculating parameters like orbital period, velocity, apogee, and perigee.
3. Describe the roles and functions of satellite sub-systems, including telemetry, AOCS, power management, and antenna configuration.
4. Analyse the impact of environmental and astronomical phenomena (e.g., eclipses, sun outages, Doppler shift) and apply appropriate mitigation strategies.
5. Design a basic satellite link budget, perform C/N ratio calculations, and evaluate the use of modulation and multiple access methods through practical case studies (e.g., GPS, DBS-TV, VSAT).

COURSE OBJECTIVES:

1. Introduce the architecture and fundamentals of satellite communication systems, their history, applications, and frequency usage.
2. Develop an understanding of orbital mechanics, satellite motion, and calculations related to orbital parameters.
3. Explore the various sub-systems in satellite communication, including TTC&M, AOCS, communication, power, and antenna systems.
4. Analyse natural phenomena affecting satellite communication, such as solar eclipses, sun transit outages, and Doppler effects.
5. Provide knowledge of satellite link budgets, noise calculations, modulation, access techniques, and real-world case studies like VSAT, GPS, and LEO-based systems.

UNIT-I: Architecture of Satellite Communication System: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks.

UNIT-II: Orbital Analysis: Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc of a satellite, concepts of Solar day and Sidereal day.

UNIT-III: Satellite sub-systems: Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems, antenna sub-system.

UNIT-IV: Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.

UNIT-V: 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.

TEXTBOOKS:

1.Timothy Pratt and Others, "Satellite Communications", Wiley India, 2nd edition,2010.

2.S. K. Raman, "Fundamentals of Satellite Communication", Pearson Education India, 2011.

REFERENCE BOOKS:

1. Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.

2. Dennis Roddy, "Satellite Communication", McGraw Hill, 4th Edition, 2008.

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I Semester	OPTICAL COMMUNICATION AND NETWORKS	L	T	P	C
		3	0	0	3

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.

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.

REFERENCE BOOKS:

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

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I Semester	SOFTWARE DEFINED RADIO	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

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

1.Understand the fundamentals of Software Radios, their evolution from traditional radios, and the various levels including SCR, SDR, ISR, and USR.
2. Analyze RF front-end architectures, dynamic range requirements, and the role of RF components in system performance for Software Radio implementation.
3. Explain and compare different signal generation techniques including direct digital synthesis, and analyze sources of spurious components and jitter effects.
4. Apply multi-rate signal processing techniques such as sample rate conversion, polyphase filtering, and digital filter banks in software radio systems.
5.Evaluate the performance of A/D and D/A converters in practical systems, and describe methods to improve conversion performance, including relevance to JTRS

COURSE OBJECTIVES:

1. Introduce the evolution of radio communication systems and the fundamental concepts, architectures, and design principles of Software Defined Radio (SDR).
2. Understand the implementation challenges in RF front-end systems, including dynamic range, receiver topologies, and performance-affecting factors.
3. Explore digital signal generation techniques, particularly direct digital synthesis (DDS), and analyze related spurious signal behaviors.
4. Introduce multirate signal processing methods such as sample rate conversion, polyphase filters, and timing recovery in digital receivers.
5. Study analog-to-digital and digital-to-analog conversion techniques and methods for improving data converter performance in SDR systems.

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: Multi-rate Signal Processing: Introduction, Sample Rate Conversion Principles, Polyphase Filters, Digital Filter Banks, Timing Recovery in Digital receivers Using Multi-rate 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:

1.Jeffery H. Reed, “Software Radio, (A modern approach to radio engineering)”, PHI PTR, 2002.
2.John J. Rouphael, “RF and Digital Signal Processing for Software Defined Radio” Elsevier, Newness Publications.

REFERENCE BOOKS:

1.C. Richard Johnson, Jr., and William A. Sethares, Telecommunication Breakdown, Prentice Hall, ISBN 0-13-143047-5, 2004.
2.Software Defined Radio: Architectures, Systems and Functions"Author:Walter Tuttlebee Publisher**:** Wiley

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I Semester	WIRELESS LANs and PANs	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

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

1. Differentiate among WLANs, PANs, and related technologies, and analyse wireless channel characteristics and application-specific design requirements.
2. Describe and evaluate the IEEE 802.11 architecture, MAC protocols, and QoSenhancements, including various 802.11 standards and roaming mechanisms.
3. Assess WLAN security mechanisms and performance parameters and explain enhancements in modern standards such as Wi-Fi 6 and 6E.
4. Analyse Bluetooth architecture and protocols, including BLE roles, profiles, and security features within IEEE 802.15.1.
5. Compare PAN technologies like Zigbee, UWB, and NFC, and assess their suitability for various IoT applications based on performance and range.

