KUMARAGURU COLLEGE OF TECHNOLOGY,

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641 049.

M.E. Embedded System and Computing

I to IV Semesters

Curriculum & Syllabus

Department of Electrical and Electronics Engineering

VISION

To be a Centre of Excellence in Globalizing Education and Research in the field of Electrical and Electronics Engineering

MISSION

The Mission of the department is to

- **E**mpower the students with state-of-art knowledge to excel as eminent electrical engineers with multi-disciplinary skills.
- **E**mphasize social values and leadership qualities to meet the industrial needs, societal problems and global challenges.
- **E**nable the technocrats to accomplish impactful research and innovations

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives of Postgraduate Program are to prepare the graduates:

PEO 1: Pursue a diverse range of careers in engineering, consultancy, and entrepreneurship.

PEO 2: Contribute to continuous professional development through higher studies and life-long learning.

PEO 3: Demonstrate their technical proficiency with ethical values and social responsibility.

PEO 4: Innovate and provide solutions for ever-changing global environments with familiarity in computational platforms in electrical engineering.

PROGRAM OUTCOMES (POs)

Graduates of the Embedded System and Computing Postgraduate Program should have the ability to:

PO 1: Acquire fundamental knowledge and understanding of Embedded system design technologies

PO 2: Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.

PO 3: Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning

PO 4: Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.

PO 5: Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.

PO 6: Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of Embedded System and Computing Program will have the ability to:

PSO 1: Design and develop an appropriate embedded system for commercial and industrial application by using optimum resources with better performance.

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KUMARAGURU COLLEGE OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATION 2024

M.E. Embedded System and Computing - Curriculum

SEMESTER I

S. No	Course code	Course Title	Course Mode	Course Type	L	T	P	C
1	24MAI503	Applied Mathematics for Embedded Systems	Embedded	BS	3	0	2	4
2	24ETT501	Advanced Digital Design and Reconfigurable Computing	Theory	ES	3	0	0	3
3	24ETI502	Microcontroller Based System Design	Embedded	PC	3	0	2	4
4	24ETT503	Real Time Operating Systems	Theory	PC	3	0	0	3
5	24ETT504	AI & ML for Embedded System	Theory	PC	3	0	0	3
6	24ETT505	Embedded Linux and Real-Time Systems	Theory	ES	3	0	0	3
							Total Credits	**20**
							Total Contact Hours/week	**22**

SEMESTER II

S. No	Course code	Course Title	Course Mode	Course Type	L	T	P	C
1	24ETT601	GPU Architectures and Programming	Theory	PC	3	0	0	3
2	24ETI602	Embedded IoT and Computing	Embedded	PC	2	0	2	3
3	24ETI603	HDL Programming	Embedded	PC	3	0	2	4
4	24ETT604	Research Methodology and Statistics	Theory	PC	3	0	0	3
5	24ETEXXX	Elective – I	Theory	PE	3	0	0	3
6	24TEXXX	Elective – II	Theory	PE	3	0	0	3
							Total Credits	**19**
							Total Contact Hours/week	**21**

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SEMESTER III								
S. No.	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**C**
1	24ETEXXX	Elective – III	Theory	PE	3	0	0	3
2	24ETEXXX	Elective – IV	Theory	PE	3	0	0	3
3	24ETEXXX	Elective – V	Embedded	PE	2	0	2	3
4	24ETJ501	Summer Internship	-	EEC	-	-	-	2
5	24ETJ601	Project Phase – I	Project	EEC	-	-	14	7
							Total Credits	**18**
							Total Contact Hours/week	**24**

SEMESTER IV								
S. No.	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**C**
1	24ETJ602	Project Phase – II	Project	EEC	-	-	30	15
							Total Credits	**15**
							Total Contact Hours/week	**30**
							Total Credits	**72**

PROFESSIONAL ELECTIVES								
S. No.	**Course code**	**Course Title**	**Course Mode**	**CT**	**L**	**T**	**P**	**C**
PROFESSIONAL ELECTIVE: I – IV								
1	24ETE501	Cloud Computing and Fog Computing	Theory	PE	3	0	0	3
2	24ETE502	Communication and Networking Technologies	Theory	PE	3	0	0	3
3	24ETE503	Data Analytics	Theory	PE	3	0	0	3
4	24ETE504	Industry 5.0	Theory	PE	3	0	0	3
5	24ETE505	Block Chain Technology	Theory	PE	3	0	0	3
6	24ETE506	Augmented Reality and Virtual Reality	Theory	PE	3	0	0	3

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7	24ETE507	AI and ML for Electric Vehicles	Theory	PE	3	0	0	3
8	24ETE508	Edge AI and Computing	Theory	PE	3	0	0	3
9	24ETE509	Machine Learning for Robotics	Theory	PE	3	0	0	3
10	24ETE510	Computational Data Science	Theory	PE	3	0	0	3
11	24ETE511	VLSI System Design	Theory	PE	3	0	0	3
12	24ETE512	Computer Architecture and Parallel Processing	Theory	PE	3	0	0	3
13	24ETE513	Multi – Core Embedded Systems	Theory	PE	3	0	0	3
14	24ETE514	Embedded Product Development.	Theory	PE	3	0	0	3
15	24ETE515	VLSI DSP Architectures	Theory	PE	3	0	0	3
16	24ETE516	Full Stack Development	Theory	PE	3	0	0	3
PROFESSIONAL ELECTIVES: V								
17	24ETE517	Embedded Programming for ARM – M4 Cortex Processor	Embedded	PE	2	0	2	3
18	24ETE518	FPGA based Embedded System Design	Embedded	PE	2	0	2	3
19	24ETE519	Python Programming for ML applications	Embedded	PE	2	0	2	3
20	24ETE520	R programming	Embedded	PE	2	0	2	3

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SEMESTER-WISE CREDITS	
SEMESTER - I	20
SEMESTER - II	19
SEMESTER - III	18
SEMESTER - IV	15
TOTAL CREDITS	**72**

COURSE TYPES	CREDITS
Basic Science	4
Engineering Science	6
Professional Core	23
Professional Electives	15
Project / Internship	24
Total Credits	**72**

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SEMESTER - I

(Syllabus)

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24MAI503	APPLIED MATHEMATICS FOR EMBEDDED SYSTEMS	L	T	P	C
		3	0	2	4
BS		SDG	8,9,13		

Pre-requisite courses	–	Data Book / Codes / Standards (If any)	-

Course Objectives:	The purpose of taking this course is to:
1	Apply Fourier transforms and solve PDEs for advanced signal processing in embedded systems.
2	Utilize graph theory and algorithms like Dijkstra's and Prim's for solving network optimization problems.
3	Solve real-world optimization problems using linear programming, simplex methods, and transportation models.
4	Analyze probabilistic systems using distributions, moments, and moment generating functions.
5	Model single and multi-server queuing systems using Markovian models for performance optimization.

Course Outcomes:	After successful completion of this course, the students shall be able to	Bloom's Taxonomy Level (BTL)
CO 1	Analyze and filter noise in communication systems by applying Fourier transforms, ensuring clearer signal transmission in embedded systems.	An
CO 2	Apply PDE solutions to model and solve heat distribution problems in the design of embedded thermal management systems for electronic devices.	Ap
CO 3	Apply Dijkstra's and Prim's algorithms to optimize routing in wireless sensor networks for smart cities, ensuring efficient data flow.	Ap
CO 4	Apply linear programming to optimize resource allocation in supply chain management for embedded systems in industrial automation.	Ap
CO 5	Apply probability distributions to model and predict the reliability of embedded control systems in autonomous vehicles under varying conditions.	Ap
CO 6	Apply queuing models to optimize server load and response times in cloud-based embedded systems for IoT applications, ensuring minimal latency.	Ap

Course Outcomes (CO)	Program Specific Outcomes (PSO)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and	Design and develop an appropriate embedded system for commercial and industrial
1	3	2	2	1	2	1	
2	3	3	2	2	3	2	
3	2	3	3	2	2	1	
4	2	2	2	3	2	1	
5	2	2	3	3	2	1	
6	2	3	3	2	3	3	

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Course Content	
FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS Fourier transform: Definitions – Properties – Transform of elementary functions – Dirac delta function – Convolution theorem – Parseval's identity – Solutions to partial differential equations: Heat equation – Wave equation – Laplace and Poison's equations. **Practical Component** • Write a MATLAB program to apply Fourier Transform to filter out noise from a signal received by an embedded sensor system. • Use a low-pass filter to remove high-frequency noise. • Solve the on edimensional heat equation using Fourier Transform in MATLAB to model the heat distribution in a microprocessor. Assume an initial temperature profile and insulated boundaries.	**9 Hours** **6 Hours**
GRAPH THEORY Introduction to paths, trees – Isomorphism – Matrix coloring and directed graphs – Some basic algorithms: Dijkstra's Algorithm, Depth-First search – Breadth-First search, Prims Algorithm, Kruskal Algorithm **Practical Component** • Using Dijkstra's algorithm, implement a MATLAB solution to find the shortest path for electricity distribution in a smart grid network. The network is represented as a graph with nodes and weighted edges. • Use Prim's algorithm in MATLAB to create a minimum spanning tree for a wireless sensor network. The network nodes and edges are represented by a weighted adjacency matrix.	**9 Hours** **6 Hours**
OPTIMIZATION TECHNIQUES Linear programming – Basic concepts – Graphical and simplex methods – Big M method – Transportation problems – Assignment problems. **Practical Component** • Solve a linear programming problem using the simplex method in MATLAB to optimize resource allocation in an embedded system with limited resources. • Assume the objective is to maximize profit subject to resource constraints. • Write a MATLAB program to solve the transportation problem for minimizing the cost of transporting goods from multiple sources to multiple destinations using the transportation method.	**9 Hours** **6 Hours**
PROBABILITY AND RANDOM VARIABLES Probability – Random variables – Binomial, Poisson, Normal, Exponential distributions – Expectations – Moments – Moment generating functions and their properties. **Practical Component** • Using MATLAB, simulate the reliability of an embedded control system using a Poisson distribution. Assume failure occurs at a rate of 2 failures per year. • Model the failure rate of electronic components in an embedded system using an exponential distribution in MATLAB. Assume the mean time between failures (MTBF) is 1000 hours.	**9 Hours** **6 Hours**

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QUEUING THEORY Single and multiple servers - Markovian queuing models - Finite and infinite capacity queues. **Practical Component** • Write a MATLAB program to model a single-server Markovian queuing system (M/M/1) for analyzing the performance of cloud-based embedded systems. • Model a multi-server queuing system (M/M/c) in MATLAB for managing network traffic in a smart home automation system.	**9 Hours** **6 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**30**	**Total Hours:**	**75**

Textbooks

1. Gupta, S.C and Kapoor V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and sons, New Delhi, 2001.
2. Taha H A, "Operations Research: An Introduction", Pearson Education Edition, Asia, New Delhi, Seventh Edition 2002.
3. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
4. Narasingh Deo, " Graph Theory with Applications to Engineering and Computer Science ", Prentice Hall India,1997.

Reference books

1. Dym, H. and McKean, H.P., "Fourier Series and Integrals", Academic Press, 1985.
2. Folland, Gerald B., "Fourier Analysis and Its Applications", American Mathematical Society, 2009.
3. West, Douglas B., "Introduction to Graph Theory", Prentice Hall, 2nd Edition, 2000.
4. Deo, Narsingh, "Graph Theory with Applications to Engineering and Computer Science", Dover Publications, 2016.
5. Taha, Hamdy A., "Operations Research: An Introduction", Pearson, 10th Edition, 2017.
6. Bazaraa, Mokhtar S., Jarvis, John J., and Sherali, Hanif D., "Linear Programming and Network Flows", Wiley, 4th Edition, 2009.
7. Ross, Sheldon M., "Introduction to Probability Models", Academic Press, 12th Edition, 2019.
8. Ross, Sheldon M., "A First Course in Probability", Pearson, 10th Edition, 2018.
9. Gross, Donald, Shortle, John F., and Thompson, James M., "Fundamentals of Queuing Theory", Wiley, 5th Edition, 2018.
10. Blanco Castañeda, Liliana, Arunachalam, Viswanathan, and Dharmaraja, Selvamuthu, "Introduction to Probability and Stochastic Processes with Applications", Wiley, 2012.

Online Resources (Web Links)

1. https://archive.nptel.ac.in/courses/111/107/111107128/
2. https://www.andrew.cmu.edu/course/14-740-s18/applications/ln/14740-l16.pdf
3. https://stattrek.com/probability/probability-distribution
4. https://www.geeksforgeeks.org/graph-data-structure-and-algorithms/
5. https://ocw.mit.edu/courses/18-152-introduction-to-partial-differential-equations-fall-2011/pages/lecture-notes/

Assessment	
Formative	Summative
Assignments / Mini project), Quiz, Lab	CAT- I, CAT – II and End Semester Examination (ESE)

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Course Curated By			
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**		**Internal Expert(s)**
1. Mr. Ramesh V.S., STEPS Knowledge Services Private Limited, Coimbatore. 2. Mr.Jayakumar Venkatesan, Valles Marineris International Private Limited- Chennai.	1. Dr.C.Porkodi, PSG College of Technology, Coimbatore. 2. Dr.P.Paramanathan, Amrita Vishwa Vidyapeetham, Coimbatore.		1. Dr. R.Marudhachalam/ Mathematics 2. Dr. K.Meena / Mathematics 3. Dr. Vijeta Iyer/ Mathematics
Recommended by BoS on	16/08/2024		
Academic Council Approval	27	**Date**	24/08/2024

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24ETT501	ADVANCED DIGITAL DESIGN AND RECONFIGURABLE COMPUTING	L	T	P	C
		3	0	0	3
ES		SDG	9, 11		

Pre-requisite courses	Digital Electronics	Data Book / Code book (If any)	-

COURSE OBJECTIVES:

The purpose of taking this course is to:

1	Design and optimize clocked synchronous sequential networks using state modeling, reduction, and ASM chart techniques.
2	Analyze and design asynchronous circuits while addressing hazards, synchronization, and mixed-mode operations.
3	Develop proficiency in fault detection and testing techniques for ensuring the reliability of digital circuits.
4	Implement synchronous state machines using programmable devices such as PAL, PLA, CPLD, and FPGA.
5	Explore the architecture and applications of reconfigurable processors and systems-on-chip for advanced computational tasks.

