24EC617	ANTENNA AND WAVE PROPAGATION	PCC	L T P C 3 0 0 3
Prerequisite:	**24EC514**		

COURSE OBJECTIVES:

✓	To understand the fundamental principles and radiation mechanisms of antennas.
✓	To analyze radiation characteristics and performance parameters of different antenna types.
✓	To study linear wire antennas and antenna arrays for practical applications.
✓	To design and analyze broadband and microwave antennas including microstrip antennas.
✓	To understand wave propagation mechanisms and their impact on wireless communication systems.
✓	To explore current trends, market growth and business opportunities in antenna and propagation technologies.

UNIT –1	ANTENNA FUNDAMENTALS	8

Applications: *Wireless, Satellite and Radar Communication*

Introduction - Types of Antennas - radiation mechanism - single wire, two- wire - Dipoles - Current distribution on a thin wire antenna - Antenna parameters - Radiation pattern - Radiation power density - Radiation intensity - Beam width - Directivity - Antenna efficiency - Gain - Beam efficiency - Bandwidth - Polarization - Input impedance - Antenna vector effective length - Equivalent areas and Friis transmission equation.

UNIT –2	LINEAR WIRE ANTENNAS	8

Applications: *Aerospace, defense, medical devices, and scientific research (radio astronomy) for data transfer, navigation, surveillance, and monitoring*

Linear Wire Antennas: Retarded potentials, radiation from small electric dipole, quarter wave monopole and half wave dipole - current distribution, - Evaluation of field components - Power radiation - Loop antennas - Features - Helical antenna - Axial mode and normal mode operations.

UNIT –3	ANTENNA ARRAYS	8

Applications: *Radar, Satellite Communications, Mobile Networks (5G/6G), Astronomy, and Military*

Introduction - 2-element arrays - Different cases - Principle of pattern multiplication - N-element uniform linear arrays - End fire arrays - EFA with increased directivity - Concept of scanning arrays - directivity relations - Binomial arrays.

UNIT –4	BROADBAND & MICROWAVE ANTENNAS	8

Applications*: WLAN, Wi-Fi and IoT devices ,GPS and navigation systems, Broadcasting and television transmission*

Broadband Antennas: Introduction, folded dipole - Yagi-Uda antenna - Reflector antennas - F/D ratio - Aperture blocking - Micro strip Antennas - Introduction, Features, Advantages and Limitations - Rectangular Micro strip antenna - Geometry, Feeding methods, Characteristics of Micro strip antennas - Circular Micro strip antenna - Geometry& design parameters.

UNIT – 5	WAVE PROPAGATION	8

Applications: *Mobile Phones & Cellular Networks, Television & Radio, Satellite Communication: Two-Way Radios, Wi-Fi & Bluetooth*

Introduction to radio wave propagation - Free space propagation - Ground wave propagation - Space wave propagation and line-of-sight communication - Radio horizon - Troposphere propagation and ducting - Sky wave propagation - Ionosphere and its layers - Critical frequency, MUF, Skip distance and skip zone - Fading and diversity - Applications of radio wave propagation.

UNIT –6	BUSINESS STATISTICS AND CURRENT TRENDS	5

Market Growth Analysis in Antenna and Wave Propagation: Overview of global market size and projected growth trends - Market segmentation by application areas (telecom, satellite, IoT, defense, radar) - Analysis of current and emerging technological trends in antennas and wave propagation - Case studies highlighting real-world applications and industry developments.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

1.	Explain antenna fundamentals and radiation parameters.
2.	Analyze linear wire antennas and evaluate radiation characteristics.
3.	Design and analyze antenna arrays for improved directivity and performance.
4.	Design broadband and micro strip antennas for modern wireless applications.
5.	Analyze different wave propagation mechanisms in communication systems.
6.	Interpret market trends and emerging technologies in antenna and propagation domains.

TEXT BOOKS:

1.	Constantine A. Balanis ., "Antenna Theory and Applications",John Wiley & Sons, 4th edition, 2021.
2.	John D. Kraus, "Antennas and Wave Propagation", 5th edition (Reprint), McGraw Hill,

	2021.
3.	A. R. Harish & M. Sachidananda, "Antenna and Wave Propagation", Oxford University Press, 2020.
REFERENCES:	
1.	Zhijun Zhang, "Handbook of Antenna Technologies", Springer, 2021**.**
2.	Kai Fong Lee, "Micro strip Patch Antennas (2nd edition)", Imperial College Press, Reprint 2020**.**
3.	Richard C. Johnson, "Antenna Engineering Handbook*"*, 5th edition, McGraw Hill, 2021**.**
4.	Debatosh Guha **&** Yahya Rahmat-Samii, "Micro strip and Printed Antennas: New Trends", Wiley, 2022.
5.	Rashidul Islam, *"*Modern Antenna Systems for 5G and Beyond*"*, Springer, 2023**.**
OTHER SOURCES:	
1.	https://www.emscience.org/en/article/pdf/preview/10.23919/emsci.2022.0002.pdf
2.	https://nptel.ac.in/courses/108101092
3.	https://www.youtube.com/watch?v=2SWoCKDo55I
4.	https://antennajournal.com/index.php/antenna/article/view/57/43
5.	https://www.antenna-theory.com/antennas/travelling/yagi.php