COURSE OBJECTIVES:

1. Introduce the fundamentals of WLANs and PANs, including wireless channel characteristics and design considerations for different application domains.
2. Explore IEEE 802.11 WLAN architectures, MAC protocols, and standards evolution from 802.11a to 802.11ax, with attention to mobility and QoS.
3. Understand WLAN security protocols and performance metrics, including interference management and recent advancements like Wi-Fi 6/6E.
4. Explain Bluetooth and IEEE 802.15.1 standards, BLE architecture, communication modes, and security features for short-range communication.
5. Provide insights into other PAN technologies such as Zigbee, UWB, NFC, and their applications in IoT environments.

UNIT I – Fundamentals of WLANs and PANs

Introduction to Wireless Personal and Local Area Networks, Differences: WLANs, PANs, WPANs, WWANs, Wireless channel characteristics: interference, fading, path loss, WLAN/PAN design considerations: coverage, throughput, scalability, Applications in home, healthcare, industrial, and vehicular domains.

UNIT II – IEEE 802.11 Wireless LANs

IEEE 802.11 architecture and services, MAC layer: CSMA/CA, DCF, PCF, Frame formats, inter-frame spacing, RTS/CTS, 802.11a/b/g/n/ac/ax standards, Mobility support and roaming, QoS enhancements: IEEE 802.11e

UNIT III – Security and Performance in WLANs

Security in WLANs: WEP, WPA, WPA2, WPA3, Authentication and encryption techniques, Wireless intrusion detection, Performance analysis: throughput, delay, capacity, Coexistence and interference management, Wi-Fi 6 and 6E: overview and enhancements

UNIT IV – Bluetooth and IEEE 802.15.1

Bluetooth architecture: piconet, scatternet, Protocol stack and operation modes, Bluetooth Low Energy (BLE): roles and communication models, Profiles: A2DP, HID, GATT, ATT, IEEE 802.15.1 standards and enhancements, Security features and vulnerabilities.

UNIT V – Other PAN Technologies: Zigbee, UWB, NFC

IEEE 802.15.4 and Zigbee protocol stack, Zigbee device types and network topologies, UWB (IEEE 802.15.3): high data rate applications, Near Field Communication (NFC) and RFID basics, Comparison: Bluetooth vs Zigbee vs UWB vs NFC, IoT applications using PANs.

TEXT BOOKS

1.Behrouz A. Forouzan, Data Communications and Networking, McGraw Hill, 5th Edition.
2.Mark Ciampa, Security+ Guide to Network Security Fundamentals, Cengage Learning, 6th Edition.
3. Kaveh Pahlavan & Prashant Krishnamurthy, Principles of Wireless Networks, Pearson Education.

REFERENCE BOOKS:

1.William Stallings, Wireless Communications and Networks, Pearson Education.
2.Deepti Gupta, Wireless and Mobile Networks: Concepts and Protocols, PHI.
3.Bluetooth SIG Documents: https://www.bluetooth.com/specifications
4.IEEE 802.11, 802.15 standards: https://standards.ieee.org
5.Zigbee Alliance Resources: https://csa-iot.org

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I Semester	MOBILE NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:
By the end of this course, students will:

1. Understand the architecture, standards, and protocols of various wireless area networks including WPAN, WLAN, and WiMAX.
2. Gain insights into wireless wide area network technologies such as GSM, CDMA, and 3G systems, and understand their underlying principles like spread spectrum.
3. Comprehend the functioning of IP-based wireless networks, mobile IP, and the implications of mobility on higher-layer protocols like TCP.
4. Explore wideband wireless technologies like UWB and compare their advantages/disadvantages with traditional systems.
5. Analyse the characteristics, protocols, and challenges of Adhoc networks and understand the core technologies underpinning 4G systems such as LTE, OFDM, MIMO, and cognitive radio.

UNIT I: Wireless Area Networks and Standards

Overview of WPAN: IEEE 802.15 (Bluetooth, RFID, Zigbee, WBAN), WLAN (IEEE 802.11), WiMAX (IEEE 802.16) protocols and architectures, Bluetooth network architecture, operation, applications, RFID and Zigbee specifications, WLAN physical and MAC layer mechanisms (CSMA/CA, WiFi MAC), wideband access (802.11n/ac), energy efficiency, WiMAX: Broadband Wireless Access, issues and challenges, comparison with IEEE 802.11.

UNIT II: Wireless Wide Area Networks

GSM, 3G, and Evolution, spread spectrum, CDMA (IS 95 to CDMA 2000), WCDMA, system processing gain, types of spread spectrum systems, power control in CDMA, uplink/downlink (BS to MS, MS to BS).