COURSE OUTCOMES

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	design and Analyze Clocked synchronous and sequential circuits for developing simple digital system	C
CO 2	design and analyze asynchronous sequential circuits in digital system	C
CO 3	understand the basics and advanced concepts in testing of digital circuits	U
CO 4	apply the techniques to design synchronous sequential circuit using programmable devices	Ap
CO 5	familiarize the basics and processors for reconfigurable computing	U

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded system for commercial and industrial
1	3	2		2			
2	3	2		2			
3	3	2	2				
4	3	2	2				
5	3	2					

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COURSE CONTENT	
SEQUENTIAL CIRCUIT DESIGN: Analysis of Clocked Synchronous Sequential Networks (CSSN) Modeling of CSSN – State Stable Assignment and Reduction – Design of CSSN – Design of Iterative Circuits – ASM Chart – ASM Realization	**9 Hours**
ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN Analysis of Asynchronous Sequential Circuit (ASC) – Flow Table Reduction – Races in ASC – State Assignment – Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards – Data Synchronizers – Designing Vending Machine Controller – Mixed Operating Mode Asynchronous Circuits	**9 Hours**
TESTING AND TESTABILITY OF DIGITAL CIRCUITS Introduction to Testing– Path Sensitization Method – Boolean Difference Method – D Algorithm – Sequential circuit testing – Test Generation — DFT Schemes – Built-in Self-Test SOC testing.	**9 Hours**
SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES Programmable devices: architecture of PAL/PLA – PLD – CPLD – FPGA – Synchronous design using programmable devices - – Realization State machine using PLD – FPGA Case Study: – Xilinx FPGA – XC4000 and Vitex	**9 Hours**
RECONFIGURABLE COMPUTING Introduction to reconfigurable processor- Architecture -Reconfigurable Computing, SoC Overview, recent trends in Reconfigurable Processor & SoC, Reconfigurable processor-based DC motor control.	**9 Hours**

Theory Hours: 45	Tutorial Hours: 0	Practical Hours: 0	Total Hours: 45

Learning Resources

Textbooks:

1. Donald G. Givone, “Digital principles and Design”, 1st Edition, Tata McGraw Hill, 2012.
2. Parag K Lala, “Digital System design using PLD” 1st Edition BS Publications, 2003.
3. Joao Cardoso, Michael Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign" Springer, 2011.

References:

1. Charles H. Roth Jr., “Digital System Design using VHDL”, 2nd Edition, Cengage Learning, 2007.
2. Pierre-Emmanuel Gaillardon, Reconfigurable Logic: Architecture, Tools, and Applications, 1st Edition, CRC Press, 2015
3. M Morris Mano and Michael D Ciletti, “Digital Design” 5th Edition, Pearson

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Online Resources (Weblinks)
1. https://www.vlsiguru.com/advanced-digital-design-course/ 2. https://fedevel.com/courses/advanced-digital-hardware-design

Assessment
SA, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. K. Paramasivam]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

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24ETI502	MICROCONTROLLER BASED SYSTEM DESIGN	L	T	P	C
		3	0	2	4
Professional core		SDG	9		

Pre-requisite courses	1. Microcontroller 2. Microprocessors and Architecture	Data Book / Code book (If any)	-

COURSE OBJECTIVES:

The purpose of taking this course is to:

1	Develop an in-depth understanding of the architectural features and operational principles of the PIC microcontroller.
2	Gain proficiency in programming PIC microcontroller peripherals using Embedded C to manage real-world applications.
3	Explore the core concepts and architectural design of the ARM processor to understand its role in modern embedded systems.
4	Apply Embedded C programming techniques to effectively control ARM processor peripherals for diverse applications.
5	Analyze and design hardware interfaces for PIC and ARM microcontrollers to enable seamless integration with external peripherals in consumer devices.

COURSE OUTCOMES

After successful completion of this course, the students shall be able to		Revised bloom's Taxonomy Levels (RBT)
CO 1	Understand the architectural features of PIC Microcontroller.	U
CO 2	Apply the techniques to control PIC peripherals using Embedded C programming.	Ap
CO 3	Understand the fundamentals of ARM processor.	U
CO 4	Apply the instructions to control ARM peripherals using Embedded C programming.	Ap
CO 5	Analyze the I/O hardware interface of PIC & ARM for consumer application with peripherals.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative	Design and develop an appropriate embedded system for commercial
1	2						3
2	2	2	2		2		
3	2						2
4	2	2	2		2		
5	2				2	3	2

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COURSE CONTENT	
PIC16F877 MICROCONTROLLER: Architecture– memory organization – addressing modes – instruction set – I/O port – Timers – UART– Flash and EEPROM memories. **PRACTICAL COMPONENT:** • I/O Programming • LED, DIP Switches	**9 Hours** **6 Hours**
PIC16F877 MICROCONTROLLER PROGRAMMING: Internal structure and Programming: SPI – I^2C bus – A/D converter, D/A converter – CCP modules – Sensor Interfacing – LCD. Programming Tools: MPLABORATORY IDE. **PRACTICAL COMPONENT:** • Timers/ Interrupts programming • Generation of PWM pulse for Motor Control • ADC interfacing with UART communication	**9 Hours** **6 Hours**
ARM ARCHITECTURE: Architecture – Memory organization – Addressing modes – Registers – Pipeline – Interrupts – Coprocessors – ARM processor families – Introduction to DSP on ARM. **PRACTICAL COMPONENT:** • I/O Programming – • LED, DIP Switches	**9 Hours** **6 Hours**
ARM PROGRAMMING: ARM general Instruction set – Thumb instruction set – General purpose I/O programs – Look -up tables – Exception and Interrupt Handling – UART – PWM – Debug support. Programming Tools: KEIL IDE. **PRACTICAL COMPONENT:** • Generation of PWM pulse for Motor Control • Seven segment display	**9 Hours** **6 Hours**
SYSTEM DESIGN-CASE STUDY: Applications development using MPLAB & KEIL IDE. PIC implementation: Generation of Gate signals for Converters and Inverters – ADC using I^2C. ARM Implementation: Frequency counter with display on LCD – Hamming Code. **PRACTICAL COMPONENT:** • ADC / Sensor Interfacing • Interfacing of LCD	**9 Hours** **6 Hours**

Theory Hours:	45	Tutorial Hours:	00	Practical Hours:	30	Total Hours:	75

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Learning Resources
Textbooks:
1. Myke Predko, "Programming and Customizing the PIC Microcontroller", McGraw-Hill, New York, 2007. 2. Andrew Sloss, Dominic Symes, and Chris Wright, ―ARM System Developer's Guide: Designing and Optimizing System‖, Morgan Kaufmann Series, 2004.
References:
1. Raj Kamal, "Embedded Systems – Architecture, Programming and Design", 2nd Edition, Tata McGraw Hill, New Delhi, 2013. 2. Tim Wilmshurst. "Designing Embedded Systems with PIC Microcontrollers. Principles and Application", 2nd Edition - November 7, 2009.
Online Educational Resources:
1. https://www.khanacademy.org/math/differential-calculus 2. https://nptel.ac.in/courses/106105171 3. https://swayam.gov.in/nd1_noc19_cs42/preview

Assessment (Embedded course)
SA, Activity and Learning Task(s)* , Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma Shankar S, Prince Sultan University, Riyadh]	[Dr. J. Ramprabu]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

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24ETT503	REAL TIME OPERATING SYSTEMS	L	T	P	C
		3	0	0	3
PC		SDG	9		

Pre-requisite courses		Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Develop a thorough understanding of real-time systems, their requirements, and the differences between real-time and general-purpose operating systems.
2	Learn about various real-time scheduling algorithms (e.g., Rate-Monotonic, Earliest Deadline First) and their applications in meeting deadlines and ensuring predictable system behaviour.
3	Explore mechanisms for handling concurrency, inter-process communication, and synchronization techniques to prevent race conditions and ensure data integrity in real-time environments.
4	Study how real-time operating systems interface with hardware and integrate with embedded systems to achieve deterministic performance.
5	Gain hands-on experience in designing, developing, and debugging real-time applications using RTOS platforms such as FreeRTOS, VxWorks, or QNX.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Students will be able to analyze, design, and implement real-time systems that meet strict timing and performance requirements using appropriate scheduling algorithms and synchronization techniques.	An
CO 2	Familiarize with key Real-Time Operating System terms and concepts	U
CO 3	Comprehend and use tools to build an embedded real-time system.	Ap
CO 4	Design and implement a simple embedded system.	E
CO 5	Understand the concepts of various RTOS for Embedded system	U

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded system for commercial and industrial
1	2		3				2
2			2				1
3		2	3				2
4	2						
5			3				2

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COURSE CONTENT	
REVIEW OF OPERATING SYSTEMS Basic Principles – System Calls – Files – Processes – Design and Implementation of processes – Communication between processes – Operating System structures.	**9 Hours**
DISTRIBUTED OPERATING SYSTEMS Topology – Network types – Communication – RPC – Client server model -Distributed file system – Design strategies.	**9 Hours**
REAL TIME MODELS AND LANGUAGES Event Based – Process Based and Graph based Models – Petrinet Models –Real Time Languages – RTOS Tasks – RT scheduling - Interrupt processing – Synchronization – Control Blocks – Memory Requirements.	**9 Hours**
REAL TIME KERNEL Principles – Design issues – Polled Loop Systems – RTOS Porting to a Target – Comparison and study of various RTOS like QNX – VX works – PSOS – C Executive – Smart card**.**	**9 Hours**
RTOS APPLICATION DOMAINS RTOS for Image Processing – Embedded RTOS for voice over IP – RTOS for fault Tolerant Applications – RTOS for Control Systems-RTOS for mobile application.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

1. Hermann Kopetz, ―Real Time Systems – Design Principles for Distributed Embedded Applications‖, Springer Science & Business Media, 2011.
2. Charles Crowley, ―Operating Systems-A Design Oriented approach‖ McGraw Hill, 2005.

References:

3. C.M. Krishna, Kang, G.Shin, ―Real Time Systems‖, Tata McGraw Hill, 2010.
4. Raymond J.A.Bhur, Donald L.Bailey, ―An Introduction to Real Time Systems‖, Prentice Hall of India, 2006.
5. Intel Manual on 16-bit embedded controllers, Santa Clara, 2005.

Online Resources (Weblinks)

1. https://ptolemy.berkeley.edu/projects/chess/eecs149/overview.html
2. https://cse.unl.edu/~goddard/Courses/RealTimeSystems/Lectures/Lecture6.pdf

Assessment (Theory course)

SA, Activity and Learning Task(s), Mini project, MCQ, End Semester Examination (ESE)

Signature of the BOS Chairman

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. S. Kaliappan]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETT504	AI AND ML FOR EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3
Professional core		SDG	9, 11		

Pre-requisite courses	Embedded Systems, Microcontroller Basics	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To illustrate the constraints and challenges involved in designing embedded systems.
2	To understand the foundational principles of artificial intelligence and machine learning.
3	To explore the types of machine learning, including supervised, unsupervised, and reinforcement learning.
4	To implement basic ML algorithms on embedded hardware.
5	To use tools and frameworks for deploying ML models on embedded systems.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Understand the process of developing machine learning models for embedded systems	U
CO 2	Understand the basic concepts and algorithms in ML and DL	U
CO 3	Understand the optimum use of ML libraries in model deployment	U
CO 4	Analyze the Embedded Hardware and the mode of deployment using ML algorithms for simple applications	An
CO 5	Design and deploy Machine learning models for resource constrained environment	C

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2	3	2					2
3	3	2	2				
4		2	2	3			1
5				2	3	1	2

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COURSE CONTENT	
INTRODUCTION TO AI & MACHINE LEARNING FOR EMBEDDED SYSTEMS: Embedded Systems fundamentals, applications, building blocks & design approach, introduction to AI & Machine Learning, Traditional vs. Embedded Machine Learning-benefits & design challenges.	**9 Hours**
MACHINE LEARNING AND DEEP LEARNING: Understanding Supervised & Unsupervised Machine Learning - comparison- ML & non-ML project. Concepts of Over-training - Classification problems in machine learning-Limitations of Machine Learning - Regression, Classification, Clustering, Reinforcement Learning, Underfitting and Overfitting, Optimization - Introduction to CNN Deep Learning Introduction -Real-Life use cases of Deep Learning	**9 Hours**
TENSORFLOW AND KERAS FRAMEWORK: Introduction to Neural Networks -TensorFlow lite framework for microcontrollers - Case Studies: Person Detection - Wake-Word Detection - Porting Models from TensorFlow to TensorFlow Lite -Debugging. Keras Basics – Keras-Sequential and Functional models- Use case implementation of Keras	**9 Hours**
ARCHITECTURE AND PERIPHERALS: Introduction to STM32 Peripherals: Functional Block, - Clock System, GPIO, Timers & Interrupts, Serial Communication- configuration– Audio SENSOR Interfacing - Audio Datalogger – Motion sensor datalogger-Deployment of projects for Audio Classification and Anamoly detection	**9 Hours**
EMBEDDED AI APPLICATIONS AND AREAS OF IMPACT: Motor fault detection and classification – Case studies focussing Data capturing from sensors, Building, and training a neural network embedded board.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

1. EthemAlpaydin, “Introduction to Machine Learning”, MIT Press, Third Edition, 2014.
2. DonaldNorris , Programming with STM32 Getting Started with the Nucleo Board and C/C++., Mc GrawHill Education, Newyork (2018).

References:

1. K. P. Murpthy, ―Machine Learning: A probabilistic perspective‖, MIT Press, 2012.
2. M. Mohri, A. Rostamizadeh, and A. Talwalkar, ―Foundations of Machine Learning‖, MIT Press,2012.
3. AurelienGeron, Hands-On Machine Learning with Scikit-Learn, Keras and Tensor Flow: Concepts, Tools and Techniques to Build Intelligent Systems, O’Reilly, Third edition 2023
4. Stuart J Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach", 3rd Edition, Prentice Hall of India, Pearson Education, New Delhi, 2021.