CO – PO MAPPING

CO	**PO**											**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	2	-	-	1	-	-	-	-	-	-	3	2	-
2	3	3	2	2	2	-	-	-	-	-	-	3	2	-
3	3	3	3	2	2	-	-	-	-	-	-	3	3	1
4	3	2	3	2	3	1	-	-	-	-	-	3	3	2
5	3	3	2	2	2	1	-	-	-	-	-	3	2	1
6	2	2	1	1	1	3	2	1	2	2	3	2	3	3
Low (1) Medium (2) High (3)														

Assessment Weightage:

Formative Assessment		Summative Assessment
CIA	Experiential Learning	End semester examination
20%	20%	60%

CIA- Continuous Internal Assessment

Assessment of course outcome

Cognitive level	CO1	CO2	CO3	CO4	CO5	CO6
R	20%	10%	-	-	10%	30%
U	50%	30%	20%	20%	40%	50%
Ap	30%	40%	30%	30%	30%	10%
An	-	20%	40%	30%	20%	10%
E	-	-	10%	20%	-	-
C	-	-	-	-	-	-

Suggested experiential learning assessment activities

Vertical I (5 marks)	Vertical II (5 marks)	Vertical III (10 marks)
1.Assignments 2.MCQs 3.Design problems	1.Poster presentation 2.Seminar	1.Case Study Analysis 2. Paper Presentation - Conference/Journal. 3. Mini Project.
The course instructor can choose different assessment activities based on students interest with reference to standing committee meeting SCM III & Academic council meeting ACM III.		

Recommended by BOS		Approved by ACM	
XX	Date:28/01/2026	XX	Date:

24EC618	WIRELESS COMMUNICATION	PCC	L T P C 3 0 0 3
Prerequisite:	**24EC405**		

COURSE OBJECTIVES:

✓	To introduce the basic cellular concepts.
✓	To understand the various signal propagation effects.
✓	To study various multiple access schemes.
✓	To learn the basics and design Specifications about OFDM and MIMO systems.
✓	To familiarize with various mobile systems and standards.
✓	To gain knowledge and awareness of the Wireless Technologies.

UNIT - 1	INTRODUCTION TO CELLULAR CONCEPT	8

Applications: *Cellular networks, Mobile telephony, Smart city infrastructure, IoT connectivity, Public safety communication systems.*

Overview of Wireless communication - Cellular concept - Frequency reuse - Channel assignment strategies - Handoff strategies - Interference and system capacity - Trunking and grade of service - Improving coverage and capacity in cellular system.

UNIT - 2	MOBILE RADIO PROPAGATION	8

Applications: *Wireless network planning, 5G small cell deployment, Indoor wireless coverage design, Satellite link budget analysis.*

Propagation mechanisms - Free space model - Two ray model - Outdoor and indoor propagation models - Link budget design - Small Scale Multipath propagation - Parameters of multipath channels - Types of small scale fading - Rayleigh and Rician fading.

UNIT - 3	DIVERSITY AND MULTIPLE ACCESS TECHNIQUES	8

Applications: *4G/5G base stations, Wi-Fi systems, Satellite communication, Military communication systems.*

Multiple antenna wireless systems - System model - Types of diversity: Antenna, Frequency, Time - Optimal receiver combining - MRC - EGC - Diversity order - Multiple access - TDMA - FDMA - CDMA - SDMA.

UNIT - 4	OFDM AND MIMO TECHNOLOGY	8

Applications: *4G LTE networks, 5G NR systems, Wi-Fi 6, Broadband wireless systems.*

OFDM system model - Transceiver mathematical model - Cyclic prefix - PAPR - Reduction techniques - SNR and BER performance - MIMO system model - Zero forcing - Minimum mean square error receivers - Singular value decomposition - Channel capacity - Beam forming - BLAST architecture - Distributed MIMO.

UNIT - 5	WIRELESS SYSTEMS AND STANDARDS	8

Applications: *Commercial cellular networks, Global roaming systems, Broadband mobile internet, Smart devices*

Wireless Standards - Overview of 2G, 3G, 4G and 5G cellular mobile standards - System examples - AMPS - GSM - EDGE - GPRS - IS 95 - CDMA 2000 - WCDMA - UMTS - LTE - 3G, 4G and 5G mobile communications.