UNIT III: Wireless Internet and Mobility Management

IP for wireless networks, mobile IP, IPv6 advancements, mobility management functions (location management, handoffs, registration), impact of mobility on TCP, types of TCP in wireless, wireless security standards.

UNIT IV: Wideband Wireless Technologies

UWB Radio Communication, fundamentals, major issues, operation, comparisons with other technologies, advantages and disadvantages.

UNIT V: Adhoc Wireless Networks and 4G Technologies

Characteristics of Adhoc networks, MAC protocols (table-driven, on-demand), routing protocols (DSDV, AODV, DSR, Hybrid), 4G technologies, features, challenges, LTE (FDD vs TDD), smart antennas, OFDM-MIMO systems, adaptive modulation, software-defined radio, cognitive radio.

TEXT BOOKS:

1.Theodore Rappaport —Wireless Communication, Prentice Hall, 2nd Edition.
2.William Stallings —Wireless Communications and Networks, Prentice Hall.
3.Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”,John Wiley & Sons.

REFERENCE BOOKS:

1.Schwartz —Mobile Wireless Communications, Cambridge University Press.
2.Mark and Zhuang —Wireless Communications and Networking, Prentice Hall.
3.Vijay Garg K, “Wireless Communications and Networks”, 2ndEdition, Morgan Kaufmann Publishers (Elsevier), 2007.

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R25 M.Tech ELECTRONICS & COMMUNICATION ENGINEERING
COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

I Semester	NETWORK SECURITY AND CRYPTOGRAPHY	L	T	P	C
		3	0	0	3

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.

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 cifers.

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.

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.

TEXT BOOKS:

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.

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

I Semester	DIGITAL DATA COMMUNICATIONS LABORATORY	L	T	P	C
		0	1	2	2

COURSE OUTCOMES:

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

1. Demonstrate the working of serial and parallel communication interfaces like RS-232 and parallel ports.
2. Establish and verify communication between PCs using LAN and understand network topologies.
3. Configure and operate basic networking hardware such as modems, hubs, and switches.
4. Identify and interconnect appropriate cables and connectors used in data communication.
5. Set up and analyse a basic wireless communication system.

COURSE OBJECTIVES:

The course aims to:

1. Introduce students to the basic hardware components and interfaces used in data communication such as serial and parallel ports, modems, and switches.
2. Enable students to practically understand LAN setup, topologies, and PC-to-PC communication using various techniques.
3. Develop skills in configuring and using networking devices such as hubs, switches, and modems.
4. Demonstrate different types of communication systems including wireless, fiber optics, and time division multiplexing.
5. Foster hands-on experience in analyzing and implementing data communication techniques and technologies.

List of Experiments:

1. Study of serial interface RS – 232
2. Study of pc-to-pc communication using parallel port
3. To establish pc-pc communication using LAN
4. Study of LAN using star topology, bus topology and tree topology
5. Study and configure modem of a computer.
6. To configure a hub/switch
7. To study the interconnections of cables for data communication.
8. Study of a wireless communication system
9. Set up of time division multiplexing using Fiber optics.
10. Digital Fiber Optical Transmitter and Receiver.

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

I Semester	INTERNET OF THINGS LABORATORY	L	T	P	C
		0	1	2	2

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 Tinker cad.
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.

Work with Node MCU for IoT connectivity and publish sensor data to cloud platforms such as Thing Speak and Blynk.

COURSE OBJECTIVES:

The course aims to:

1. Introduce the fundamental concepts of IoT architecture, physical layer devices, and microcontrollers like Arduino and NodeMCU.
2. Provide hands-on experience with interfacing various sensors, actuators, and display modules with Arduino.
3. Familiarize students with simulation and development tools like Tinkercad, Scratch for Arduino (S4A), Arduino IDE, and MIT App Inventor.
4. Enable students to collect, process, and display sensor data and control hardware using mobile applications and cloud platforms.
5. Empower learners to implement simple IoT-based applications like home automation, alerts, and remote monitoring using ThingSpeak and Blynk.