Online Educational Resources:

1. www.SkillsBlock.in

Signature of the BOS Chairman

Assessment (Theory course)
SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETT505	EMBEDDED LINUX AND REAL - TIME SYSTEMS	L	T	P	C
		3	0	0	3
Professional core		SDG	9, 11		

Pre-requisite courses	Operating System Basics	Data Book / Code book (If any)	-

COURSE OBJECTIVES:

The purpose of taking this course is to:

1	Understand Linux architecture, commands, and system programming concepts for application development.
2	Understand real-time system concepts, Linux kernel, and preemption mechanisms.
3	Understand real-time scheduling policies, POSIX threads, and synchronization mechanisms
4	Understand IPC mechanisms and deterministic memory management in RT Linux.
5	Understand embedded Linux development, device drivers, and real-time performance tools

COURSE OUTCOMES

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Apply Linux commands and system calls to develop basic programs.	Ap
CO 2	Understand real-time scheduling, determinism, and RT Linux kernel features	U
CO 3	Develop multithreaded programs using scheduling and synchronization techniques.	Ap
CO 4	Implement IPC mechanisms for real-time application development.	Ap
CO 5	Develop embedded real-time applications and analyze system performance.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2	2				2
2	3	3	2				3
3	3		3				3
4		2	2	2	2		3
5		3	3		2	2	3

COURSE CONTENT

LINUX BASICS AND SYSTEM PROGRAMMING Linux Operating System Overview – Linux Architecture: Kernel, Shell, File System – Linux File System and File Operations – Basic Linux Commands and Shell Scripting – Process Management: fork(), exec(), wait() – Linux System Calls – Introduction to POSIX Standards	**9 Hours**

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REAL-TIME SYSTEMS AND RT LINUX OVERVIEW Real-Time Systems: Hard, Soft, Firm – RTOS vs General Purpose OS – Determinism and Latency – Linux Kernel Architecture – Kernel Preemption – Introduction to PREEMPT_RT Real-Time Scheduling Overview.	**9 Hours**
REAL-TIME SCHEDULING AND THREADS Real-Time Scheduling Policies – Process Priority and Context Switching – POSIX Threads – Thread Scheduling – Thread Synchronization (Mutex, Semaphore) – Priority Inversion and Priority Inheritance.	**9 Hours**
REAL-TIME IPC AND MEMORY MANAGEMENT Pipes and FIFOs – Message Queues – Shared Memory – Sockets – Real-Time Signals and Timers – Memory Management in RT Linux –Memory Locking and Deterministic Allocation	**9 Hours**
EMBEDDED RT LINUX AND DEVICE DRIVERS Embedded Linux Overview – Cross Compilation – Buildroot / Yocto Overview – Board Support Package – Introduction to Device Drivers – Interrupt Handling in Linux – Real-Time Performance Tools	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources
Textbooks:
References:
1. Gene Sally, **"***Pro Linux Embedded Systems",* Apress (Springer), 2010. 2. Karim Yaghmour **"***Building Embedded Linux Systems",* O'Reilly Media, 2008. 3. Daniel P. Bovet, Marco Cesati, "*Understanding the Linux Kernel",* O'Reilly Media, 2005. 4. Phillip A. Laplante, "*Real-Time Systems Design and Analysis",* Wiley, 2011. 5. Jane W. S. Liu , "*Real-Time Systems",* Pearson, 2000.
Online Educational Resources:

Assessment (Theory course)
SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R. S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

SEMESTER - II

(Syllabus)

Signature of the BOS Chairman

24ETT601	GPU ARCHITECTURES AND PROGRAMMING	L	T	P	C
		3	0	0	3
Professional core		SDG	9		

Pre-requisite courses		Data Book / Code book (If any)	-

COURSE OBJECTIVES:

The purpose of taking this course is to:

1	To understand GPU Architecture & Parallelism Concepts
2	To develop CUDA-Based Parallel Programs
3	To analyse and Resolve Programming Challenges
4	To optimize Performance of GPU Applications
5	To explore OpenCL and GPU-based Algorithms

COURSE OUTCOMES

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Understand working proficiency with CUDA, algorithmic GPU programming and parallel computing	U
CO 2	Comprehend with classic scientific computing algorithms and problems	An
CO 3	Optimize GPU code and debug GPU code	Ap
CO 4	OpenCL basics and frameworks to develop efficient GPU-accelerated applications.	An
CO 5	Apply learning algorithms on embedded GPUs	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2	3				3
2	3	3					2
3		3	3				3
4	2		3		2		3
5		3	3		2	2	3

COURSE CONTENT

GPU ARCHITECTURES:	**9 Hours**
Introduction to the ideas of parallelism and the GPU programming model CPU vs GPU Parallelizing algorithms on paper, CUDA Hardware Overview - Threads, Blocks, Grids, Warps, Scheduling - Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory.	

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CUDA PROGRAMMING: Hardware of Graphics Processing Units and parallel communication patterns, Brief on GPU architecture, Basics of CUDA C, Floating point precision and support on GPUs	**9 Hours**
PROGRAMMING ISSUES COMMON PROBLEMS: CUDA ERROR HANDLING, PARALLEL PROGRAMMING Issues, Synchronization, Algorithmic Issues, Finding and Avoiding Errors. Optimizing CUDA Applications: Problem Decomposition, Memory Considerations.	**9 Hours**
OPENCL BASICS: OpenCL Standard – Kernels – Host Device Interaction – Execution Environment – Memory Model – Basic OpenCL Examples.	**9 Hours**
ALGORITHMS ON GPU PARALLEL PATTERNS: Convolution, Prefix Sum, Sparse Matrix - Matrix Multiplication - Programming Heterogeneous Cluster.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

References:

1. GPUs for Graphics: OpenGL 4.0 Shading Language Cookbook, 2nd Edition.
2. Jason Sanders, Edward Kandrot, CUDA by Example: An Introduction to General-Purpose GPU Programming, Publisher: Addison-Wesley Professional,2013, 3rd Edition.
3. Shane Cook, CUDA Programming: A Developer's Guide to Parallel Computing with GPUs (Applications of GPU Computing), First Edition, Morgan Kaufmann, 2012.
4. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, ―Heterogeneous computing with OpenCL‖, 3rd Edition, Morgan Kauffman, 2015
5. Nicholas Wilt, ―CUDA Handbook: A Comprehensive Guide to GPU Programming, Addison - Wesley, 2013.
6. Jason Sanders, Edward Kandrot, ―CUDA by Example: An Introduction to General Purpose GPU Programming‖, Addison - Wesley, 2010.

Assessment (Theory course)

SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By

Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R. S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETI602	EMBEDDED IOT AND COMPUTING	L	T	P	C
		2	0	2	3
Professional core		SDG	11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Understand the architecture and design principles of Embedded IoT systems.
2	Learn to integrate sensors, actuators, and microcontrollers for IoT applications.
3	Master communication protocols such as MQTT, HTTP, and CoAP.
4	Understand networking and security concept for IoT.
5	Design and deploy IoT applications for real-world scenarios.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Understand the basic concepts of IoT deployment in resource constrained environments.	U
CO 2	Understand the concepts of Sensors actuators and microcontrollers for IoT applications.	U
CO 3	Understand the communication protocols specific to IoT modules	U
CO 4	Understand the networking and security concepts for IoT	U
CO 5	Design and deploy simple IoT applications using appropriate communication protocols	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3						3
2	3	2	2				
3	3		2				2
4	3		2		2		
5			3		3	2	1

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COURSE CONTENT	
OVERVIEW AND BASICS: Overview of IoT and Embedded Systems - Applications and Use Cases of IoT - Hardware Components: Microcontrollers, Sensors, and Actuators - Overview of IoT Platforms and Ecosystems - Microcontroller and Microprocessor Basics - Programming Microcontrollers (C/C++, Python)	**10 Hours**
ELEMENTS AND PROTOCOLS: Introduction to Arduino, Raspberry Pi, and ESP32 - Digital and Analog Input/Output - Types of Sensors (Temperature, Proximity, Light, etc.) - Actuator Basics (Motors, Relays, etc.) - Overview of IoT Communication Protocols - Wired Protocols: UART, SPI, I2C - Wireless Protocols: Wi-Fi, Bluetooth, Zigbee, LoRa, and 6LoWPAN-MQTT, CoAP, and HTTP for IoT	**10 Hours**
IP ADDRESSING AND NETWORK CONFIGURATIONS, SECURITY FOR IOT Cloud Platforms for IoT: AWS IoT, Azure IoT, Google Cloud IoT - Data Management and Analytics in the Cloud - Edge Computing vs. Cloud Computing - IoT Security Challenges and Best Practices - Encryption and Authentication Protocols - Case Studies on IoT Security Breaches	**10 Hours**
Practical 1. Familiarize with IoT development platforms such as Arduino, Raspberry Pi 2. Sensor Integration and Data Acquisition 3. Actuator Control 4. Wireless Communication Implementation 5. Smart home automation	**30 Hours**

Theory Hours:	30	Tutorial Hours:	00	Practical Hours:	30	Total Hours:	60

Learning Resources

Textbooks:

1. Peter Marwedel, "Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, and the Internet of Things", Springer Nature Switzerland AG; 4th ed (2022).
2. Rajkumar Buyya, Amir Vahid Dastjerdi, "*Internet of Things: Principles and Paradigms''*, Elsevier Science Publisher, USA (2016).

References:

1. S. Misra, A. Mukherjee, and A. Roy, "Introduction to IoT", Cambridge University Press, New Delhi, 2021.
2. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and Sons Ltd, UK, 2014.
3. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", John Wiley and Sons Ltd., UK 2012.
4. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer, New York, 2011.

Signature of the BOS Chairman

Online Educational Resources:
1. https://www.khanacademy.org/math/differential-calculus 2. https://nptel.ac.in/courses/106105171 3. https://swayam.gov.in/nd1_noc19_cs42/preview

Assessment (Embedded course)
SA, Activity and Learning Task(s)* , Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R. S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETT603	HDL PROGRAMMING	L	T	P	C
		3	0	2	4
Professional core		SDG	9		

Pre-requisite courses		Data Book / Code book (If any)	-

COURSE OBJECTIVES:

The purpose of taking this course is to:

1	Describe the functional requirements of the Hardware description language
2	Apply VHDL Concept to digital design
3	Dramatize digital design using Verilog HDL
4	Develop sequential design using Verilog HDL.
5	Describe the functional concepts of system C.

COURSE OUTCOMES

After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Acquire the Knowledge in VHDL constructs.	U
CO 2	Acquire the knowledge of programming structure of simple and complex design.	Ap
CO 3	Demonstrate knowledge of HDL design flow, digital circuits design, switch de bouncing, metastability, memory device applications	Ap
CO 4	Design and develop the combinational and sequential circuits using behavioural modelling	Ap
CO 5	Acquire the knowledge of different data types and model the combinational logic using system C.	U

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	2		3				2
2		2	3		1	2	2
3	2	2	3	2	2		2
4	2		2				2
5	2		2				3

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COURSE CONTENT	
VHDL FUNDAMENTALS: Fundamental Concepts – Modeling Digital Systems – Domains and Levels of Modeling – Modeling Languages – VHDL Modeling concepts – Scalar Data Types and Operations – Constants and variables – Scalar Types – Type Classification – Attributes and Scalar types – Expressions and operators – Sequential Statements – If statements – Case statements – Null Statements **Lab Experiments using VHDL** Adder, subtractor MUX and DMUX 4-bit Parallel adder	**9 Hours** **6 Hours**
COMPOSITE DATA TYPES AND BASIC MODELING CONSTRUCTS: Arrays – Unconstrained Array types – Array Operations and Referencing – Records – Basic Modeling Constructs – Entity Declarations – Architecture Bodies – Behavioral Descriptions – Structural Descriptions – Design Processing. Case Study: A pipelined Multiplier **Lab Experiments using VHDL** Combinational circuit design 4x4 Array multiplier Shift registers	**9 Hours** **6 Hours**
INTRODUCTION TO LOGIC DESIGN WITH VERILOG: Structural models of combination logic, logic simulation, design verification, test methodology, propagation delay, truth table models of combinational and sequential logic with verilog modules, ports, gate types, gate delays, data flow modelling, continuous assignments delays, expressions, operators, operands, operator types **Lab Experiments using Verilog HDL** Simple program in logic gates Decoder, encoder MUX and DMUX	**9 Hours** **6 Hours**
LOGIC DESIGN WITH BEHAVIORAL MODELS OF COMBINATIONAL AND SEQUENTIAL LOGIC: Behavioral modeling, data types for behavioral modeling, behavioral models of combinational logic, propagation delay and continuous assignments, latches and level sensitive circuits in verilog, cyclic behavioural models of flip flops and latches, cyclic behavior and edge detection, a comparison of styles for behavioral modeling. **Lab Experiments using Verilog HDL** Counter design Combinational design using structural description Multiplier design Parallel adder FPGA implementation of digital design.	**9 Hours** **12 Hours**
SYSTEM C: Overview, Design methodology, capabilities and System C-RTL. Data types: Value Holders, Summary of types, bit type, Logic type, signed integer, unsigned integer, resolved and user defined types. Modeling of Combinational Logic: File structures, Reading and writing ports, signals, logic operators, arithmetic operators-unsigned, signed, relational operators, vectors and ranges, if statement, switch statement, loops, methods, structures, multi processes and delta delays.	**9 Hours**

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Theory Hours:	45	Tutorial Hours:	00	Practical Hours:	30	Total Hours:	75

Learning Resources
Textbooks:
References:
1. Peter J. Ashenden, “The Designer’s Guide to VHDL”, 3rd Edition,Morgan Kaufmann Publishers, 2008, San Francisco. 2. ZainalabedinNavabi, “VHDL Analysis and Modeling of DigitalSystems”, 2nd Edition, McGraw Hill International Editions, 2013. 3. James M.Lee, “Verilog Quick start”, 3rd Edition, Kluwer AcademicPublishers, 2002. 4. Michael D Ciletti - Advanced Digital Design with the VERILOG HDL, 2ND Edition, PHI, 2009 5. Samir Palnitkar - Verilog HDL, 2nd edition, Pearson Education, 2003. 6. J. Bhasker, A SystemC Primer, Star Galaxy Publishing, Second Edition, 2010 7. David Black, Jack Donovan, Bill Bunton and Anna Keist, SystemC: From the Ground Up, Springer, Second Edition, 2009
Online Educational Resources:
1. www.SkillsBlock.in

Assessment (Embedded course)
SA, Activity and Learning Task(s)* , Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.V.Kandasamy]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETT604	RESEARCH METHODOLOGY AND STATISTICS	L	T	P	C
		3	0	0	3
Professional core		SDG	9		