UNIT - 6	CURRENT TRENDS IN WIRELESS COMMUNICATION	5

Evolution from 5G to 6G - Terahertz communication - Reconfigurable Intelligent Surfaces (RIS) - AI/ML in wireless networks - Cognitive radio and dynamic spectrum access - IoT and machine type communication - Industry developments, emerging companies and global market trends in next generation wireless communication.

45 PERIODS

OUTCOMES:

At the end of the course the students would be able to

1	Understand cellular concepts and signal propagation in mobile communication.
2	Explain the fundamental principles of signal propagation in wireless communication.
3	Compare and contrast various multiple access techniques and their suitability for different applications
4	Analyze OFDM & MIMO configurations to enhance wireless communication systems.
5	Explain the architecture and evolution of GSM, CDMA, and 3G, 4G LTE, and 5G.
6	Analyze emerging wireless technologies such as 5G, 6G , IoT and AI enabled Communication systems.

TEXT BOOKS:

1.	Theodore S. Rappaport, Wireless Communications: Principles and Practice, 3rd Edition, Pearson, 2022.
2.	Andrea Goldsmith, Wireless Communications, Cambridge University Press, Reprint Edition 2023.
3.	David Tse & Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, Latest Reprint 2023.
REFERENCES:	
1.	Erik Dahlman, Stefan Parkvall & Johan Skold, 5G NR: The Next Generation Wireless Access Technology, Academic Press, 2020.
2.	Abbas Jamalipour (Ed.), Hand book on 6G Wireless Communications and Networking, Springer, 2022.
3.	Biswa P. S. Sahoo & Debabrata Das, Machine Learning in Wireless Communications: Theory and Applications, Springer, 2021.
4.	Sundeep Rangan, Tarik Taleb & H. Vincent Poor, Fundamentals of 5G Mobile Networks, Cambridge University Press, 2020.
OTHER SOURCES:	
1.	https://www.classcentral.com/course/swayam-fundamentals-of-mimowireless - communication-6702.
2.	https://www.classcentral.com/course/youtube-introduction-optical-wireless-communications-for-beyond-5g-networks-and-iot-330271.
3.	https://wizape.com/English/Advanced-Wireless-Communication-Technologies.
4.	https://www.coursera.org/learn/foundations-of-advanced-wireless-communication.

CO – PO MAPPING

CO	PO											PSO		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
1	3	2	1	-	-	-	-	-	-	-	1	2	1	1
2	3	3	2	1	1	-	-	-	-	-	1	3	2	1
3	3	2	2	1	1	-	-	-	-	-	1	3	2	1
4	3	3	3	2	2	-	-	-	-	1	1	3	3	2
5	2	2	2	1	1	-	-	-	-	1	2	2	2	2
6	3	3	3	2	2	1	1	-	-	2	2	3	3	3
LOW (1) ; MEDIUM (2) ; HIGH (3)														

Assessment Weightage:

Formative Assessment		Summative Assessment
CIA	Experiential Learning	End semester examination
20%	20%	60%

CIA - Continuous Internal Assessment

Assessment of course outcome

Cognitive level	CO1	CO2	CO3	CO4	CO5	CO6
R	10%	-	10%	15%	20%	10%
U	80%	75%	50%	20%	35%	40%
Ap	10%	15%	25%	35%	25%	20%
An	-	10%	15%	30%	20%	30%
E	-	-	-	-	-	-
C	-	-	-	-	-	-

Suggested experiential learning assessment activities

Vertical I (5 marks)	Vertical II (5 marks)	Vertical III (10 marks)
1.Poster presentation on architectures. 2. MCQs 3. Open book	1. Self-study – NPTEL / MOOC / Swayam 2. Online Courses 3.Assignments	1. Design & Simulation. 2. Case study Analysis 3.Industry Webinar Report
The course instructor can choose different assessment activities based on students interest with reference to standing committee meeting SCM III & Academic council meeting ACM III.		

Recommended by BOS		Approved by ACM	
XX	Date:28/01/2026	XX	Date:

24EC619	CMOS VLSI DESIGN AND PHYSICAL IMPLEMENTATION	PCC	L T P C 3 0 2 4
Prerequisite:	**24EC408**		

COURSE OBJECTIVES:

✓	To understand the operation, modeling, characteristics and second-order effects of MOS transistors.
✓	To study CMOS fabrication processes, layout design rules and technology-related issues involved in implementing reliable VLSI circuits.
✓	To design various CMOS combinational logic families with emphasis on performance and power optimization.
✓	To design static and dynamic sequential circuits while addressing timing, clocking, and synchronization issues in VLSI systems.
✓	To design arithmetic and system-level building blocks and understand the complete VLSI physical design flow from floor planning to routing.
✓	To understand the role of statistics, process variations, data analytics, and emerging industry trends in modern VLSI design and manufacturing.
✓	To design and simulate combinational and sequential digital circuits using HDL and implement them on FPGA platforms.
✓	To design and realize arithmetic units, memory elements, and finite state machines using hardware description languages.
✓	To acquire practical knowledge of CMOS circuit design, simulation, and layout generation using VLSI design tools.