List of Experiments:

1. Introduction to IoT, IoT Architecture, introduction to Physical layer
2. Introduction to sensors, actuators, and transducers. Introduction to microcontrollers and microprocessors
3. Introduction to Arduino. Introduction to Scratch programming, S4A tool, and Arduino IDE.
4. Introduction to Tinker cad and some practical examples
5. Working with analog, digital inputs & outputs
6. Interfacing Arduino with Embedded sensors and Actuators
7. Interfacing Arduino with additional sensors
8. Working on Displays and interfacing with Arduino
9. Arduino & LCD Based Projects
10. Arduino interfacing with Keypad and its operation

11. Creating the app (app designing using MIT) and controlling your hardware with your app.
12. Introduction to NodeMCU and basic tasks
13. Introduction to Cloud, some IoT Cloud Platforms publishing sensor data to a cloud using Thing speak
14. Controlling your sensor data using Thing speak and MIT APP Inventor
15. Email notifications, app alerts using Blynk cloud
16. Home Automation Using Blynk app

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

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

II Semester	MOBILE CELLULAR COMMUNICATIONS (INCLUDING 5G &B5G)	L	T	P	C
		3	1	0	4

COURSE OUTCOMES:

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

1. Explain the evolution and fundamentals of mobile and cellular communication systems, including multiple access schemes and mobile communication technologies.
2. Analyze cellular geometry concepts, frequency reuse, and various techniques such as cell splitting, sectoring, and microcell/picocell implementation to enhance coverage and capacity.
3. Compare and evaluate different MAC techniques (FDMA, TDMA, CDMA) based on their capacity and spectral efficiency in wireless communication.
4. Demonstrate understanding of wireless technologies up to 4G, including 3G and 4G interfaces, limitations, and advantages, along with smart antenna techniques.
5. Describe and analyze the architecture, operation, and key specifications of 5G communication systems, including error correction techniques and technical advancements over previous generations.

COURSE OBJECTIVES:

The course aims to:

1. Introduce the evolution and fundamentals of mobile and cellular communication systems, including analog and digital technologies.
2. Explain the concepts of cellular geometry, frequency reuse, and techniques for enhancing network capacity and coverage such as cell splitting and sectoring.
3. Provide understanding of multiple access techniques (FDMA, TDMA, CDMA) and analyse their spectral efficiencies and capacity in wireless systems.
4. Explore the technological progression from 2G to 4G, with an emphasis on 3G air interface technologies, limitations, advantages, and smart antenna techniques.
5. Introduce the principles, features, and key specifications of 5G technologies, and discuss their advancements and error correction mechanisms.

UNIT-I: Introduction to Mobile and Cellular Communication Systems

Introduction to Mobile and Cellular Communication Systems, Generations of wireless mobile systems, Cellular Geometry, Introduction to cellular concept, Principle of Operation of a Cellular Mobile system, Call transfer operation to/from one mobile phone to another mobile, Analog and Digital Cellular Mobile Systems, Multiple Access Schemes, Existing Mobile Communication Technologies.

UNIT-II: Cellular Geometry, Frequency Reuse, Cell Splitting and Sectoring

Introduction, Cellular Geometry, Frequency Reuse, Improving Coverage and Capacity in Cellular Systems, Cell Splitting, Sectoring, Range Extension by the use of Repeaters, Microcell Zone concept, Picocell Zone Concept.

UNIT-III: MAC Techniques and Spectral Efficiencies
Multiple Access Techniques for Wireless Communication and Advanced Transceiver Schemes, capacity and spectral Efficiency of FDMA, TDMA and CDMA.

UNIT-IV: Wireless Generations Technologies up to 3G and 4G
3G Air interface technologies, 3G spectrum, Internet Speeds of 2G, 2.5G and 3G Technologies, Limitations of 3G, CDMA, CDMA2000, WCDMA, Comparison of WCDMA and CDMA2000. 4G Evolution, Objectives of the projected 4G, Advantages of 4G network technology over 3G, Applications of 4G, 4G Technologies, Smart Antenna Techniques and Limitations of 4G.

UNIT-V: 5G Communications
Introduction, Principle of operation of 5G Technology, Key parameters and Technical Specifications of 5G, Description of 5G technologies, 5G cellular system Error Correction Techniques.

TEXT BOOKS:

1.Gottapu Sasibhushana Rao, Raj Kumar Goswami, M.N.V.S.S Kumar "Mobile and Cellular Communication (Including 5G & Beyond and Microstrip Antennas)", Paramount Book Distributors, 2025

2. Wireless Communications: Principles and Practice by Theodore S. Rappaport

REFERENCE BOOKS:

1."Wireless Communications: From Fundamentals to Beyond 5G" by Andreas F. Molisch, published by Wiley (IEEE Press) 8 December 2022.

2.N. Ojaroudi Parchin, Ed., 'Advanced Wireless Communications and Mobile Networks – Current Status and Future Directions'. IntechOpen, May 29, 2025. doi:10.5772/intechopen. 1006224.