Pre-requisite courses		Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To introduce students to the fundamental concepts of scientific research and enable them to identify and formulate research problems effectively.
2	To develop the ability to apply statistical methods for organizing, summarizing, and interpreting data.
3	To provide knowledge of statistical modelling and hypothesis testing techniques for data-driven decision making.
4	To equip students with skills to design ethical and effective research plans, including appropriate data collection methods.
5	To enhance students' ability to prepare structured research reports and communicate findings clearly and professionally.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Apply the scientific methods to identify and formulate research problems for effective research planning.	Ap
CO 2	Analyze statistical data to summarize and describe the characteristics of the data effectively.	An
CO 3	Evaluate statistical models and perform hypothesis testing to make informed decisions based on data.	Ap
CO 4	Design comprehensive research plans incorporating ethical standards and appropriate data collection methods.	Ap
CO 5	Create structured research reports that effectively present and analyze data to communicate findings clearly.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative	Design and develop an appropriate embedded system for commercial and industrial application by using optimum resources with better performance.
1	3	3	3		2		
2	3	2	2		2		
3	2	3	3		2		
4	2	3	3		2		
5	2	2	2		2		

Signature of the BOS Chairman

COURSE CONTENT	
INTRODUCTION TO RESEARCH METHODS: Definition and Objectives of Research, Scientific Methods, Various Steps in Scientific Research, Research planning, Selection of a Problem for Research, Formulation of the Selected Problems, Purpose of the Research, Formulation of research objectives, Formulation of research questions, Hypotheses Generation and Evaluation, Literature search, and review, Research abstract.	**9 Hours**
INTRODUCTION TO STATISTICS: Population and Sample, Sampling and sample size, Population Proportion and Population Mean, Sample Proportion and Sample Mean, Estimation of Standard Error and confidence Interval, Identifying the dependent and independent variables, Introduction to data, Types of data and their importance, Descriptive Statistics and Inferential Statistics, Summarizing and describing data, Measures of Central Tendency and Measures of Dispersion, Mean, Median, Mode, Range, Variance, Standard Deviation.	**9 Hours**
STATISTICAL MODELING AND ANALYSIS: Probability Distributions, Normal, Binomial, Poisson, Fundamentals of Statistical Analysis and Inference, Hypothesis Testing, Confidence interval, Test of Significance, Comparison of Means (T test, Z test), Analysis of variance (ANOVA), Measures of association/Relationship, Chi-square test, Simple Regression Analysis, Multiple Regression analysis, Correlation, Data visualization techniques.	**12 Hours**
RESEARCH DESIGN/PLAN: Types and Methods of Research, Classification of Research, Research Ethics, Sampling Techniques, Methods of Collecting Primary Data, Use of Secondary Data, Experimentation, Design of Experiments, Survey Research and Construction of Questionnaires, Pilot Studies and Pre-tests, Data Collection methods, Processing of Data, Editing, Classification and Coding, Transcription, Tabulation, Validity and Reliability.	**6 Hours**
RESEARCH REPORTS: Structure and Components of Research Report/thesis, Types of Report, Planning of Report/thesis Writing, Research Report Format, Layout of Research Report, Presentation of data and Data Analysis Reporting, Mechanism of writing a research report, Principles of Writing, Writing of Report.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

1. Ranjit Kumar, Research Methodology a Step-by-Step Guide for Beginners, 4th Edition, Sage Publishing, 2014.

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References:
1. C.R. Kothari, Research Methodology Methods and Techniques, 3/e, New Age International publishers, 2014. 2. R. Pannerselvam, Research Methodology, 2nd edition, Prentice Hall India, 2014. 3. Devore, J.L., Probability and statistics for Engineering and the Sciences, Cengage Learning, ebook, 8th edition, 2010.

Assessment (Theory course)
SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.V.Kandasamy]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

Professional Electives (Syllabus)

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24ETE501	CLOUD COMPUTING AND FOG COMPUTING	L	T	P	C
		3	0	0	3
Professional elective		SDG	9, 11		

Pre-requisite courses	Digital Electronics	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To introduce the core concepts, architecture, and challenges of cloud and fog computing, emphasizing virtualization and resource management
2	To understand various cloud service models and architectures and multi-tenancy in service management.
3	To explore cloud deployment models and virtualization technologies, highlighting their role in secure and scalable cloud infrastructure.
4	To examine the fundamentals and architecture of fog computing and its integration with IoT and edge systems.
5	To analyze fog computing protocols and apply them through case studies in domains like transportation, healthcare, and agriculture.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Explain the architecture, types, characteristics, and challenges of cloud computing, and distinguish it from fog and edge computing models.	U
CO2	Describe and compare various cloud service models and architectures and evaluate their effectiveness for different application scenarios.	U
CO3	Apply virtualization technologies and analyse their role in different cloud deployment models and security frameworks.	Ap
CO4	Understand the role of fog computing in IoT systems and analyse its architecture and benefits compared to traditional cloud models.	An
CO5	Evaluate fog computing protocols and examine their real-world applications across diverse industry sectors.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	PSO1
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2	3	2				2	2
3	3	2	3			2	3
4	2	2			2		3
5		2		2	2		3

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COURSE CONTENT

UNDERSTANDING CLOUD AND FOG COMPUTING Basic Concepts and Terminology - Cloud Computing Architectural Framework - Types of Clouds - pros and cons of cloud computing – Cloud Characteristics-Key challenges in cloud computing - Major Cloud players - Virtualization in Cloud Computing - Parallelization in Cloud Computing - cloud resource management – Cloud Enabling Technology.	**9 Hours**
CLOUD SERVICE MODELS Software as a Service (SaaS) - Infrastructure as a Service (IaaS)- Platform as a Service (PaaS)- Web services – Service Oriented Architecture (SoA) - Elastic Computing - On Demand Computing Service Management in Cloud Computing - Multi-tenancy computing architecture.	**9 Hours**
CLOUD DEPLOYMENT MODELS Public cloud – Private Cloud –Hybrid cloud – Community cloud - Need for virtualization – Types of Virtualizations – Virtualization OS – VMware, KVM – System VM – Process VM - Virtual Machine Monitor – Properties – Cloud Computing Security	**9 Hours**
FOG COMPUTING Fog Computing-Definition-Characteristics-Application Scenarios –Fog Computing and Internet of Things-Pros and Cons -Need and Reasons for Fog Computing- Fog Computing and Edge Computing-IoT, FOG, Cloud Benefits-Fog IoT architectural model, Challenges on IoT Stack Model via TCP/IP Architecture.	**9 Hours**
FOG PROTOCOLS AND CASE STUDIES Fog Protocol-Fog Kit- Proximity Detection Protocols- DDS/RTPS computing protocols – Case Studies: Smart Transportation & Autonomous Vehicles, Industrial IoT (IIoT) & Smart Manufacturing, **Healthcare & Remote Patient Monitoring,** Agriculture & Environmental Monitoring.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

References:

1. Cloud computing concepts, technology and Architecture – Thomas Erl, Zaigham Mahmood, Ricardo Puttini , Pearson , 2017. 2.Instant Guide to Cloud Computing, Anand Nayar (Ed), Ashokkumar, sudeep Tanwar, BPB, 2019.
2. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India, 2010.
3. Fog Computing: Theory and Practice by Assad Abbas, Samee U. Khan, Albert Y. Zomaya
4. 2. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: Packt Publishing, 2020, ISBN: 9781839214806
5. Fog and Edge Computing: Principles and Paradigms (Wiley Series on Parallel and Distributed Computing) by Rajkumar Buyya and Satish Narayana Srirama

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Assessment (Theory course)
SA, Activity and Learning Task(s)* , Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R. S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE502	COMMUNICATION AND NETWORK TECHNOLOGIES	L	T	P	C
		3	0	0	3
Professional elective		SDG	9		

Pre-requisite courses	Embedded system	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To understand the fundamentals of digital and analog signal communication and its differences.
2	To explore communication protocols, error control techniques, functionalities of the data link, network, and transport layers.
3	To examine the layered design of computer networks, including OSI and TCP/IP models and their respective protocols.
4	To understand various networking models, architectures, and real-world applications
5	To analyze real-world data communication networks through case studies of modern, large-scale networking infrastructures and deployments.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Understand the fundamental concepts of data communication including signal types, transmission methods, and the role of physical media and connecting devices.	U
CO2	Analyze communication protocols across data link, transport, and network layers, including error control, MAC, and channelization techniques.	An
CO3	Compare and contrast OSI and TCP/IP reference models and describe their layer-wise functions and services in network communication.	Ap
CO4	Classify and evaluate different networking models and applications and explain access and communication over modern example networks.	An
CO5	Analyze the architecture and operational strategies of large-scale data center networks	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2	3	3	2				3
3	3	2					2
4		2	3		2		3
5			3	2	2		3

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COURSE CONTENT

DATA COMMUNICATION CONCEPTS & COMPONENTS Digital and Analog Data and Signals - Asynchronous and Synchronous transmission- Nyquist Bit Rate, Shannon Capacity - Connecting Devices & Transmission Media: Network Interface Cards, Connectors, Hubs, Transceivers & Media Connectors; Link-Layer Switches, Bridge, Routers, Gateways, Virtual LANs- Basics of Data Encoding and Modulation Techniques	**9 Hours**
COMMUNICATION LAYERS, PROTOCOLS AND STANDARDS Data Link Layer – Data Link layer Protocols - Error Control: Error Detection and Correction; Sliding Window Flow Control Protocols - Media Access Control - Collision free protocols with Controlled Access - Channelization: FDMA, TDMA, CDMA; IEEE LAN standards: Ethernet - IEEE 802.11 Wireless LAN; Wi-Max; Bluetooth – Transport Layer- Network Layer – Congestion Control and Quality of Services (Introduction)	**9 Hours**
NETWORK CHARACTERIZATION Goals and Applications; Categorization according to Size, Purpose, Design issues & Transmission Technologies; Network Architecture and Service Models; Design issues for the Layers; OSI and TCP/IP Reference Models; Functions of layers and protocols of TCP/IP; Comparison of OSI & TCP/IP; Data Transmission using TCP/IP.	**9 Hours**
NETWORKING MODELS & APPLICATIONS Centralized, Decentralized, and Distributed; Client-Server and Peer-to-Peer; File sharing & Web-based; Content Distribution Networks. Introduction to Example Networks: The Internet and its Conceptual View; Accessing the Internet; Connection-Oriented Networks: X.25, Frame Relay and ATM.	**9 Hours**
CASE STUDIES Google's Data Center Networking - Facebook's Express Backbone - Cisco Smart Grid Network for Energy - AT&T 5G Network Deployment - Mumbai Monorail Network Communication System	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources
Textbooks:
References:
1. Aunurag Kumar, D. Manjunath, Joy Kuri, "Communication Networking", Morgan Kaufmann Publishers, 2011. 2. J.F. Kurose & K.W. Ross, "Computer Networking- A Top-Down Approach Featuring the Internet", Pearson, 2nd Edition, 2003. 3. Nader F.Mir, "Computer and Communication Networks", Pearson Education, 2009. 3. B.Sklar, "Digital Communications, Fundamentals and Applications", 2nd Edition, Pearson Education 2007. 5. Andrew S.Tanenbaum, "Computer Networks", Pearson Education, Inc., 2003

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Online Educational Resources:
https://onlinecourses.nptel.ac.in/noc21_ee09/preview

Assessment (Theory course)
SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R. S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE503	DATA ANALYTICS	L	T	P	C
		3	0	0	3
Professional elective		SDG	9, 11		

Pre-requisite courses		Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To provide foundational knowledge in data science,
2	To introduce the fundamentals of the Internet of Things (IoT)
3	To apply data science techniques to IoT environments
4	To explore advanced and emerging applications of IoT and data science

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Apply core concepts of mathematics, statistics, and programming to solve basic data science problems involving data preprocessing, management, and visualization.	Ap
CO2	Understand the architecture, components, and communication protocols of IoT systems, including sensors, microcontrollers, and embedded programming.	U
CO3	Integrate machine learning and analytics techniques into IoT systems for real-time decision-making, anomaly detection, and predictive maintenance.	Ap
CO4	Analyze the role of IoT and data science across various industry domains and propose relevant solutions to real-world problems.	An
CO5	Explore advanced technologies such as CEP, Blockchain, and Quantum Computing and evaluate their potential in enhancing IoT systems.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2	2				2
2	3	2	2				3
3		3	3	2	2		3
4		3		2	2		2
5			2		3		2

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COURSE CONTENT

FOUNDATIONAL DATA SCIENCE: Mathematics and Statistics: Linear Algebra -Calculus -Probability and Statistics Programming Basics: Python and R - Data Management: Databases (SQL, NoSQL)- Data warehousing - Machine Learning: Supervised and unsupervised learning algorithms - Deep learning concepts Data Visualization: Introduction to Tools like Tableau, Matplotlib, Seaborn	**12 Hours**
IOT FUNDAMENTALS: Introduction to IoT: Definitions, characteristics, and architectures of IoT - Physical and logical design of IoT - Enabling technologies (sensors, actuators, etc.) - IoT frameworks and protocols (MQTT, CoAP, etc.); IoT Hardware and Software: Microcontrollers (Arduino, Raspberry Pi) - Embedded systems programming; IoT Networking: Wireless technologies (Wi-Fi, Bluetooth, Zigbee, etc.) - Cloud platforms for IoT (AWS, Azure, Google Cloud)	**12 Hours**
DATA SCIENCE FOR IOT: Data Acquisition and Preprocessing - IoT Analytics: Big data analytics for IoT - Edge computing and analytics -Network analytics; Machine Learning for IoT: Predictive maintenance - Anomaly detection -Pattern recognition; Cloud Computing for IoT: Security in IoT: Challenges and solutions for IoT security	**10 Hours**
APPLICATIONS OF IOT AND DATA SCIENCE: Smart Cities - Industrial IoT (IIoT) – Health care - Other Applications: Agriculture, retail, logistics, etc.	**6 Hours**
ADVANCED TOPICS: Complex Event Processing (CEP): Real-time data analysis and pattern detection; Blockchain for IoT: Secure data management and transactions in IoT; Quantum Computing for IoT: Potential applications in data processing and security.	**5 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

References:

1. Deisenroth, M. P., Faisal, A. A., & Ong, C. S. (2020). *Mathematics for Machine Learning*. Cambridge University Press.
2. Ross, S. M. (2014). *Introduction to Probability and Statistics for Engineers and Scientists* (5th ed.). Academic Press. ISBN 978-0-12-3948113.
3. McKinney, W. (2022). *Python for data analysis: Data wrangling with pandas, NumPy, and Jupyter* (3rd ed.). O'Reilly Media.
4. Grolemund, G., & Wickham, H. (2017). *R for Data Science: Import, Tidy, Transform, Visualize, and Model Data*. O'Reilly Media.
5. Bahga, A. & Madisetti, V. (2014). *Internet of Things: A Hands-On Approach*. VPT/Create-Space Inc., Atlanta. ISBN 978-0996025515
6. Mukhopadhyay, D., Bhattacharyya, S., Krishnan, B., & Roy, S. (Eds.). (2023). *Blockchain for IoT* (1st ed.). Chapman & Hall.
7. Hidary, J. D. (2019). *Quantum Computing: An Applied Approach*. Springer International Publishing. ISBN 978-3-030-23921-3