UNIT-1	MOS TRANSISTOR THEORY	8

Applications: *CMOS Image Sensors in Cameras and Power Management ICs.*

NMOS and PMOS transistors, CMOS logic, MOS transistor theory - Introduction, Enhancement mode transistor action, Ideal I-V characteristics, DC transfer characteristics, Design equations - Second order effects - MOS models and small signal AC characteristics - Simple MOS capacitance model, Detailed MOS gate capacitance model, Detailed MOS diffusion capacitance model.

UNIT-2	CMOS TECHNOLOGY AND DESIGN RULE	8

Applications: *Layout design for ASIC chips used in automotive electronics.*

CMOS fabrication and layout - CMOS technologies, P -Well process, N -Well process, twin -tub process - MOS layers stick diagrams and layout diagram - Layout design rules - Latch up in CMOS circuits - CMOS process enhancements - Technology related CAD issues - Fabrication and packaging.

UNIT-3	COMBINATIONAL LOGIC CIRCUITS	8

Applications: *ALU design in microcontrollers and Control logic in robotics systems.*

Circuit Families: Static CMOS, Ratioed Circuits, Cascade Voltage Switch Logic, Dynamic Circuits, Pass Transistor Logic, Transmission Gates, Domino, Dual Rail Domino, CPL, DCVSPG, DPL.

Power: Dynamic Power, Static Power, Low Power Architecture.

UNIT-4	SEQUENTIAL CIRCUIT DESIGN	8

Applications: *Memory elements in RAM, cache memory and Traffic light controllers and industrial automation systems.*

Static latches and registers - Dynamic latches and registers - Pipelining - Schmitt Trigger - Mono stable sequential circuits - Astable sequential circuits - Timing issues: Basic timing concepts, Clocking issues, Static timing analysis.

UNIT-5	VLSI SYSTEM COMPONENTS CIRCUITS AND SYSTEM LEVEL PHYSICAL DESIGN	8

Applications: *Arithmetic units in DSP processors and Chip design for autonomous vehicles.*

Multiplexers - Decoders - Comparators - Priority encoders - Shift registers - Arithmetic circuits - Ripple carry adders - Carry look ahead adders - High-speed adders - Multipliers - Physical design - Design flow - Floor planning - Placement - Clock tree synthesis -Routing.

UNIT-6	BUSINESS STATISTICS AND CURRENT TRENDS	5

Role of Statistics in VLSI - Yield analysis and defect density - Process variations & Monte Carlo - Data analytics in VLSI - Role of data analytics in EDA tools - Industry trends - Business perspective of VLSI.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Design of basic combinational and sequential (Flip-flops) circuits using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA.
2. Design an Adder; Multiplier (Min 8 Bit) using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA.
3. Design and implement Universal Shift Register using HDL. Simulate it using Xilinx/Altera software.
4. Design Memories using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA.
5. Design Finite State Machine (Moore) using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA
6. Design Finite State Machine (Mealy) using HDL. Simulate it using Xilinx/Altera Software and

implement by Xilinx/Altera FPGA.
7. Design 4-bit Asynchronous up/down counter using HDL. Simulate it using Xilinx/Altera software and implement by Xilinx/Altera FPGA
8. Design and simulate a CMOS Basic Gates & Flip-Flops. Generate Manual/Automatic Layout.
9. Design and simulate a CMOS Inverting Amplifier. Generate Manual/Automatic Layout.
10. Design and simulate a 4-bit synchronous counter using Flip-Flops. Generate Manual/Automatic Layout.
TOTAL: 30 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to	
1.	Describe the operation, characteristics, and modeling of MOS transistors.
2.	Illustrate CMOS fabrication processes, layout design rules and to address issues like latch-up and process variations.
3.	Design various CMOS combinational logic circuits with consideration of power dissipation and performance metrics.
4.	Design sequential circuits while addressing timing constraints, clocking strategies, and synchronization issues.
5.	Design arithmetic circuits and system-level components and interpret the VLSI physical design flow.
6.	Interpret the impact of process variations, yield analysis, and statistical methods in VLSI design.
7.	Design and implement combinational and sequential circuits using HDL and validate their functionality through simulation and FPGA implementation.
8.	Develop arithmetic circuits, memory modules and finite state machines (Moore and Mealy) using HDL.
9.	Design and simulate CMOS logic circuits and analog blocks, and generate layouts while verifying design rules using VLSI tools.
TEXTBOOKS:	
1.	Neil H. E. Weste, David Money Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", 5th edition, Pearson, 2023.
2.	Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", 4th edition, McGraw-Hill Education, 2021.
3.	Jan M. Rabaey, AnanthaChandrakasan, BorivojeNikolić, "Digital Integrated Circuits: A Design Perspective", 3rd edition (updated reprint), Pearson, 2019.
REFERENCES:	