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

II Semester	DETECTION AND ESTIMATION THEORY	L	T	P	C
		3	1	0	4

COURSE OUTCOMES:

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

1. Demonstrate understanding of random processes, including discrete linear models, Markov processes, point processes, and Gaussian processes relevant to signal processing.
2. Apply detection theory to solve problems using MAP, Bayes, and Neyman-Pearson decision rules for both binary and multiple hypothesis testing.
3. Develop and analyze linear and nonlinear minimum mean square error (MMSE) estimators, and design digital Wiener and Kalman filters for signal estimation.
4. Estimate and interpret statistical parameters and distributions using point estimation, nonparametric methods, interval estimates, hypothesis testing, and linear regression models.
5. Evaluate stationarity and ergodicity of random processes and perform both model-free and model-based estimation of autocorrelation and power spectral density functions from data.

COURSE OBJECTIVES:

The course aims to:

1. To introduce fundamental concepts of random processes including Markov models, point processes, and Gaussian processes.
2. To develop understanding of detection theory using Bayesian and Neyman-Pearson approaches for signal classification under uncertainty.
3. To explore MMSE estimation techniques such as Wiener and Kalman filters for linear and nonlinear systems.
4. To provide knowledge of statistical inference including hypothesis testing, distribution estimation, and regression analysis.
5. To enable parameter estimation of random processes using model-free and model-based approaches with spectral analysis tools.

UNIT –I: Random Processes: Discrete Linear Models, Markov Sequences and Processes, Point Processes, and Gaussian Processes.

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

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

UNIT –IV: Statistics: Measurements, Nonparametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.

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

TEXT BOOKS:

1. Steven M. Kay, "Fundamentals of Statistical signal processing, volume-1: Estimation theory". Prentice Hall 2011.
2. Steven M. Kay, "Fundamentals of Statistical signal processing, volume-2: Detection theory". Prentice Hall 2011.

REFERENCE BOOKS:

1. Harry L. Van Trees, "Detection, Estimation, and Modulation Theory, Part I," John Wiley & Sons, Inc. 2011.
2. A. Papoulis and S. Unnikrishna Pillai, "Probability, Random Variables and stochastic processes, 4e". The McGraw-Hill 2010.

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

II Semester	COMPUTER NETWORKS	L	T	P	C
		3	1	0	4

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.

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, Intrado main Routing Protocols, Interdo main 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.

TEXT BOOKS:

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 McGraw Hill

REFERENCE BOOKS:

1.High Speed Networks and Internets – Performance and Quality of Service, William Stallings, Second Edition, Pearson Education.
2. Top Down 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.

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

II Semester	COGNITIVE RADIO	L	T	P	C
		3	0	0	3

COURSEOUTCOMES:

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

1. Understand the fundamentals of cognitive radio and dynamic spectrum access.
2. Analyze spectrum sensing techniques and spectrum management policies.
3. Design the Wireless Networks Based on the Cognitive Radios.
4. Gives an Understanding of Cognitive Radio Architecture.
5. To Understand Concepts Behind Wireless Networks and Next Generation Networks

COURSE OBJECTIVES:

1. Understand the principles, characteristics, and applications of cognitive radio systems.
2. Study various spectrum sensing techniques and challenges in dynamic spectrum access.
3. Learn cognitive techniques like environment and position awareness in radios.
4. Explore cognitive radio architecture and its integration with software-defined radios.
5. Analyse the architecture and key spectrum functions of next-generation wireless networks.

UNIT I: Introduction to Cognitive Radio:

Definition and characteristics of cognitive radio, Cognitive radio vs. traditional radio systems, Cognitive cycle and functions, Dynamic spectrum access and spectrum holes, Regulatory aspects and spectrum policies, Applications and benefits of cognitive radio.

UNIT II: Spectrum Sensing and Measurement:

Spectrum sensing challenges, Energy detection, matched filter detection, cyclostationary feature detection, Cooperative spectrum sensing techniques, Wideband spectrum sensing, Sensing-throughput trade-off, Spectrum measurement and monitoring methods.

UNIT III: Introduction to Cognitive Radios:

Marking Radio Self -aware, Cognitive techniques – Position Awareness, Environment Awareness in Cognitive Radios, Optimization of Radio Resources, Artificial Intelligence Techniques.

UNIT IV: Cognitive Radio Architecture:

Cognitive Radio – Functions Components and Design Rules, Cognition Cycle – Orient, Plan Decide and act phases, Interface Hierarchy, Architecture Maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture.

UNIT V: Next Generation Wireless Networks:

The XG Network Architecture, Spectrum Sensing, Spectrum Management, Spectrum Mobility, Spectrum Sharing, Upper Layer Issues, Cross Layer Design.

TEXT BOOKS:

1. Joseph Mitola III, Software Radio Architecture: Object-Oriented Approaches to Wireless Systems Engineering, Wiley-IEEE Press, 2000.
2. Bruce A. Fette (Ed.), Cognitive Radio Technology, 2nd Edition, Elsevier, 2009.
3. Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou, Cognitive Radio Communications and Networks: Principles and Practice, Academic Press, 2010.