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Assessment (Theory course)
SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R. S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE504	INDUSTRY 5.0	L	T	P	C
		3	0	0	3
Professional elective		SDG	9, 11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To understand the evolution of industrial revolutions
2	To identify the core principles of Industry 5.0
3	To understand the role of AI,IoT and other technologies in human-centric systems.
4	To apply human-centred design and ethics in innovation.
5	To promote sustainable and resilient manufacturing.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Understand Industry 4.0 concepts, technologies, and limitations, and explain their role in enabling the transition to Industry 5.0.	U
CO 2	Understand the benefits of digital transformation in Industry 5.0	U
CO 3	Understand and integrate advanced technologies in Human-Centric systems	U
CO 4	Familiarize the cyber security in industry	Ap
CO 5	Familiarize the basics and processor for reconfigurable computing	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3				2		2
2		2			3		2
3	2		2		2		3
4				2	3	2	2
5	3		3		2		3

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COURSE CONTENT

OVERVIEW OF INDUSTRY 4.0 Evolution of Industrial Revolutions- Introduction to Industry 4.0- Core Technologies of Industry 4.0- Applications of Industry 4.0- Benefits of Industry 4.0- Challenges and Limitations of Industry 4.0- Transition from Industry 4.0 to Industry 5.0- Industry 4.0 vs Industry 5.0	**9 Hours**
FOUNDATIONS OF INDUSTRY 5.0 Emergence and key characteristics Opportunities and Challenges – Drivers of Industry 5.0 – Digital Literacy and Emerging Technologies **-** Digital business transformation - Retail industry, Urban Development, e-Governance and the public sector, Elements of Society 5.0, Data Driven to Society, Humanity Vs Society 5.0.	**9 Hours**
CORE TECHNOLOGIES Artificial Intelligence and Machine Learning – Human Robot Collaboration and Safety Standards -Edge Computing -Industrial IoT – Block Chain Integration – Next Generation Sensors - Collaborative Platform and Product Lifecycle Management, Big Data and Advanced Analysis.	**9 Hours**
CYBER SECURITY IN INDUSTRY 5.0 Architecture of CPS - Data science and technology for CPS - Emerging applications in CPS including social space, crowd sourcing, Networking systems for CPS applications - Wearable cyber physical systems and applications, -Intellectual Property Rights (IPR)	**9 Hours**
CASE STUDIES Manufacturing and Smart Factories – Health Care and Medical Technology – Agriculture and Food Production – Logistics and Supply Chain – Assistive Technology and Human Augmentation	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Online Educational Resources:

1. https://www.udemy.com/course/introduction-to-industry-50/
2. https://www.online.vtu.ac.in/course-details/Introduction-To-Industry-40-And-Industrial-Internet-Of-Things

References:

1. Elena G. Popkova, Yulia V. Ragulina, Aleksei V. Bogoviz, Industry 4.0: Industrial Revolution of the 21st Century, Springer, 1sted 2019 edition.
2. Oliver Grunow, SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies", Studylab Publications, 2016.
3. Allam Hamdan, Arezou Harraf , Amina Buallay , Pallvi Arora, Hala Alsabatin, "From Industry 4.0 to Industry 5.0: Mapping the Transitions", Springer, 2011
4. Fabio De Felice, Antonella Petrillo, Digital Effects, Strategies, and Industry 5.0, First Edition, CRC Press, 2024.
5. Rijwan Khan, Pushkar Praveen Infrastructure Possibilities and Human-Centered Approaches with Industry 5.0, IGI-Global Scientific Publishing, 2024

Signature of the BOS Chairman

Assessment (Theory course)
SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.V.Kandasamy]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE505	BLOCK CHAIN TECHNOLOGY	L	T	P	C
		3	0	0	3
Professional elective		SDG	9		

Pre-requisite courses	Digital Electronics	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To understand the origin and working principles of blockchain technology
2	To explore core cryptographic concepts that underpin blockchain security.
3	To study the architecture and operations of Bitcoin and methods of storage and usage.
4	To analyze the process of Bitcoin mining and its implications for anonymity and privacy.
5	To examine real-world blockchain applications through case studies, focusing on domains such as supply chains, healthcare, agriculture, and energy trading.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Understand the foundational concepts and origin of blockchain technology and evaluate its potential to transform traditional business networks.	U
CO2	Understand and apply cryptographic concepts such as hash functions, Merkle trees, and digital signatures in the context of blockchain.	U
CO3	Analyse the principles of decentralization and evaluate various consensus mechanisms like proof of work used in blockchain networks.	An
CO4	Examine Bitcoin architecture and transactions and interpret storage methods and exchange mechanisms in cryptocurrency systems.	An
CO5	Apply blockchain concepts to analyse real-world use cases across sectors such as healthcare, agriculture, and energy	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2			2		2
2	3		2				2
3		3		2			2
4	2	2			2		2
5		3			2	2	3

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COURSE CONTENT

BLOCK CHAIN FUNDAMENTALS Tracing Block chain's Origin, Revolutionizing the Traditional Business Network, How Blockchain Works, What Makes a Blockchain Suitable for Business? Introduction to Cryptography: Cryptographic Hash Functions, SHA256, Hash Pointers and Data Structures, Merkle tree.	**9 Hours**
DIGITAL SIGNATURES Elliptic Curve Digital Signature Algorithm (ECDSA), Public Keys as Identities, A Simple Crypto currency. Centralization vs. Decentralization, Distributed Consensus, Consensus without identity using a block chain, Incentives and proof of work.	**9 Hours**
BIT COIN Bit coin transactions, Bit coin Scripts, Applications of Bit coin scripts, Bit coin blocks, The Bit coin network- Storage of and Usage of Bit coins: Simple Local Storage, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets.	**9 Hours**
BIT COIN MINING The Task of Bit coin miners, Mining Hardware, Mining pools, Mining incentives and strategies. Bit coin and Anonymity: Anonymity Basics, Mixing, Zero coin and Zero cash	**9 Hours**
CASE STUDY Supply Chain Transparency – Healthcare Records -Agricultural Financing - Energy Trading	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

References:

1. BlockChain for dummies, Manav Gupta, Second IBM Limited Edition, 2018, John Wiley & Sons.
2. Bitcoin and Cryptocurrency Technologies, Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, 2016.
3. Blockchain: Blueprint for a New Economy, Melanie Swan, First edition, 2015, O'Reilly Media.
4. Bitcoin: Programming the Open Blockchain, Andreas M. Antonopoulos, Mastering, Second edition, 2017, O'Reilly Media

Online Educational Resources:

Assessment (Theory course)

SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Signature of the BOS Chairman

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.R.Sandhyadevi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE506	AUGMENTED REALITY AND VIRTUAL REALITY	L	T	P	C
		3	0	0	3
Professional elective		SDG	9, 11		

Pre-requisite courses	Embedded system	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To introduce foundational concepts in 3D graphics and immersive technologies.
2	To develop practical skills for designing, building, and deploying AR and VR applications across mobile and headset platforms.
3	To apply C# programming for scripting interactive elements in AR/VR environments
4	To understand the essentials of Virtual Reality development, including device integration
5	To explore real-world applications of AR and VR across industries

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Understand the basic concepts of 3D graphics and distinguish between AR, VR, and MR technologies, including their applications.	U
CO2	Use Unity 3D to design and develop basic AR/VR applications by integrating assets, user interfaces, and physics-based interactions.	U
CO3	Apply C# programming concepts to create interactive features and animations in Unity-based AR/VR projects.	Ap
CO4	Design and deploy immersive VR applications using Unity 3D and C# for platforms like Oculus Quest, considering usability and interface design.	Ap
CO5	Analyse the use of AR/VR across different industries and propose suitable design strategies for domain-specific applications.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2			2		2
2	2		3		2		3
3	2		3				3
4		2	3		2		3
5		3			2	2	2

Signature of the BOS Chairman

COURSE CONTENT

INTRODUCTION TO 3D GRAPHICS AND AR VR FUNDAMENTALS Introduction to 3D graphics concepts – modelling, file formats – texturing – lighting and rendering – animation – AR / VR and MR (Mixed Reality) concepts – mobile phones and headset applications – Basic introduction to AR Core and AR Kit	**9 Hours**
EXPLORING THE UNITY 3D PROGRAMMING TOOLKIT Introduction to Unity 3D Interface – Using Unity 3D to create AR and VR applications – Importing and creating assets – User Interfaces for AR and VR – Combining assets into complex models – Adding physics to the interactions - Creating an AR Application and publishing to a mobile device.	**9 Hours**
C# PROGRAMMING AND SCRIPTING FOR AR AND VR C# programming introduction – data types and classes – programming logic – using C# to write scripts for Unity 3D – Using C# to animate and add advanced interactions to AR and VR models.	**9 Hours**
VIRTUAL REALITY APPLICATION ESSENTIALS Virtual Reality fundamentals – VR design considerations – Using Unity 3D and C# programming to create VR applications – Oculus Quest VR headset fundamentals – User interface considerations - Creating a VR application and publishing to the Oculus VR headsets.	**9 Hours**
INDUSTRY APPLICATIONS OF AR AND VR Industry domains where AR and VR are applied – healthcare, manufacturing, field service, retail and branding – Design considerations while creating domain specific applications – Example industry application	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

References:

1. Schmalstieg, D., & Hollerer, T. (2016). *Augmented reality: Principles and practice*. Addison-Wesley.
2. Sherman, W. R., & Craig, A. B. (2018). *Understanding virtual reality: Interface, application, and design* (2nd ed.). Morgan Kaufmann.
3. Linowes, J. (2018). *Unity virtual reality projects* (2nd ed.). Packt Publishing.
4. Hocking, J. (2022). *Unity in action: Multiplatform game development in C# with Unity* (3rd ed.). Manning Publications.
5. Doran, J. P. (2022). *Unity 2022 mobile game development: Build, run, and publish games for Android and iOS using Unity*. Packt Publishing.

Assessment (Theory course)

SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Signature of the BOS Chairman

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R.S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE507	AI AND ML FOR ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3
Professional elective		SDG	9		

Pre-requisite courses		Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Introduce AI/ML fundamentals and their applications in electric vehicle (EV) systems.
2	Apply machine learning techniques for optimizing battery management, motor control, and energy efficiency in EVs.
3	Analyze vehicle data with AI/ML for predictive maintenance and driver behavior.
4	Integrate AI/ML in real-time control and IoT EV platforms.
5	Design and evaluate AI algorithms for autonomous driving and EV performance.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO1	Understand the fundamentals of AI/ML and their applications in electric vehicle (EV) systems.	U
CO2	Apply machine learning techniques to optimize battery management, motor control, and energy efficiency in EVs.	Ap
CO3	Analyze vehicle data using AI/ML models for predictive maintenance and driver behavior monitoring.	An
CO4	Integrate AI/ML with real-time vehicle control systems and IoT-based EV platforms.	Ap
CO5	Design and evaluate AI-driven algorithms for autonomous driving and EV performance prediction.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2		3	3		2		3
3		3		2	2		3
4			3	2	2		3
5		3	3		2		3

Signature of the BOS Chairman

COURSE CONTENT

INTRODUCTION TO AI, ML AND EV SYSTEMS Overview of Electric Vehicles: Components and Architecture-Introduction to Artificial Intelligence and Machine Learning-Importance of AI/ML in EV ecosystem-EV Sensors and Data Acquisition-Case Studies: AI Applications in EV Industry	**12 Hours**
MACHINE LEARNING FOR BATTERY MANAGEMENT SYSTEMS (BMS) State of Charge (SoC) & State of Health (SoH) Estimation-Supervised Learning: Linear Regression, Decision Trees, SVM-Unsupervised Learning: Clustering for Cell Balancing-Battery Aging Models & Anomaly Detection-Deep Learning for Battery Diagnostics	**12 Hours**
AI IN MOTOR CONTROL AND POWERTRAIN OPTIMIZATION Role of AI in PMSM, BLDC Motor Control-Fuzzy Logic & Neural Networks for Adaptive Control-Reinforcement Learning for Energy Management-ML-based Torque Prediction and Regenerative Braking Optimization-Energy Efficiency & Powertrain Modelling	**10 Hours**
PREDICTIVE MAINTENANCE & TELEMATICS Fault Detection and Prognostics in EV Subsystems-Vehicle Health Monitoring using ML-Telematics & IoT Integration for Data-driven Maintenance-Driver Behavior Analysis using AI Models-AI-based Route Planning and Range Estimation	**6 Hours**
AI IN AUTONOMOUS AND CONNECTED ELECTRIC VEHICLES Sensor Fusion: Lidar, Radar, Camera Data-Computer Vision for Object Detection and Navigation-Path Planning using Deep Reinforcement Learning-V2X Communication and AI for Smart Grid Interaction-Ethics and Safety in AI-based EV Systems	**5 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

References:

1. **"Artificial Intelligence and Machine Learning for EV Applications"** – Compilation of Research Articles (Springer/IEEE Access – Suggested for case-based learning)
2. **"Electric Vehicle Technology Explained"** – James Larminie and John Lowry
3. **"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow"** – Aurélien Géron
4. **"Intelligent Electric Vehicles: Concepts and Applications"** – Amir Khajepour, M. Saber Fallah, Avesta Goodarzi
5. **IEEE Papers and NPTEL/AICTE course material on AI in EVs**

Assessment (Theory course)

SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Signature of the BOS Chairman

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. J. Ramprabu]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE508	EDGE AI AND COMPUTING	L	T	P	C
		3	0	0	3
Professional elective		SDG	9, 11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To introduce the principles and purposes of Edge Computing
2	To understand the IoT architecture and its integration with Edge Computing
3	To explore machine learning and deep learning techniques at the edge
4	To examine hardware and software tools for Edge A
5	To analyze key application areas of Edge AI.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Define and explain the core concepts of Edge Computing and analyze its relevance across various use cases and hardware architectures.	U
CO 2	Illustrate the IoT architecture and differentiate IoT, M2M, and SCADA systems with real-world case studies such as telemedicine and connected ecosystems.	U
CO 3	Apply machine learning and deep learning algorithms at the edge by utilizing lightweight libraries like TensorFlow Lite and PyTorch Mobile for real-time AI applications.	Ap
CO 4	Examine various edge AI hardware platforms and programming tools to implement efficient edge-based AI solutions with hardware accelerators.	An
CO 5	Evaluate domain-specific applications of Edge AI in fields like Industrial IoT, healthcare, smart cities, autonomous vehicles, and robotics.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2			2		2
2	3	2			2		2
3		3	3		2		3
4	2		3		2		3
5		3			2	2	3