1.	David A. Hodges, Horace G. Jackson, Resve A. Saleh, "Analysis and Design of Digital Integrated Circuits", 4th edition, McGraw-Hill, 2020.
2.	Behzad Razavi, "Design of Analog CMOS Integrated Circuits", 2nd edition, McGraw-Hill Education, 2016 (reprint 2020).
3.	Neil H. E. Weste, Kamran Eshraghian, "Principles of CMOS VLSI Design", 3rd edition (recent reprint), Pearson, 2018.
4.	Kiat Seng Yeo, Kaushik Roy, "Low-Voltage, Low-Power VLSI Subsystems", 2nd edition, McGraw-Hill, 2020.
5.	Andrew B. Kahng, Jens Lienig, Igor L. Markov, Jin Hu, "VLSI Physical Design: From Graph Partitioning to Timing Closure", Springer, 2022.
OTHERSOURCES:	
1.	https://www.cmosvlsi.com/coursematerials.html
2.	https://icbook.eecs.berkeley.edu/resources/powerpoint-slides
3.	https://www.engppt.com/2011/12/cmos-vlsi-design-methodologies.html
4.	https://users.ece.utexas.edu/~mcdermot/vlsi1

CO –PO MAPPING

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	2	1	-	1	-	-	-	-	-	1	3	1	1
2	3	2	2	2	2	1	-	-	-	-	1	3	2	1
3	3	3	3	2	2	-	-	-	-	-	1	3	3	2
4	3	3	3	2	2	-	-	-	-	-	1	3	3	2
5	3	3	3	2	2	1	-	-	-	-	1	3	3	2
6	2	3	1	1	-	1	-	-	-	-	2	2	1	1
7	3	2	3	2	3	-	-	1	-	-	1	3	3	3
8	3	3	3	2	3	-	-	1	-	-	1	3	3	3
9	3	3	3	2	2	-	-	1	-	-	1	3	3	3
Low(1) Medium(2) High(3)														

Assessment Weightage:

For Theory component:

FormativeAssessment		**SummativeAssessment**
CIA	Experiential Learning	Endsemesterexamination
20%	20%	60%

CIA-Continuous Internal Assessment

For Laboratory component:

Formative Assessment		Summative Assessment
CIA	Experimental practices	End semester examination
20%	20%	60%

Assessment of course outcome

Cognitive level	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9
R	15%	25%	20%	15%	15%	20%	10%	10%	20%
U	60%	55%	40%	45%	50%	65%	20%	20%	20%
Ap	25%	20%	20%	20%	15%	-	35%	35%	25%
An	-	-	-	-	-	15%	10%	10%	10%
E	-	-	-	-	-	-	-	-	-
C	-	-	20%	20%	20%	-	25%	25%	25%

Suggested experiential learning assessment activities

Vertical I (5marks)	Vertical II (5marks)	Vertical III (10marks)
1. Poster presentation 2. Multiple choice quizzes 3. Open book/problem solving exams	1. Self-study–NPTEL / MOOC / Swayam 2. Online certifications	1. Simulation and design projects 2. Market survey
The course instructor can choose different assessment activities based on students Interest with reference to standing committee meeting SCM III & Academic council meeting ACM III.		

Recommended by BOS		Approved by ACM	
III	Date: 28/01/2026	XX	Date:

24EC620	ADVANCED EMBEDDED SYSTEM AND IoT	PCC	L T P C 3 0 2 4
Prerequisite:	**24EC512**		

COURSEOBJECTIVES:

✓	To understand high-performance embedded architectures and heterogeneous computing platforms.
✓	To design advanced real-time systems using RTOS and Embedded Linux.
✓	To develop IoT systems using modern communication protocols and networking technologies.
✓	To implement edge computing, cloud integration and intelligent data processing.
✓	To design secure and AI-enabled IoT systems for industrial applications.
✓	To understand the embedded and IoT industry trends, business models, government initiatives, and entrepreneurship opportunities.
✓	To analyze and implement high-performance embedded and RTOS-based systems.
✓	To develop IoT applications with networking, cloud and security integration.
✓	To design intelligent embedded systems using Edge AI concepts.