REFERENCE BOOKS:

1. Huseyin Arslan, Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.
2. Kwang-Cheng Chen, Ramjee Prasad, Cognitive Radio Networks,Wiley, 2009.
3. Markus Dillinger, Kambiz Madani, Nancy Alonistioti, *Software Defined Radio:* Architectures, Systems and Functions, Wiley, 2003.
4. Timothy J. Brown, Cognitive Radio Networks, Wiley, 2015.

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

II Semester	OFDM & MIMO TECHNIQUES	L	T	P	C
		3	0	0	3

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

1. Explain the principles of OFDM and its advantages in wireless communication systems.
2. Design and evaluate OFDM system components including FFT/IFFT, cyclic prefix, and synchronization.
3. Analyze MIMO system models and apply techniques like spatial diversity and multiplexing.
4. Apply advanced MIMO concepts such as beamforming, massive MIMO, and channel estimation.
5. Integrate OFDM and MIMO techniques for modern wireless applications like 5G and assess system performance.

COURSE OBJECTIVES:

1. Understand the fundamentals of OFDM and its significance in wireless communication.
2. Analyze and design OFDM systems including synchronization, channel estimation, and PAPR reduction.
3. Learn the principles and techniques of MIMO systems and their performance benefits.
4. Explore advanced MIMO technologies such as beamforming, massive MIMO, and precoding.
5. Study the integration of OFDM and MIMO for high-speed wireless communication in 5G and beyond.

UNIT-I. Introduction to OFDM
Basics of multicarrier modulation, Need for OFDM in wireless communication, Orthogonality of subcarriers, Mathematical representation of OFDM signals, IFFT and FFT implementation in OFDM, Spectral efficiency and bandwidth utilization, Cyclic prefix and its role in combating ISI, Time and Frequency domain representation, OFDM system model, Comparison with single carrier modulation.

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UNIT-II. OFDM System Design
Transmitter and receiver block diagrams, Pilot tones and channel estimation, Synchronization techniques (timing and frequency), PAPR in OFDM and reduction techniques, Equalization in OFDM systems, Error correction coding for OFDM, Subcarrier allocation strategies, Windowing, and filtering, OFDM performance in multipath fading channels, High Speed OFDM Packet Access (HSOPA), Applications of OFDM.

UNIT-III. Introduction to MIMO Systems

Concept of multiple antennas in wireless communication, MIMO channel models and representations, Spatial diversity and multiplexing gain, MIMO system capacity analysis, MIMO detection techniques, Channel state information and feedback, Space-time block coding (Alamouti scheme), Space-time trellis coding, Practical MIMO implementations.

UNIT-IV. Advanced MIMO Techniques

Beamforming principles and types, Multi-user MIMO systems, Massive MIMO concept and challenges, Precoding techniques (linear and nonlinear), Interference alignment, Hybrid beamforming for mmWave systems, Energy efficiency in MIMO systems, Channel estimation techniques for large MIMO arrays.

UNIT-V. OFDM-MIMO Integration and Applications

Combining OFDM with MIMO for high-speed communication, Spatial multiplexing in OFDM-MIMO systems, OFDM-MIMO channel estimation and equalization, Resource allocation in OFDM-MIMO networks, Link adaptation and adaptive modulation, Massive MIMO with OFDM in 5G and beyond, Challenges in OFDM-MIMO synchronization, Performance evaluation metrics, Case studies of OFDM-MIMO in 5G NR

TEXT BOOKS:

1. Gottapu Sasibhushana Rao, Raj Kumar Goswami, and MNVSS Kumar, "Mobile and Cellular Communication (Including 5G & Beyond and Microstrip Antennas", Paramount Book Distributors.
2. R. van Nee and R. Prasad, "OFDM for Wireless Multimedia Communications", Artech House.
3. MIMO-OFDM Wireless Communications With MATLAB."Yong Soo Cho, Chun-Ang University, Republic of Korea; Jaekwon Kim, Yonsei University, Republic of Korea; Won Young Yang, Chung-Ang University, Republic of Korea;Chung G.Kang, Korea University, Republic of Korea.

REFERENCE BOOKS:

1. Yong Soo Cho, Jaekwon Kim, Won Young Yang, Chung G. Kang, "MIMO-OFDM Wireless Communications with MATLAB", Wiley.
2. Richard Van Nee, Ramjee Prasad, "OFDM for Wireless Multimedia Communications", Artech House.
3. David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press.