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COURSE CONTENT

IoT AND EDGE COMPUTING DEFINITION AND USE CASES Introduction to Edge Computing Scenario's and Use cases- Edge computing purpose and definition, Edge computing use cases, Edge computing hardware architectures, Edge platforms, Edge vs Fog Computing, Communication Modles-Edge, Fog and M2M.	**9 Hours**
IoT ARCHITECTURE AND CORE IoT MODULES A Connected ecosystem, IoT versus machine-to-machine versus, SCADA, The value of Network and Metcalfe's and Beckstrom's laws, IoT and Edge Architecture, Role of an architect, Understanding Implementations with examples-Example use case and deployment, Case study -Telemedicine palliative care, Requirements, Implementation, Use case retrospective.	**10 Hours**
MACHINE LEARNING AND DEEP LEARNING AT THE EDGE: Fundamentals: Machine learning algorithms, neural networks (ANN, CNN, RNN), training vs. inference- Edge AI Concepts: On-device inference, model optimization for edge devices - Machine Learning Libraries: TensorFlow Lite, PyTorch Mobile, Deep Learning Applications: Image classification, object detection, natural language processing at the edge -TinyML: Introduction to developing machine learning models for ultra-low power devices.	**12 Hours**
AI HARDWARE AND SOFTWARE TOOLS FOR EDGE DEVICES Edge Devices: Introduction to various edge devices like NVIDIA Jetson, Raspberry Pi, Arduino, STM32.- Programming Languages: Python – Software Frameworks: TensorFlow Lite, PyTorch - Hardware Acceleration: GPUs, NPUs, FPGAs for AI acceleration - Parallel Programming	**9 Hours**
APPLICATIONS OF EDGE AI: Industrial IoT - Autonomous Vehicles – Healthcare - Smart Cities – Robotics	**5 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Online Educational Resources:

References:

1. IoT Edge Computing for Architects –Second Edition, by Perry Lea, Publisher: Packet Publishing, 2020, ISBN: 9781839214806.
2. Hanes, D., Salgueiro, G., Grossetete, P., Barton, R., & Henry, J. (2017). *IoT fundamentals: Networking technologies, protocols, and use cases for the Internet of Things*. Cisco Press.
3. Ibrahim, D. (2021). *Learning embedded systems with STM32 microcontrollers*. Newnes.
4. Bishop, C. M. (2006). *Pattern recognition and machine learning*. Springer.
5. Wang, X., Chen, M., & Niyato, D. (2020). *Edge AI: Convergence of edge computing and artificial intelligence*. Springer.

Assessment (Theory course)

SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Signature of the BOS Chairman

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R. S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE509	MACHINE LEARNING FOR ROBOTICS	L	T	P	C
		3	0	0	3
Professional elective		SDG	11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Introduce the fundamentals of machine learning and its application in autonomous robotic systems.
2	Explore supervised and unsupervised learning techniques for robotic perception and decision-making.
3	Introduce reinforcement learning for real-time robotic control and behavior learning.
4	Apply machine learning algorithms with robotic sensors and actuators for navigation and manipulation.
5	Design and evaluate machine learning models for robotic applications using simulation or hardware.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Understand the fundamentals of machine learning and its role in autonomous robotic systems.	U
CO 2	Apply supervised and unsupervised learning techniques to solve robotic perception and decision-making problems.	Ap
CO 3	Develop reinforcement learning models for real-time robotic control and behavior learning.	Ap
CO 4	Integrate ML algorithms with robotic sensors and actuators for navigation and manipulation tasks.	Ap
CO 5	Design, implement, and evaluate machine learning models for specific robotic applications using simulation or hardware.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2		3	2				3
3		3	3	2			3
4			3		2		3
5			3	2	2		3

Signature of the BOS Chairman

COURSE CONTENT

INTRODUCTION TO MACHINE LEARNING AND ROBOTICS Overview of Robotics: Types, Applications-Introduction to Machine Learning: Supervised, Unsupervised, RL-Role of ML in Robotics: Autonomy, Adaptation, and Intelligence-Case Studies: ML Applications in Robotics	**9 Hours**
SUPERVISED LEARNING FOR ROBOTIC PERCEPTION Linear Regression, Logistic Regression-Decision Trees, k-NN, SVMs-Image Classification using CNNs-Feature extraction from robotic sensors (camera, lidar)	**9 Hours**
UNSUPERVISED AND DEEP LEARNING IN ROBOTICS Clustering (k-Means, DBSCAN) and Dimensionality Reduction (PCA, t-SNE)-Autoencoders for anomaly detection and compression-Semantic segmentation for scene understanding-SLAM and feature mapping using ML	**9 Hours**
REINFORCEMENT LEARNING AND POLICY LEARNING Markov Decision Processes (MDP), Q-learning-Deep Q-Networks (DQN), Policy Gradients-Actor-Critic Methods, Imitation Learning-Real-time decision making and control using RL	**9 Hours**
IMPLEMENTATION AND REAL-WORLD APPLICATIONS ML Pipelines in ROS (Robot Operating System)-Simulation tools: Gazebo, OpenAI Gym-Human-Robot Interaction and Learning-Project Work: Applying ML in robotic arms, drones, or mobile robots	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Online Educational Resources:

References:

1. "Probabilistic Robotics" – Sebastian Thrun, Wolfram Burgard, and Dieter Fox
2. "Reinforcement Learning: An Introduction" – Richard S. Sutton and Andrew G. Barto
3. "Deep Learning for Robotics" – Joseph Howse, Aaron Martinez (Packt Publishing)
4. "Machine Learning for Robotics and Control" – C.S. George Lee (Online Resources)

Assessment (Theory course)

SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By

Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.J.Ramprabu]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE510	COMPUTATIONAL DATA SCIENCE	L	T	P	C
		3	0	0	3
Professional elective		SDG	9, 11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To introduce the foundational concepts, benefits, and processes of data science,
2	To develop skills in describing and summarizing data and normal distribution concepts.
3	To understand and analyze relationships between variables
4	To gain hands-on experience with Python libraries such as NumPy and Pandas
5	To apply data visualization techniques using Matplotlib and Seaborn

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Understand the scope, benefits, and applications of Data Science in various domains.	U
CO 2	Classify different types of data and variables used in statistical analysis.	U
CO 3	Analyze the relationship between variables using correlation and regression techniques.	An
CO 4	Perform numerical operations using python libraries and related functions.	Ap
CO 5	Create various visualizations to build aesthetically pleasing statistical graphics for data exploration.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3				2		2
2	3	2					2
3		3		2			2
4			3		2		3
5			2		3		2

Signature of the BOS Chairman

COURSE CONTENT	
INTRODUCTION Data Science: Benefits and uses – facets of data – Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation – Exploratory Data analysis – build the model– presenting findings and building applications – Data Mining – Data Warehousing – Basic Statistical descriptions of Data	**9 Hours**
DESCRIBING DATA Types of Data – Types of Variables -Describing Data with Tables and Graphs – Describing Data with Averages – Describing Variability – Normal Distributions and Standard (z) Scores	**9 Hours**
DESCRIBING RELATIONSHIPS Correlation –Scatter plots –correlation coefficient for quantitative data – computational formula for correlation coefficient – Regression –regression line – least squares regression line – Standard error of estimate – interpretation of r2 – multiple regression equations –regression towards the mean	**9 Hours**
PYTHON LIBRARIES FOR DATA WRANGLING Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables	**9 Hours**
DATA VISUALIZATION Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three-dimensional plotting – Geographic Data with Basemap – Visualization with Seaborn.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources
Online Educational Resources:
References:
1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016. 2. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017. 3. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016. (Units IV and V) 4. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green Tea Press, 2014

Assessment (Theory course)
SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Signature of the BOS Chairman

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R. S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE511	VLSI SYSTEM DESIGN	L	T	P	C
		3	0	0	3
Professional elective		SDG	9		

Pre-requisite courses	Digital Electronics	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Introduce the fundamental concepts of VLSI design processes and the CMOS fabrication process.
2	Educate the electrical properties of MOS devices and the characteristics of CMOS logic circuits.
3	Enable to analyze CMOS circuit characteristics and comprehend design rules.
4	Provide the skills to apply various CMOS design styles in the realization of combinational and sequential modules.
5	Empower to design data path and array subsystems utilizing CMOS logic techniques

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO1	Understand the fundamental concepts of VLSI design process and CMOS fabrication process.	U
CO2	Study the electrical properties of MOS devices and characteristics of CMOS logic.	U
CO3	Interpret the CMOS circuit characteristics and design rules.	U
CO4	Apply different CMOS design styles to realize combinational and sequential modules.	E
CO5	Design datapath and array subsystems using CMOS logic	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2	3	2					2
3	2		2				2
4		3	3		2		3
5			3	2	2		3

Signature of the BOS Chairman

COURSE CONTENT

VLSI DESIGN METHODOLOGY & MOS TECHNOLOGY VLSI Design process — Architectural Design — Logical design — Physical design — Layout styles — Full custom — Semicustom approaches - An overview of wafer fabrication — Wafer processing — Oxidation — Patterning — Diffusion — Ion implantation — Deposition — Silicon gate NMOS process — CMOS processes — nWell — pWell — Twintub — Silicon on insulator.	**9 Hours**
ELECTRICAL PROPERTIES OF MOS AND CMOS CIRUITS NMOS enhancement transistor — PMOS enhancement transistor — Threshold voltage — Threshold voltage equations — MOS device equations — Basic DC equations — Second order effects — Small signal AC characteristics — NMOS inverter— Steered Input to an NMOS inverter — Depletion mode and enhancement mode pull-ups — CMOS inverter — DC characteristics — Inverter delay — Pass transistor — Transmission gate.	**9 Hours**
CIRCUIT CHARACTERISTICS AND DESIGN RULES CMOS process enhancements — Interconnect - Circuit elements - Latch up – Latch up prevention techniques - Need for Layout design rules —CMOS nWell pWell design rules — Simple Layout examples — Sheet resistance — Area capacitance — Wiring Capacitance — Drive large capacitive loads.	**9 Hours**
LOGIC DESIGN Switch Logic — Pass Transistor and transmission gate —CMOS Inverter — Logic gates- Static CMOS logic — Dynamic CMOS logic — Clocked CMOS logic — Precharged domino CMOS logic — Structured design — Simple combinational logic design examples.	**9 Hours**
DATAPATH AND ARRAY SUBSYTEMS DESIGN CMOS Design: Full adder – n-bit adder- Adder cum Subtractor - Carry Look Ahead Adder-Array multiplier - Divider logic - Dynamic register element - Dynamic shift register-Barrel Shifter - MOS ROM Memroy: OR ROM – NAND ROM - RAM Cells: 6T -3T-1T RAM cells.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

References:

1. Douglas A.Pucknell, K. Eshragian, "Basic VLSI Design", 3rd edition, Prentice Hall of India, 2009, New Delhi.
2. Neil. H.E.Weste, Kamaran Eshraghian, "Principles of CMOS VLSI Design", 2nd Edition, Addison Wesley Publications, 2005.
3. Neil. H.E.Weste, David Money Harris, "CMOS VLSI Design. A Circuits and Systems Perspective", Fourth Edition, Pearson Education, 2011.
4. Wayne Wolf, "Modern VLSI Design: Systems on Si1icon", 3rdEdition, Pearson Education, 2002.
5. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, "Digital Integrated Circuits: A Design Perspective", 2nd Edition, Prentice Hall of India, 2003.
6. David Black, Jack Donovan, Bill Bunton and Anna Keist, SystemC: From the Ground Up, Springer, Second Edition, 2009

Signature of the BOS Chairman

Online Educational Resources:
3. https://onlinecourses.nptel.ac.in/noc21_ee09/preview

Assessment (Theory course)
SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.K.Paramasivam Dr.V.Kandasamy]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE512	COMPUTER ARCHITECTURE AND PARALLEL PROCESSING	L	T	P	C
		3	0	0	3
Professional elective		SDG	9, 11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Understand the fundamental structure of computers and performance evaluation metrics.
2	Analyze pipelined processor design and explore instruction-level parallelism techniques.
3	Explain the principles of memory hierarchy, cache design, and virtual memory management in modern computer architectures.
4	Examine various parallel computing models and architectures.
5	Apply parallel programming paradigms and performance analysis techniques to evaluate and optimize high-performance computing applications.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Understand the fundamentals of computer architecture including instruction sets, CPU organization, and memory systems.	U
CO 2	Analyze and design pipelined and superscalar architectures for performance enhancement.	An
CO 3	Explain parallel architectures, interconnection networks, and memory consistency models.	U
CO 4	Evaluate various parallel processing models including SIMD, MIMD, and multithreading.	An
CO 5	Apply parallel processing techniques for performance improvement in real-world applications.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2		3	3				3
3	2	3					2
4		3		2			2
5		3	3		2		3

Signature of the BOS Chairman

COURSE CONTENT

Fundamentals of Computer Architecture Basic Structure of Computers - Instruction Set Architecture (RISC vs CISC) - CPU Organization and ALU Design - Control Unit: Hardwired and Microprogrammed - Performance Metrics (CPI, MIPS, FLOPS)	**9 Hours**
Pipelining and Instruction-Level Parallelism Basic Pipelining Concepts - Hazards: Data, Control, and Structural - Instruction Scheduling and Reordering - Superscalar and VLIW Architectures - Dynamic Scheduling and Tomasulo's Algorithm	**9 Hours**
Memory Hierarchy and Cache Architectures Memory Hierarchy Design - Cache Mapping Techniques and Replacement Policies - Virtual Memory and Paging - TLB and MMU Operations - Shared and Distributed Memory Architectures	**9 Hours**
Parallel Architectures and Models Flynn's Taxonomy: SISD, SIMD, MISD, MIMD - Multicore and Manycore Systems - Shared Memory vs Distributed Memory Models -Multithreading: SMT, CMT - Interconnection Networks: Mesh, Torus, Hypercube	**9 Hours**
Parallel Programming and Performance Analysis Parallel Programming Models: MPI, OpenMP, CUDA - Amdahl's Law, Gustafson's Law - Load Balancing and Scalability Issues - Case Studies: Parallel Applications in HPC, AI, and Scientific Computing - Tools for Simulation and Profiling	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Online Educational Resources:

References:

1. **"Computer Architecture: A Quantitative Approach"** – John L. Hennessy and David A. Patterson
2. **"Computer Organization and Design"** – David A. Patterson and John L. Hennessy
3. **"Parallel Computer Architecture: A Hardware/Software Approach"** – David Culler and Jaswinder Pal Singh
4. **"Introduction to Parallel Computing"** – Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar

Assessment (Theory course)

SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Signature of the BOS Chairman

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. V.Kandasamy]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE513	MULTI – CORE EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3
Professional elective		SDG	11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To introduce students to the fundamentals of embedded system architectures with a focus on multi-core processor design, enabling them to analyze, evaluate, and apply multi-core solutions for performance optimization in real-time and embedded computing environments.
2	To equip students with the knowledge and skills to understand and apply task partitioning, scheduling algorithms, and synchronization mechanisms in multi-core embedded systems for efficient parallel execution and resource management
3	To introduce inter-process communication and memory management techniques in multi-core systems.
4	To study performance, power, and real-time constraints in multi-core embedded applications.
5	To develop embedded software for multi-core platforms using RTOS and simulation tools.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Understand the architecture and design of multi-core processors in embedded systems.	U
CO 2	Analyze task partitioning, scheduling, and synchronization techniques for multi-core environments.	An
CO 3	Apply inter-process communication methods and memory management in multi-core systems.	Ap
CO 4	Evaluate performance, power, and real-time constraints in multi-core embedded applications.	Ap
CO 5	Design and develop embedded software for multi-core platforms using RTOS and simulation tools.	C

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2		3		2			2
3		2	3				3
4		3		2	2		3
5			3		3		3

Signature of the BOS Chairman

COURSE CONTENT

Introduction to Embedded and Multi-Core Systems Basics of Embedded Systems and their Applications - Introduction to Multi-core Processors - Motivation for Multi-core in Embedded Systems - Comparison: Single-core vs Multi-core Embedded Platforms - Real-Time Systems and Constraints	**9 Hours**
Multi-Core Architectures and Communication Symmetric vs Asymmetric Multi-core Systems - Shared vs Distributed Memory - Interconnect Architectures: Bus, Crossbar, NoC - Communication Mechanisms: Message Passing, Shared Memory - Cache Coherency and Memory Consistency	**9 Hours**
Task Scheduling and Parallelism Task and Thread-Level Parallelism - Task Partitioning Techniques (Static vs Dynamic) - Real-Time Scheduling on Multi-Core (EDF, RM) - Load Balancing and Migration - Synchronization: Spinlocks, Mutex, Semaphores	**9 Hours**
RTOS and Software for Multi-Core Role of RTOS in Multi-Core Systems - Multi-core Aware RTOS: VxWorks, Free RTOS SMP, QNX Neutrino - OS Services: Scheduling, IPC, Resource Management - Programming Models: POSIX Threads, OpenMP - Debugging and Profiling Multi-core Software	**9 Hours**
Design Methodologies and Applications Embedded Design Flow for Multi-Core Systems - Power and Thermal Management - Case Studies: Automotive, IoT Gateways, Drones, Consumer Electronics - Performance Evaluation: Throughput, Latency, WCET - Tools: ARM DS-5, Keil MDK, Xilinx Vitis, Simulink	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Online Educational Resources:

References:

1. **"Multi-Core Embedded Systems"** – G. Oswald and W. Wolf
2. **"Embedded Systems Architecture"** – Tammy Noergaard (2nd Edition, Newnes)
3. **"Real-Time Concepts for Embedded Systems"** – Qing Li, Caroline Yao
4. **"The Art of Multiprocessor Programming"** – Maurice Herlihy and Nir Shavit

Assessment (Theory course)

SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Signature of the BOS Chairman

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. V. Kandasamy]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE514	EMBEDDED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3
Professional elective		SDG	9, 11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To familiarize students with the fundamental processes, challenges, and organizational structures involved in successful product development.
2	To equip students with the skills to gather, interpret, and prioritize customer needs and establish precise product specifications.
3	To enable students to generate, screen, and test product concepts using systematic methodologies for effective decision-making.
4	To provide insights into product architecture, industrial design, and cost-effective manufacturing practices for optimized product development.
5	To develop proficiency in prototyping, economic analysis, and project management for successful embedded product development

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Apply concepts of product development and outline product planning process	U
CO 2	Apply relative importance of customer needs in establishing product specifications	U
CO 3	Identify concept generation activities and summarize the methodology involved in concept selection and testing	U
CO 4	Outline supply chain considerations in product architecture and understand the industrial design process	E
CO 5	Apply design for manufacturing concepts in estimating manufacturing costs	Ap
CO 6	Apply principles of prototyping in product development economics and highlight importance of managing projects	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	2				2		1
2		3			2		2
3		3		2			2
4		2			3		2
5			3		2		2
6			2	2		2	2

Signature of the BOS Chairman

COURSE CONTENT

INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS – PRODUCT PLANNING Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development. A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process	**9 Hours**
IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflect on the results and the process, Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.	**9 Hours**
CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflect on the results and the process, Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.	**9 Hours**
PRODUCT ARCHITECTURE - INDUSTRIAL DESIGN - DESIGN FOR MANUFACTURING Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design. Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.	**9 Hours**
PROTOTYPING - PRODUCT DEVELOPMENT ECONOMICS - MANAGING PROJECTS Prototyping basics, principles of prototyping, technologies, planning for prototypes, Elements of economic analysis, base case financial mode,. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Signature of the BOS Chairman

Learning Resources
Textbooks:
References:
1. Karl Ulrich,T, Steven Eppinger, D, “Product Design and Development”, McGrawHill, 2015. 2. Chitale, AK, Gupta, RC, “Product Design and Manufacturing” PHI, 2013. 3. Timjones, “New Product Development:An Introduction to a multifunctional process”, Butterworth-Heinemann, 1997. 4. Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, “Product Design for Manufacture and Assembly”, CRC Press, 2011.
Online Educational Resources:
https://onlinecourses.nptel.ac.in/noc21_ee09/preview

Assessment (Theory course)
SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.S.Kaliappan]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE515	VLSI DSP ARCHITECTURES	L	T	P	C
		3	0	0	3
Professional Elective		SDG	9		

Pre-requisite courses		Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Provide a strong foundation in number systems and arithmetic structures used in VLSI-based digital signal processing.
2	Impart knowledge of digital signal processing concepts for VLSI implementation.
3	Analyze and address design challenges associated with digital filters in DSP.
4	Expose students to the architecture and design of DSP processors, ASICs, and VLSI circuit technologies.
5	Enable students to design and synthesize DSP architectures using VLSI techniques.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Understand different number systems and arithmetic techniques used in DSP architectures.	U
CO 2	Analyze the design and structure of digital filters of DSP Architectures.	An
CO 3	Apply signal processing concepts to develop VLSI implementations of DSP algorithms.	Ap
CO 4	Evaluate standard DSP processors, ASICs, and integrated circuit design methodologies suitable for embedded DSP applications.	Ev
CO 5	Design and synthesize DSP architectures for efficient hardware realization.	C

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2		3		2			2
3		3	3		2		3
4	2		3		2		3
5			3	2	2		3

Signature of the BOS Chairman

COURSE CONTENT	
ARITHMATIC UNITS AND INTEGRATED CIRCUITS Conventional number system - Redundant Number system - Residue Number System .Bit-parallel and Bit Serial arithmetic - Distributed Arithmetic - Basic shift accumulator - Reducing the memory size - Complex multipliers - Improved shift-Accumulator.	**9 Hours**
DIGITAL SIGNAL PROCESSING Digital signal processing - Sampling of analog signals - Selection of sample frequency - Signal-processing systems - Frequency response - Transfer functions - Signal flow graphs - Filter structures - Adaptive DSP algorithms - FFT-The Fast Fourier Transform Algorithm - Image coding - Discrete cosine transforms.	**9 Hours**
DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS FIR filters - FIR filter structures - FIR chips - IIR filters - Specifications of IIR filters - Multirate systems - Interpolation with an integer factor L - Sampling rate change with a ratio L/M - Multirate filters. Finite word length effects -Parasitic oscillations - Scaling of signal levels - Round-off noise - Measuring round-off noise - Coefficient sensitivity - Sensitivity and noise.	**9 Hours**
DSP INTEGRATED CIRCUITS AND VLSI CIRCUIT TEHNOLOGIES Standard digital signal processors - Application specific IC's for DSP - DSP systems - DSP system design - Integrated circuit design. MOS transistor - MOS logic - VLSI process technologies - Trends in CMOS technologies.	**9 Hours**
DSP ARCHITECTURES AND SYNTHESIS DSP system architectures - Standard and Ideal DSP architecture - Multiprocessors and multi computers -Systolic and Wave front arrays - Mapping of DSP algorithms onto hardware - Implementation based on complex PEs - Shared memory architecture with Bit – serial PEs - Layout of VLSI circuits - FFT processor - DCT processor and Interpolator as case studies.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources

Textbooks:

References:

1. Lars Wanhammer, "DSP Integrated Circuits", Academic press, New York 2001.
2. A.V.Oppenheim et.al, "Discrete-time Signal Processing", Pearson education, 2014.
3. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital signal processing–A practical approach", 2ndedition, Harlow Prentice Hall, 2011.
4. Keshab K.Parhi, „VLSI digital Signal Processing Systems design and Implementation", JohnWiley & Sons, 2007.

Online Educational Resources:

4. www.SkillsBlock.in

Assessment (Theory course)

SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Signature of the BOS Chairman

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.K.Paramasivam Dr.V.Kandasamy]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE516	FULL STACK DEVELOPMENT	L	T	P	C
		3	0	0	3
Professional elective		SDG	9, 11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	To introduce core JavaScript programming concepts and object manipulation.
2	To explore the Document Object Model (DOM) and learn techniques for dynamic content manipulation, event handling, and interactive web page development.
3	To understand form handling and validation and gain foundational knowledge of the MERN stack with a focus on building modular React components.
4	To integrate front-end applications with REST and GraphQL APIs**,** applying advanced React concepts.
5	To implement backend functionality using MongoDB and Node.js**.**

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Understand and apply the basic syntax and structure of JavaScript programs.	U
CO 2	Understand the structure and components of the DOM in web pages.	U
CO 3	Identify and use the components of the MERN stack with a focus on React.	Ap
CO 4	Integrate REST APIs and GraphQL endpoints into React applications.	Ap
CO 5	Demonstrate CRUD operations in MongoDB and Implement modularization for front-end and back-end using Webpack.	C

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2	2	2					1
3		3	3				2
4			3		2		2
5			3	2	2		3

Signature of the BOS Chairman

COURSE CONTENT	
INTRODUCTION Basic JavaScript Instructions, Statements, Comments, Variables, Data Types, Arrays, Strings, Functions, Methods & Objects, Decisions & Loops.	**9 Hours**
DOCUMENT OBJECT MODEL (DOM) DOM Manipulation, Selecting Elements, Working with DOM Nodes, Updating Element Content & Attributes, Events, Different Types of Events, How to Bind an Event to an Element, Event Delegation, Event Listeners.	**9 Hours**
FORM ENHANCEMENT AND VALIDATION Introduction to MERN: MERN components, Server less Hello world. React Components: Issue Tracker, React Classes, Composing Components, Passing Data Using Properties, Passing Data Using Children, Dynamic Composition.	**9 Hours**
REACT WITH REST AND GRAPHQL API INTEGRATION React State - Initial State, Async State Initialization, Updating State, Lifting State Up-Event Handling - Stateless Components -Component Hierarchy, Communication, Stateless Components. Express - REST API, GraphQL, Field Specification, Graph Based, Single Endpoint, Strongly Typed, Introspection, Libraries, The About API, GraphQL Schema File, The List API, List API Integration, Custom Scalar types, The Create API, Create API Integration, Query Variables	**9 Hours**
MONGO DB, MODULARIZATION AND WEB PACKS MongoDB: Basics, Documents, Collections, Databases, Query Language, Installation, The Mongo Shell, MongoDB CRUD Operations, Create, Read, Projection, Update, Delete, Aggregate, MongoDB Node.js Driver, Schema Initialization, Reading from MongoDB, Writing to MongoDB- Modularization and Webpack ,Back-End Modules Front-End Modules and Webpack Transform and Bundle, Libraries Bundle ,Hot Module Replacement, Debugging Define Plugin: Build Configuration, Production Optimization.	**9 Hours**

Theory Hours:	**45**	**Tutorial Hours:**	**00**	**Practical Hours:**	**00**	**Total Hours:**	**45**

Learning Resources
Online Educational Resources:
References:
1. Jon Duckett, "JavaScript & jQuery: Interactive Front-End Web Development", Wiley, 2014. 2. Vasan Subramanian, Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node. Apress, 2019.