UNIT-1	HIGH PERFORMANCE EMBEDDED ARCHITECTURES	8

Applications: *Industrial automation, Automotive safety systems, Home automation*

System-on-Chip (SoC) architecture - Multi-core and heterogeneous embedded systems - ARM Cortex-A and Cortex-R architecture overview -Digital Signal Processor (DSP) architecture - FPGA-based embedded system design concepts - Hardware accelerators - AMBA bus architecture - Memory hierarchy and cache coherency - Power-aware and performance-aware embedded system design - Comparison of MCU, MPU and FPGA-based platforms.

UNIT-2	ADVANCED REAL-TIME OPERATING SYSTEMS AND EMBEDDED LINUX	8

Applications: *Air traffic control, missile guidance systems, Spacecraft systems, Multi-tasking embedded systems*

Real-time operating system fundamentals - Deterministic scheduling - Rate Monotonic (RMS) and Earliest Deadline First (EDF) algorithms with schedulability analysis - Priority inversion and inheritance - Task synchronization and inter-task communication - Memory management and protection mechanisms - FreeRTOS/RTX concepts - Embedded Linux architecture and boot process - Kernel modules and device driver framework - Board Support Package (BSP) - GPIO, UART, SPI and I2C driver interfacing - Cross compilation and build systems overview.

UNIT-3	INTERNET OF THINGS: ARCHITECTURE AND NETWORKING	8

Applications: *Smart homes, Smart factories, Environmental monitoring, Wearable devices, Cloud-based IoT communication*

Introduction to IoT - IoT reference models and layered architecture (Perception, Network and Application layers) - Industrial IoT (IIoT) architecture - Sensor networks and data acquisition -IoT hardware platforms - Communication technologies: Wi-Fi, BLE, LoRaWAN, NB-IoT - LPWAN technologies - 6LoWPAN and Thread -Time Sensitive Networking (TSN) - Application protocols: MQTT, MQTT-SN, CoAP, HTTP and DDS - IoT interoperability standards - IoT security threats and risk analysis.

UNIT-4	**IoT PLATFORMS AND EDGE COMPUTING**	**8**

Applications: *Smart city infrastructure, Autonomous vehicles, Smart grids, traffic analysis*

Cloud platforms for IoT - AWS IoT, Azure IoT and Google IoT Core - Cloud-native IoT architecture - Edge and Fog computing models – Gateway and edge node design - Microservices-based IoT architecture -RESTful services and API integration -Containerization concepts - Data acquisition, preprocessing and filtering - IoT data storage models - Stream processing and real-time analytics - IoT dashboards and visualization techniques -Digital Twin concept and applications.

UNIT-5	**IoT SECURITY AND INTELLIGENT SYSTEMS**	**8**

Applications: *Defense communication systems, IoT gateways, Web-connected embedded systems, Intelligent automation, Smart transportation*

Secure IoT system architecture - Hardware root of trust - Secure boot mechanisms - Cryptographic techniques for embedded systems - TLS/SSL implementation concepts - Device provisioning and lifecycle management - Secure firmware over-the-air updates - Real-time IoT system integration - Edge AI and Tiny ML deployment - AIoT frameworks - Smart manufacturing systems - Industry 4.0 concepts - Open-source hardware ecosystems (RISC-V based embedded platforms) - Case studies of intelligent IoT deployments.

UNIT-6	**BUSINESS STATISTICS AND CURRENT TRENDS**	**5**

Overview of embedded and IoT industry - Semiconductor and electronics market trends - Embedded product development lifecycle - IoT business models - Government initiatives (ISM, PLI, DLI, SPECS, EMC 2.0) - Entrepreneurship and career opportunities in Embedded and IoT domain.

TOTAL: 45 PERIODS

LIST OF EXERCISE

Exercise 1: Heterogeneous Computing and Hardware Acceleration
Evaluation of Multi-Core SoC architectures and implementation of FPGA-based hardware accelerators to optimize computational tasks.

Exercise 2: Real-Time Operating Systems (RTOS) and Deterministic

Implementation of Free RTOS tasks using RMS and EDF scheduling algorithms, including inter- task communication and synchronization mechanisms (Semaphores / Mutexes).
Exercise 3: Embedded Linux System Integration and Driver Development Analysis of the Embedded Linux boot sequence and development of custom kernel modules for peripheral interfacing and device driver management.
Exercise 4: Secure Edge-to-Cloud IoT Frameworks Design of an end-to-end IoT system utilizing MQTT/CoAP protocols, REST API cloud integration, and TLS-based security for device provisioning.
Exercise 5: LPWAN Connectivity and Edge Intelligence (TinyML) Deployment of TinyML models for real-time edge inference combined with long-range communication using LoRa or NB-IoT technologies.
Upon completion of the prescribed laboratory exercises, each student is required to design and implement an integrated project that incorporates the principles of high-performance SOC architectures, real-time task orchestration, and secure edge-to-cloud connectivity, but is not limited to these domains.
TOTAL: 30 PERIODS