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II Semester	SMART ANTENNAS AND BEAM FORMING TECHNIQUES	L	T	P	C
		3	0	0	3

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

1. Explain antenna fundamentals and measure key parameters using techniques like anechoic chamber testing.
2. Apply synthesis techniques to design antenna arrays with desired radiation characteristics.
3. Design microstrip antennas using cavity and transmission line models and implement advanced material-based designs.
4. Analyse antenna requirements for various communication systems including MIMO, SDR, cognitive radio, and radar.
5. Implement and evaluate adaptive beamforming algorithms such as MMSE, DMI, and LCMV for enhanced performance.

COURSE OBJECTIVES:
1. Understand radiation mechanisms and key antenna parameters for various applications.
2. Learn antenna array synthesis methods using mathematical tools like Fourier transform and Chebyshev techniques.
3. Analyse and design microstrip antennas and explore modern antenna design methods using artificial materials.
4. Explore integrated antenna applications in wireless, medical, military, and cognitive systems using numerical methods.
5. Study and apply classical and advanced beamforming algorithms for improved signal reception and interference suppression.

UNIT :1
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 –Schelkun off 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 GapDefective 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

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

UNIT - IV

Beam Forming Fundamentals: Classical Beam former, Statistically Optimum Beamforming Weight Vectors, Maximum SNR Beam former, Multiple Sidelobe Canceller and Maximum, SINR Beamformer, Minimum Mean Square Error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive Algorithms for Beamforming

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

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
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R25 M.Tech ELECTRONICS & COMMUNICATION ENGINEERING
COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

II Semester	INFORMATION THEORY AND CODING	L	T	P	C
		3	0	0	3

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.

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-Acousting 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.

TEXT BOOKS:

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

REFERENCE BOOKS:

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

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R25 M.Tech ELECTRONICS & COMMUNICATION ENGINEERING
COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

II Semester	EMI/EMC	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

At the end of this course the student can be able to:

1. Understand the electromagnetic environment the definitions of EMI and EMC, history of EMI some examples of practical experiences due to EMI such as mains power supply, switches and relays etc.
2. Understand the celestial electromagnetic noise the occurrence of lightning discharge and their effects, the charge accumulation and discharge in an electrostatic discharge, model ESD wave form, the various cases of nuclear explosion and the transients.
1. Understand the methods to measure RE and RS in the open are test sites
2. Understand the measurement facilities and procedures using anechoic chamber, TEM cell, reverberating chamber GTEM cell.
3. Apply grounding, shielding, bonding techniques, and design EMI filters for interference mitigation.

COURSE OBJECTIVES:

1. To introduce enough knowledge regarding the Electromagnetic interference/ Electromagnetic compatibility, Its practical experiences and concerns, and various sources both the natural and nuclear sources of EMI.
2. To know the practical experiences due to EMI such as mains power supply, switches and relaysetc and Analyse EM Propagation and Crosstalk
3. To know various methods of the measurements radiated and conducted interference in open area test sites and in chambers.
4. To Learn about the various methods of minimizing the EMI.
5. To know the National/International EMC Standards.

UNIT -I: Introduction, Natural and Nuclear Sources of EMI / EMC:
Electromagnetic environment, History, Concepts, Practical experiences and concerns, frequency spectrum conservations, An overview of EMI / EMC, Natural and Nuclear sources of EMI.

UNIT -II: EMI from Apparatus, Circuits and Open Area Test Sites:
Electromagnetic emissions, Noise from relays and switches, Non-linearities in circuits, passive intermodulation, Cross talk in transmission lines, Transients in power supply lines, Electromagnetic interference (EMI), Open area test sites and measurements.

UNIT -III: Radiated and Conducted Interference Measurements and ESD:
Anechoic chamber, TEM cell, GH TEM Cell, Characterization of conduction currents / voltages, Conducted EM noise on power lines, Conducted EMI from equipment, Immunity to conducted EMI detectors and measurements, ESD, Electrical fast transients / bursts, Electrical surges.

UNIT -IV: Grounding, Shielding, Bonding and EMI filters:
Principles and types of grounding, Shielding and bonding, Characterization of filters, Power lines filter design.

UNIT -V: **Cables, Connectors, Components and EMC Standards:**
EMI suppression cables, EMC connectors, EMC gaskets, Isolation transformers, optoisolators, National / International EMC standards.