Assessment (Theory course)
SA, Activity and Learning Task(s)*, Mini project, MCQ, End Semester Examination (ESE)

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.R.Sandhyadevi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE517	EMBEDDED PROGRAMMING FOR ARM – M4 CORTEX PROCESSOR	L	T	P	C
		2	0	2	3
Professional elective		SDG	9,11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Understand ARM Cortex-M4 architecture and develop basic embedded programs
2	Program peripherals and manage real-time embedded tasks efficiently.
3	Understand advanced ARM Cortex-M4 features and application concepts.
4	Apply Cortex-M4 peripherals to design and implement embedded system experiments..
5	Analyze and troubleshoot real-time tasks, communication protocols, and sensor interfaces.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Understand ARM Cortex-M4 features and implement GPIO programs.	U
CO 2	Configure peripherals and implement tasks using FreeRTOS.	Ap
CO 3	Understand DSP, low-power, and embedded system design concepts	U
CO 4	Demonstrate GPIO, timers, ADC/DAC, and communication interfaces on Cortex-M4.	Ap
CO 5	Develop multitasking applications using FreeRTOS and handle interrupts efficiently.	Ap

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3	2					2
2		3	3				3
3			3		2		3
4			3	2	2		3
5			3		3		3

Signature of the BOS Chairman

COURSE CONTENT

ARM CORTEX-M4 ARCHITECTURE & PROGRAMMING: ARM Family Overview & Cortex-M Series IntroductionCortex-M4 Features: Pipeline, Registers, Modes, Stack-ARM Thumb-2 Instruction Set-Exception & Interrupt Handling-Memory Map & Bus Interfaces- Embedded C & ARM Assembly Basics- Startup Code, Linker Script- Using IDEs: Keil uVision, STM32CubeIDE- CMSIS: Cortex Microcontroller Software Interface Standard- GPIO Configuration & LED Blinking Example	**10 Hours**
PERIPHERAL PROGRAMMING & REAL-TIME SYSTEMS: Timers & PWM Generation- UART, SPI, I2C Communication-ADC, DAC, and Sensor Interfacing-NVIC & External Interrupt Handling-Real-Time Concepts & SysTick Timer-Task Switching & Cooperative Multitasking-RTOS Integration: FreeRTOS with ARM Cortex-M4-Debugging with Logic Analyser & Serial Monitor	**10 Hours**
ADVANCED APPLICATIONS & CASE STUDIES: Low Power Modes & Energy Efficient Coding- ARM Cortex-M4 DSP Extensions Overview- Embedded Applications Overview: Motor Control, IoT Node, Wearables-Design Considerations for Real-Time Embedded Systems- Testing & Deployment Strategies on STM32F4 or Tiva-C Boards	**10 Hours**
PRACTICAL COMPONENT: 1. GPIO & LED Blinking 2. Timer & PWM Generation 3. UART, SPI & I2C Communication 4. ADC & DAC Interfacing 5. External Interrupt Handling 6. Free RTOS Task Management 7.	**30 Hours**

Theory Hours:	**30**	**Tutorial Hours:**	**00**	**Practical Hours:**	**30**	**Total Hours:**	**60**

Learning Resources

Online Educational Resources:

References:

1. **"The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors"** – Joseph Yiu
2. **"Embedded Systems: Introduction to ARM Cortex-M Microcontrollers"** – Jonathan Valvano
3. **"ARM System Developer's Guide"** – Andrew N. Sloss, Dominic Symes, Chris Wright
4. **ARM Cortex-M4 Processor Technical Reference Manual** – (Official ARM documentation)

Signature of the BOS Chairman

Assessment (Embedded course)
SA, Activity and Learning Task(s)* , Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.R.S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE518	FPGA BASED EMBEDDED SYSTEM DESIGN	L	T	P	C
		2	0	2	3
Professional elective		SDG	9		

Pre-requisite courses	Digital Electronics	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Introduce the fundamentals of embedded systems and FPGA technology
2	Develop an understanding of system-level design methodologies
3	Provide hands-on experience in advanced FPGA tools
4	enable students to conceptualize and implement real-time embedded applications using FPGA platforms
5	promote independent learning, system-level thinking, and technical innovation through hands-on projects

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Analyze and apply the architectural features of platform FPGAs and programmable logic devices for embedded applications.	An
CO 2	Design and evaluate embedded system architectures using modular design principles, control flow graphs, and reuse methodologies on FPGA platforms.	Ev
CO 3	Develop and debug embedded systems using VHDL and modern FPGA tools	Ap
CO 4	Design and implement application-specific embedded systems using FPGA-based tools.	C
CO 5	Demonstrate the ability to solve complex engineering problems using functional embedded system prototype on FPGA platforms.	C

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3		1				
2	2	2	2	2	2		
3	3	2	2	1	2		1
4	2	3	3	2	3	3	2
5	2	3	3	3	3	3	2

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COURSE CONTENT

EMBEDDED SYSTEM AND FPGA Embedded systems - design challenges – platform FPGAs-CMOS Transistor – programmable logic devices – Field programmable gate array – Hardware description languages -From HDL to configuration bit stream -case study :Xilinx virtex 5	**10 Hours**
SYSTEM DESIGN Principles of system design-Design quality, Modules and interfaces, Abstraction and state, Cohesion and coupling, Designing and Reuse, Control flow graph, Design-Origins of platform FPGA designs	**10 Hours**
ADVANCED FPGA DESIGN VHDL for spatial design -Debugging platform FPGA design -overview of zynq 7000 architecture and vivado- simple embedded system design using zynq and vivado	**10 Hours**
Typical Project Titles: **System Design & Acceleration** 1. High-Speed UART Communication Interface Design on FPGA 2. General Purpose Processor on FPGA 3. Hardware Acceleration of Matrix Multiplication using FPGA for AI Workloads **Signal Processing & Communication** 4. FPGA-Based Real-Time Image Edge Detection using Sobel Operator 5. Low-Power FFT Processor Design for Wireless Communication on FPGA **Control Systems & Robotics** 6. FPGA-Based PID Controller for a 2-DOF Robotic Arm 7. Obstacle Avoidance Robot Using FPGA and Ultrasonic Sensors 8. Real-Time Traffic Light Controller using VHDL on FPGA **IoT and Smart Systems** 9. FPGA-Based Smart Home Controller Integrated with IoT Gateway 10. Real-Time Air Quality Monitoring System using FPGA and Wireless Sensor Network	**30 Hours**
	9 Hours

Theory Hours:	**30**	**Tutorial Hours:**	**00**	**Practical Hours:**	**30**	**Total Hours:**	**60**

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Learning Resources
Textbooks:
1. Ron sass ,Andrew G Schmidt Embedded system design with platform FPGAs principles and practices,2011, First Edition, Tata McGraw Hill, India. 2. Wayne wolf, FPGA based system design,2011, First edition, Prentice Hall, Modern semiconductor design series, USA.
References:
1. Charles H.Roth Jr.Digital system design using VHDL ,2012,Reprint, PWS publishing company, USA. 2. V.A.Padroni circuit design with VHDL 2011, First edition, MIT press Cambridge, England. 3. www.xilinx.support > documentation> datasheets.
Online Educational Resources:
8. https://elearn.nptel.ac.in/shop/partnering-courses/registration-ongoing/workshop-on-fpga-architecture-and-programming-using-verilog-hdl-2/?v=c86ee0d9d7ed

Assessment (Embedded course)
SA, Activity and Learning Task(s)* , Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.K.Paramasivam Dr.V.Kandasamy]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman

24ETE519	PYTHON PROGRAMMING FOR ML APPLICATIONS	L	T	P	C
		2	0	2	3
Professional elective		SDG	9, 11		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Understand Python fundamentals, OOP concepts, and file handling techniques.
2	Learn data manipulation, cleaning, and visualization techniques using Python libraries.
3	Understand machine learning, deep learning concepts, and development tools.
4	Understand Python programming, data analysis, and visualization fundamentals.
5	Apply machine learning techniques to build basic predictive models.

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		**Revised Bloom's Taxonomy Levels (RBT)**
CO 1	Apply Python programming and OOP to solve basic data processing problems.	Ap
CO 2	Analyze datasets and visualize insights using NumPy, Pandas, and visualization tools.	An
CO 3	Build basic machine learning and deep learning models.	Ap
CO 4	Implement Python programs for data handling, analysis, and visualization tasks.	Ap
CO 5	Develop and evaluate basic machine learning models for real-world applications.	E

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3		2				2
2		2	3				3
3	3	2					2
4		3	3		2		3
5			2		3		3

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COURSE CONTENT

PYTHON PROGRAMMING & DATA HANDLING: Python Basics: Variables, data types (integer, float, string, list, tuple, dictionary)- Operators and Expressions Control Flow: if/else, loops- Functions and Modules- File Handling: Reading and writing files- Introduction to OOP: Classes, objects, inheritance, polymorphism	**10 Hours**
DATA ANALYSIS & VISUALIZATION: NumPy: Arrays, matrix operations, basic linear algebra-Pandas: DataFrames, data cleaning, transformation- Handling missing data and outliers- Data preprocessing and feature engineering basics-Data Visualization: Matplotlib and Seaborn (plots, charts, patterns)	**8 Hours**
MACHINE LEARNING & DEEP LEARNING: Introduction to Machine Learning: Supervised, unsupervised, reinforcement learning-Supervised Learning: Linear regression, logistic regression, SVM, decision trees-Ensemble Methods: Random forests, boosting-Unsupervised Learning: K-Means clustering, dimensionality reduction-Model Evaluation: Accuracy, precision, recall, F1-score-Deep Learning: Neural networks basics- Frameworks: TensorFlow or PyTorch-Applications: Image recognition, NLP- Tools: Jupyter Notebook, PyCharm, VS Code, Cloud platforms (AWS, Azure, Google Cloud)	**12 Hours**
PRACTICAL COMPONENT 1. Python Basics: Programs using variables, data types, control structures, and functions. 2. File Handling & OOP: File operations and implementation of classes with inheritance. 3. NumPy & Pandas: Array operations and basic dataset loading and cleaning. 4. Data Visualization: Create plots to analyze data using Matplotlib and Seaborn. 5. Machine Learning: Train and evaluate a basic regression or classification model. 6. Build an end-to-end ML/DL application with pre- processing and evaluation.	**30 Hours**

Theory Hours:	**30**	**Tutorial Hours:**	**00**	**Practical Hours:**	**30**	**Total Hours:**	**60**

Learning Resources

Online Educational Resources:

References:

1. Lutz, M. (2013). *Learning Python* (5th ed.). O'Reilly Media.
2. McKinney, W. (2022). *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter* (3rd ed.). O'Reilly Media.
3. Müller, A. C., & Guido, S. (2016). *Introduction to Machine Learning with Python: A Guide for Data Scientists*. O'Reilly Media
4. Chollet, F. (2021). *Deep Learning with Python* (2nd ed.). Manning Publications.
5. Erl, T., Mahmood, Z., & Puttini, R. (2013). *Cloud Computing: Concepts, Technology & Architecture*. Prentice Hall.

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Assessment (Embedded course)
SA, Activity and Learning Task(s)* , Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr. R. S. Sandhya Devi]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

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24ETE520	R PROGRAMMING	L	T	P	C
		2	0	2	3
Professional elective		SDG	9		

Pre-requisite courses	Nil	Data Book / Code book (If any)	-

COURSE OBJECTIVES:	
The purpose of taking this course is to:	
1	Equip students with the foundational knowledge of R programming language to enable efficient problem-solving and data manipulation
2	Enable students to develop, visualize, and analyze structured and unstructured data using R libraries, to model and interpret engineering data
3	Foster practical skills in using R for simulation, automation, and machine learning application

COURSE OUTCOMES		
After successful completion of this course, the students shall be able to		Revised Bloom's Taxonomy Levels (RBT)
CO 1	Implement basic mathematical operations using R programming.	U
CO 2	Compute the basic statistical parameters from R language coding.	U
CO 3	Apply R programming concepts for probability distributions and statistical testing.	Ap
CO 4	Interpret the linear regression model and diagnosis through R programming.	An
CO 5	Illustrate plot and charts using R programming for visualize the data.	An

Course Outcomes (CO)	Program Outcomes (PO) (Strong-3, Medium – 2, Weak-1)						
	1	2	3	4	5	6	
	Acquire fundamental knowledge and understanding of Embedded system design technologies	Demonstrate a degree of mastery to solve the complex problems in the field of embedded system design.	Apply suitable techniques, resources and modern engineering with IT tools in the field of embedded system design through continuous learning	Formulate relevant research problems, conduct experimental and/or analytical study and analyze results using modern mathematical and scientific methods.	Design, validate technological solutions and document effectively, for the practical and multidisciplinary projects relevant to industrial and societal requirements with environmental concerns and professional ethics.	Communicate and perform effectively as an individual and as a member or leader in diverse teams to prove technical and administrative capability.	Design and develop an appropriate embedded
1	3		2				2
2	3	2					2
3		3		2			2
4		2	3	2			2
5			2		2		2

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COURSE CONTENT

PROGRAMMING FUNDAMENTALS Obtaining and installing R from CRAN – Numeric, arithmetic, assignment, and vectors – Matrices and arrays – non-numeric values – lists, data frames, special values, classes, and coercion – basic plotting – reading and writing files – calling functions – conditions and loops – writing functions – exceptions, timings, and visibility	**10 Hours**
STATISTICS AND PROBABILITY Describing Raw Data – Mean, Median, Mode, Counts, Percentages, Proportions, Quantiles, Percentiles, Variance, Standard Deviation, Interquartile Range, Covariance and Correlation – basic data visualization – probability distributions	**10 Hours**
STATISTICAL TESTING, MODELING AND ADVANCED GRAPHICS Sampling distributions and confidence – hypothesis testing – analysis of variance – simple linear regression – multiple linear regression – linear model selection and diagnostics – advanced plot customization	**10 Hours**
PRACTICAL COMPONENT CONTENTS:	
LIST OF EXPERIMENTS	
1. Implement simple R program to perform numeric and arithmetic operations using vectors, matrices, and arrays. 2. Create R program to perform basic functions operation with lists, data frames, special values, classes, plotting, conditions, and loops. 3. Identify elementary statistics parameters from R program coding. 4. Visualizing the raw data using R program from pie charts, histograms, bar, box, and scatter plots. 5. Implement simple R program to realize random variables and probability distributions. 6. Create R program to perform probability mass functions and density functions. 7. Implement simple R program to perform hypothesis testing and ANOVA. 8. Create R program to perform multiple line regression. 9. Implement simple R program to realize model selection algorithms. Visualizing statisitical data using R program in three dimensional with advanced customization.	**30 Hours**

Theory Hours:	**30**	**Tutorial Hours:**	**00**	**Practical Hours:**	**30**	**Total Hours:**	**60**

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Learning Resources
Online Educational Resources:
References:
1. Sandip Rakshit, “Statistics with R Programming”. McGraw-Hill Education, 2018. 2. Trejo, Omar, and Trejo Navarro, Omar. “R Programming By Example: Practical, Hands-on Projects to Help You Get Started with R”. United Kingdom, Packt Publishing, 2017. 3. Lovelace, Robin, and Gillespie, Colin, “Efficient R Programming: A Practical Guide to Smarter Programming”. Japan, O'Reilly Media, Incorporated, 2017. 4. G. Sudhamathy, C. Jothi Venkateswaran, “R Programming: An Approach to Data Analytics”. MJP Publisher, 2019. 5. Pedro J. Aphalo, “Learn R As a Language”. CRC Press, 2020.

Assessment (Embedded course)
SA, Activity and Learning Task(s)* , Mini project, MCQ, End Semester Examination (ESE) Lab Workbook, Experimental Cycle tests, viva-voce, etc…

Course Curated By		
Expert(s) from Industry	**Expert(s) from Higher Education Institutions**	**Internal Expert(s)**
[Suganya M, Bosch Global Software Technologies PVT Ltd]	[Dr. Uma shankar S, Prince Sultan University, Riyadh]	[Dr.V.Kandasamy]
Recommended by BoS on	**07.05.2025**	
Academic Council Approval	No: 28	26.06.2025

Signature of the BOS Chairman