COURSE OUTCOMES:	
At the end of the course the students would be able to	
1.	Analyze high-performance embedded architectures and heterogeneous systems.
2.	Design advanced real-time embedded systems using RTOS and Embedded Linux.
3.	Develop IoT systems using modern networking and communication technologies.
4.	Implement edge-cloud integrated IoT systems with analytics capabilities.
5.	Design secure and intelligent IoT systems for industrial applications.
6.	Analyze embedded and IoT industry trends, market dynamics, and entrepreneurial opportunities for professional development.
7.	Implement and evaluate high-performance embedded and RTOS-based systems.
8.	Develop secure IoT applications with networking and cloud integration.
9.	Design and deploy intelligent Edge AI-based embedded solutions.
TEXTBOOKS:	
1.	Raj Kamal**,** Embedded Systems: SoC, IoT, AI and Real-Time Systems, 4th Edition, 2020, McGraw Hill Education. ISBN-13: 978-9353168025**.**
2.	Adesh Kumar, Surajit Mondal, Gaurav Verma & Prashant Mani (Eds.)**,** Embedded Devices and Internet of Things: Technologies and Applications**,** 1st Edition, 2025, CRC Press. ISBN-13: 978-1032606002**.**
3.	Sudeep Pasricha & Muhammad Shafique**,** Embedded Machine Learning for Cyber-Physical, IoT, and Edge Computing: Use Cases and Emerging Challenges, 1st Edition, 2023, Springer Nature.

REFERENCES:	
1.	Chris Simmonds, Mastering Embedded Linux Programming, 2nd Edition, 2020, Packt Publishing. ISBN-13: 978-1787288850**.**
2.	Peter Marwedel, Embedded System Design, 3rd Edition, 2023**,** Springer Nature, ISBN: 978-3031090549
3.	Arshdeep Bahga & Vijay Madisetti, Internet of Things: A Hands-On Approach, 2nd Edition, 2024, Universities Press. ISBN: 978-9355512713
4.	Frank Vahid & Roman Lysecky, Embedded System Design: A Unified Hardware/Software Introduction, 2nd Edition (2020)**,** Wiley, ISBN-13: 978-1119457888
5.	Peter Waher, Learning MQTT**,** 2nd Edition, 2023, Packt Publishing. ISBN-13: 978-1803247830
OTHERSOURCES:	
1.	https://www.coursera.org/specializations/internet-of-things-uci
2.	https://www.edx.org/course/embedded-systems-shape-the-world
3.	https://www.udemy.com/course/mastering-rtos
4.	https://www.pluralsight.com/paths/secure-iot-development

CO –PO MAPPING

CO	PO											PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	3	2	1	-	1	-	-	-	-	-	1	3	1	1
2	3	2	2	2	2	1	-	-	-	-	1	3	2	1
3	3	3	3	2	2	-	-	-	-	-	1	3	3	2
4	3	3	3	2	2	-	-	-	-	-	1	3	3	2
5	3	3	3	2	2	1	-	-	-	-	1	3	3	2
6	3	3	1	1	-	1	-	-	-	-	1	2	1	1
7	3	2	3	2	2	-	-	1	-	-	1	3	3	3
8	3	3	3	2	2	-	-	1	-	-	1	3	3	3
9	3	3	3	2	2	-	-	1	-	-	1	3	3	3
Low(1) Medium(2) High(3)														

Assessment Weightage:

For Theory component:

Formative Assessment		**Summative Assessment**
CIA	Experiential Learning	End semester examination
20%	20%	60%

CIA-Continuous Internal Assessment

For Project component:

Formative Assessment		Summative Assessment
CIA	Experimental practices	End semester examination
20%	20%	60%

Assessment of course outcome

Cognitive level	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9
R	15%	25%	20%	15%	10%	20%	-	-	-
U	60%	55%	40%	45%	50%	65%	10%	10%	10%
Ap	25%	20%	30%	30%	30%	-	10%	10%	10%
An	-	-	10%	10%	10%	15%	10%	10%	10%
E	-	-	-	-	-	-	20%	20%	20%
C	-	-				-	50%	50%	50%

Suggested experiential learning assessment activities

Vertical I (5marks)	Vertical II (5marks)	Vertical III (10marks)
1. Poster presentation 2. Multiple choice quizzes 3. Open book/problem solving exams	1. Self-study–NPTEL/ MOOC/ Swayam 2. Online certifications	1. Simulation and design projects 2. Market survey
The course instructor can choose different assessment activities based on students Interest with reference to standing committee meeting SCM III & Academic council meeting ACM III.		