TEXT BOOKS:

4. Engineering Electromagnetic Compatibility - Dr. V.P. Kodali, IEEE Publication, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.
5. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules 1-9

REFERENCE BOOKS:

1. Introduction to Electromagnetic Compatibility - Ny, John Wiley, 1992, by C.R. Pal.

2. EMC for Product Designers "Author: Tim Williams, Publisher: Newnes ,Edition: 5th Edition.

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R25 M.Tech ELECTRONICS & COMMUNICATION ENGINEERING

COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

II Semester	RADIO AND NAVIGATIONAL AIDS	L	T	P	C
		3	0	0	3

COURSEOUTCOMES:

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

1. Explain the principles, configurations, and error sources of terrestrial and radio positioning systems.
2. Apply various navigation methods to determine position and trajectory.
3. Analyze advanced satellite navigation techniques for accuracy enhancement.
4. Evaluate inertial navigation equations, alignment methods, and error propagation.
5. Integrate GNSS systems with error correction techniques for reliable navigation solutions.

COURSE OBJECTIVES:

1. Understand the principles and configurations of radio positioning systems and factors affecting positioning accuracy.
2. Explore terrestrial radio navigation systems including LORAN, ILS, and indoor/urban positioning technologies.
3. Introduce fundamental navigation concepts such as position fixing, dead reckoning, and integrated navigation systems.
4. Study advanced satellite navigation techniques including Differential GNSS and carrier-phase positioning.
5. Examine inertial navigation systems and their equations, alignment methods, and error propagation models.

UNIT I: Principles of Radio Positioning: Radio Positioning Configurations and Methods, Positioning Signals, User Equipment, Propagation, Error Sources, and Positioning Accuracy. Terrestrial Radio Navigation: Point-Source Systems, Loran, Instrument Landing System, Urban and Indoor Positioning, Relative Navigation, Tracking, Sonar Transponders.

UNIT II: Introduction To Navigation: What Is Navigation, Position Fixing, Dead Reckoning, Inertial Navigation, Radio and Satellite Navigation, Terrestrial Radio Navigation, Satellite Navigation, Feature Matching, The Complete Navigation System.

UNIT III: Advanced Satellite Navigation: Differential GNSS, Carrier-Phase Positioning and Attitude, Poor Signal-to-Noise Environments, Multipath Mitigation, Signal Monitoring, Semi Codeless Tracking.

UNIT IV: Inertial Navigation: Inertial-Frame Navigation Equations, Earth-Frame Navigation Equations, Local-Navigation-Frame Navigation Equations, Navigation Equations Precision, Initialization and Alignment, INS Error Propagation, Platform INS, Horizontal-Plane Inertial Navigation.

UNIT V: Satellite Navigation & GNSS Systems: Fundamentals: GPS, GLONASS, Galileo, Beidou, IRNSS, signal structure, measurement errors (ionospheric/tropospheric/multipath), Dilution of Precision (GDOP, PDOP), ephemeris, clock/correction errors, Differential GNSS, WAAS, integrity monitoring, carrier-phase techniques.

TEXT BOOKS:

1. G S RAO, Global Navigation Satellite Systems, McGraw-Hill Publications, New Delhi, 2010.
2. Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems, Paul D. Groves Artech House, 2008 and 2013 Second Edition.
3. 2. B. Hofmann Wollenhof, H. Lichtenegger, and J. Collins, "GPS Theory and Practice", Springer Wien, New York, 2000.

REFERENCE BOOKS:

1. Pratap Misra and Per Enge, "Global Positioning System Signals, Measurements, and Performance," Ganga-Jamuna Press, Massachusetts, 2001.
2. Ahmed El-Rabbany, "Introduction to GPS," Artech House, Boston, 2002.
3. Bradford W. Parkinson and James J. Spilker, "Global Positioning System: Theory and Applications," Volume II, American Institute of Aeronautics and Astronautics, Inc., Washington, 1996.

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

II Semester	ADVANCED COMMUNICATIONS LAB	L	T	P	C
		0	1	2	2

COURSE OUTCOMES:

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

1. Identify the different types of network devices and their functions within a network.
2. Understand and build the skills of sub-netting and routing mechanisms.
3. Understand basic protocols of computer networks, and how they can be used to assist in network design and implementation.

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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II Semester	COMPUTER NETWORKS LAB	L	T	P	C
		0	1	2	2

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.

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 Dijsktra'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
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

II Semester	SEMINAR-II	L	T	P	C
		0	0	2	1

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

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

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.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

COURSE OBJECTIVES:

1. To understand the fundamentals of research problems, their sources, and methods of investigation.
2. To develop skills in effective literature review, research ethics, and avoiding plagiarism.
3. To learn the techniques of technical writing, research proposal preparation, and presentation.
4. To understand various forms of Intellectual Property Rights and the patenting process.
5. To explore recent developments in IPR, including software, biological systems, 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 BOOKS:

1. Ranjit Kumar, 2nd Edition, "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 TechnologicalAge",2016.
7.T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand,2008

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COMMUNICATION SYSTEMS COURSE STRUCTURE & SYLLABUS

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

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

III Semester	Dissertation Part– A$	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