RecommendedbyBOS		ApprovedbyACM	
II	Date:28/01/2026	XX	Date:

	CAREER AWARENESS AND PROFESSIONAL PROFILE BUILDING	T	LTPC 2001
Prerequisite:	Basic awareness of Engineering disciplines, fundamental communication skills, willingness to explore career options and self-development.		
COURSE OBJECTIVES:			
✓	Expose students to government,non-government,and global electronics industries and Professional bodies.		
✓	Enable understanding of job roles and responsibilities in electronics and communication Sectors.		
✓	Develop employability-oriented technical and professional skill sets.		
✓	Equip students with resume-building and professional profile development skills.		
✓	Enable learners to prepare effective general and technical resumes aligned with industry expectations.		
✓	Develop the ability to customize resumes for specific job roles and improve them through evaluation and feedback.		
UNIT-1	**EXPLORING GOVERNMENT & NON-GOVERNMENT NATIONAL AND INTERNATIONAL INDUSTRIES AND ASSOCIATIONS IN ELECTRONICS AND COMMUNICATION**		2
Overview of the Electronics& Communication Industry- Government Organizations – National (India)-International-Non Government Organizations–National-International-Role of Professional Associations in ECE- Major National and International Electronics Industries- Emerging Trends and Global Opportunities-Industry–Academia Interaction and Career Pathways.			
UNIT-2	**EXPLORING JOB ROLES AND RESPONSIBILITIES INVARIOUS INDUSTRIES OF ELECTRONICS AND COMMUNICATION**		2
Introduction to ECE Industry Job Landscape-Job Roles in Core Electronics Industries, communication and Networking Industries, Software, Electronics Integrated Domains, Manufacturing, Testing, and Quality Assurance-Job Roles in Defense, Aerospace, and Research Organizations, Emerging and Interdisciplinary Areas- Roles in Management, Support, and Allied Functions-Professional Responsibilities and Work Ethics-Industry Expectations and Employability Skills.			
UNIT-3	**SKILLSET REQUIRED FOR EMPLOYABILITY IN GOVERNMENT& NON GOVERNMENTAND MNCs FOR A SPECIFIC JOB ROLE**		2

Core Technical Skills Required for the Job Role-Employability Skills for Government Sector, Private Sector and MNCs-Soft Skills and Professional Skills-Career Readiness and Continuous Learning-Mapping Skills to Career Pathways		
UNIT-4	**FUNDAMENTALS OF RESUME BUILDING,DIFFERENT TYPES OF RESUME**	2
Introduction to Resume and Its Importance-Fundamentals of Resume Building-Formatting and Presentation Techniques-Different Types of Resumes.		
UNIT-5	**ESSENTIALS OF A TECHNICAL RESUME**	2
Important aspects of technical resume-Courses, Internships, Project profile and performance profile.		
UNIT-6	**EVALUATION AND SUGGESTIONS FOR THE PREPARED RESUMES**	2
Resume Customization for Job Roles- Common Resume Mistakes and Best Practices- Feedback, Suggestions, and Resume Improvement.		
		TOTAL: 12 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO No	Course Outcome
CO 1	Identify major government,non-government,and international electronics industries and Professional bodies.
CO 2	Explain job roles and responsibilities in various electronics and communication sectors.
CO 3	Analyze employability skills required for specific job roles across sectors.
CO 4	Apply fundamental resume building principles, formatting techniques, and appropriate resume types to prepare a professional resume.
CO 5	Create a structured technical resume by effectively presenting courses, internships, projects, and performance profiles.
CO 6	Evaluate and refine resumes for specific job roles by analyzing common mistakes and incorporating constructive feedback.

TEXTBOOKS:

1.	V.S.Rao,**"Career Development and Employability Skills"** ,McGraw Hill Education, India.
2.	Yuvraj Singh &David F.Beer,**"Resume Writing and Interview Skills"**, Pearson Education.

REFERENCES:	
1.	Ramesh Singh, **"Professional Skills for Engineers"**, Oxford University Press.
2.	Harvey Deitel &Paul Deitel, **"Technical Communication for Engineers"**, Pearson.
3.	DaleCarnegie, **"How to Win Friends and Influence People"**, Simon&Schuster.
OTHER SOURCES:	
1.	https://www.aicte-india.org
2.	https://nptel.ac.in
3.	https://www.linkedin.com/learning
4.	https://www.ncs.gov.in

CO–POMAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
2	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
3	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
6	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
	Low(1) Medium(2) High(3)														

Recommended by BOS		Approved by ACM	
XX	Date:	XX	Date: