CMS COLLEGE OF ENGINEERING AND TECHNOLOGY
(AN AUTONOMOUS INSTITUTION)
(Affiliated to Anna University | Approved by AICTE |Accredited by NAAC – 'A' Grade)
Appachigoundenpathy, Kummittipathi (PO), Coimbatore – 641 032.

REGULATIONS 2026

Curriculum & Syllabus.

M.E. – Embedded System Technologies.

Applicable to the students admitted during the Academic year 2026 – 2027 onwards.

CMS COLLEGE OF ENGINEERING AND TECHNOLOGY
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Appachigoundenpathy, Kummittipathi (PO), Coimbatore – 641 032.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M.E.- Embedded System Technologies

CHOICE BASED CREDIT SYSTEM (CBCS)

Regulations 2026

Curriculum & Syllabus

M. J. [signature]

Chairman - Board of Studies
Department Electrical and Electronics Engineering
CMS College of Engineering and Technology
(Autonomous)
Kumittipathi, Coimbatore - 641 032

INSTITUTION VISION:

A Centre of excellence, capable of empowering seekers of knowledge through holistic education.

INSTITUTION MISSION:

Create worthy citizens by providing holistic, qualitative, value based education and makes them creative members of global society.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION:

To be a center of excellence in Electrical and Electronics Engineering, developing skilled and ethical engineers through innovation, research, and lifetime learning to contribute to AI, IoT, robotics, communication, and sustainable technologies for society.

MISSION:

- To reinforce fundamental concepts in core Engineering such as circuits, embedded systems, communication systems, signal processing, and power electronics.
- To foster ethical practices in developing sustainable engineering solutions for renewable energy, healthcare, and smart infrastructure.
- To formulate students for successful careers in industry, research, and entrepreneurship through skill development and professional training.

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POSTGRADUATE AUTONOMOUS CURRICULUM

Programme: M.E. Embedded System Technologies **Regulation:2026**

Abbreviations:

BS – Basic Science	**T** – Theory Course
ES – Enginerring Science	**L** – Laboratory Course
PC – Programme Core	**LIT** – Laboratory Integrated Theory
PE – Programme Elective	**PW** – Project Work
SL –Self-Learning	**TCP** – Total Contact Period(s)
SD – Skill Development	

PROGRAM OUTCOMES (POs)

PO1: An ability to independently carry out research / investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report / document.

PO3: Students should be able to demonstrate a degree of mastery in embedded system technologies.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Develop a strong grasp of essential Electrical and Electronics Engineering concepts to address engineering challenges

PEO2: Build successful professions in industry, research, entrepreneurship, or higher education, while continually refining their skills through lifelong learning.

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PROGRAM SPECIFIC OUTCOMES (PSOs)

On Successful Completion of the Electrical and Electronics Engineering Degree Programme, the Graduates shall exhibit the following:

PSO1: Leverage foundational knowledge in circuits, embedded systems, communication systems, signal processing, and power electronics to develop innovative engineering solutions.

PSO2: Design, develop, and implement electronic systems using recent tools and technologies in emerging domains such as Artificial Intelligence, Internet of Things (IoT), robotics, 5G/6G communication, and sustainable energy systems.

PSO3: Contribute to industry, research, entrepreneurship, and society by developing sustainable and socially responsible engineering solutions in areas such as healthcare, renewable energy, and smart infrastructure.

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M.E. EMBEDDED SYSTEM TECHNOLOGIES

REGULATIONS 2026

CURRICULUM AND SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER – I

S.No.	Course Code	Course Name	Course Type	L - T - P - J	Credits	TCP	Category
1	26PMA101	Applied Mathematics for Embedded Systems Technologists	T	3 - 1 - 0 - 0	4	4	FC
2	26PES101	Advanced Digital System Design	T	3 – 0 – 0 - 0	3	3	PC
3	26PES102	Design of Embedded Systems	T	3 – 0 – 0 - 0	3	3	PC
4	26PES103	Micro controller Based System Design	T	3 – 0 – 0 - 0	3	3	PC
5	26PES104	IoT for Smart Systems	T	3 – 0 – 0 - 0	3	3	PC
6	26PES105	Software for Embedded Systems	T	3 – 0 – 0 - 0	3	3	PC
7	26PES106	Embedded Programming Laboratory	L	0 – 0 – 4 - 0	2	4	PC
8		Self-Learning Course	-	-	1	-	SL
					22	**23**	

SEMESTER – II

S.No.	Course Code	Course Name	Course Type	L - T - P - J	Credits	TCP	Category
1	26PES201	Embedded System Networking	T	3 – 0 – 0 - 0	3	3	PC
2	26PES202	Embedded Control System	T	3 - 0 – 0 - 0	3	3	PC
3	26PES203	VLSI Design and Reconfigurable Architecture	T	3 - 0 – 0 - 0	3	3	PC
4	26PES204	Real Time Operating System	T	3 - 0 – 0 - 0	3	3	PC
5		Programme Elective - I	T	3 – 0 – 0 - 0	3	3	PE
6	26PES205	Embedded System Laboratory	L	0 – 0 – 4 - 0	2	4	PC
7		Industrial Training	--	--	1	-	SD
8	26PESS01	Mini Project	--	--	1	-	SD
					19	**19**	

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SEMESTER – III

S.No.	Course Code	Course Name	Course Type	L - T - P - J	Credits	TCP	Category
1		Programme Elective - II	T	3 – 0 – 0 - 0	3	3	PE
2		Programme Elective - III	T	3 – 0 – 0 - 0	3	3	PE
3		Programme Elective - IV	T	3 - 0 – 0 - 0	3	3	PE
4		Programme Elective - V	T	3 – 0 – 0 - 0	3	3	OE
5		Industry Oriented Course	--	1 – 0 – 0 - 0	1	1	SD
6	26PESS02	Project Work - I	--	0 – 0 – 0 - 12	6	12	SD
					19	**25**	

SEMESTER – IV

S.No.	Course Code	Course Name	Course Type	L - T - P - J	Credits	TCP	Category
1	26PESS03	Project Work - II	--	0 – 0 – 0 - 24	12	24	SD
					12	**24**	

Total Credits: 72

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PROGRAMME ELECTIVES:

S.No	Course Code	Course Name	Course Type	L– T–P –J	Credits	TCP	Category
1	26CSP921	Python Programming for Machine Learning	T	3-0-0-0	3	3	PE
2	26ESP701	Distributed Embedded Computing	T	3-0-0-0	3	3	PE
3	26ESP702	Virtual Instrumentation	T	3-0-0-0	3	3	PE
4	26ESP703	Wireless and Mobile Communication	T	3-0-0-0	3	3	PE
5	26ESP704	MEMS and NEMS Technology	T	3-0-0-0	3	3	PE
6	26ESP705	DSP Based System Design	T	3-0-0-0	3	3	PE
7	26ESP706	Embedded Systems Security	T	3-0-0-0	3	3	PE
8	26ESP707	Robotics and Automation	T	3-0-0-0	3	3	PE
9	26ESP708	Entrepreneurship and Embedded Product Development	T	3-0-0-0	3	3	PE
10	26ESP709	Smart Grid	T	3-0-0-0	3	3	PE
11	26ESP710	Automotive Embedded System	T	3-0-0-0	3	3	PE
12	26CSP922	Machine Learning and Deep Learning	T	3-0-0-0	3	3	PE
13	26ESP711	Multimedia Communication	T	3-0-0-0	3	3	PE
14	26ESP712	Electric Vehicles and Power Management	T	3-0-0-0	3	3	PE
15	26ESP713	Reconfigurable Processor and SoC Design	T	3-0-0-0	3	3	PE
16	26ESP714	Embedded Sensor Networks	T	3-0-0-0	3	3	PE
17	26ESP715	Computer Vision	T	3-0-0-0	3	3	PE
18	26ESP716	Embedded Networking and Automation of Electrical System	T	3-0-0-0	3	3	PE
19	26ESP717	Renewable Energy and Grid Integration	T	3-0-0-0	3	3	PE
20	26ESP718	Smart System Design	T	3-0-0-0	3	3	PE

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26PET101	APPLIED MATHEMATICS FOR EMBEDDED SYSTEMS TECHNOLOGISTS	T	L	T	P	J	C
			3	1	0	0	4

Course Objectives:

1	The techniques of Fourier transform to solve partial differential equations.
2	To become familiar with graph theory for modelling the embedded system.
3	To understand and apply linear programming and optimization techniques, including simplex-based methods, transportation models, and assignment problems
4	To acquire knowledge in probability, random variables and standard distributions
5	To understand the basic concept of queuing theories to address stochastic and dynamic environment in embedded technology.

Syllabus:

FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS	12 Hours

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.

Activity: Simulate one-dimensional heat conduction in a metal rod using MATLAB/Python/Excel. Analyze the solution using Fourier Transform and interpret the temperature distribution.

GRAPH THEORY	12 Hours

Introduction to paths, trees, vector spaces - Matrix coloring and directed graphs - Some basic algorithms – Shortest path algorithms – Depth - First search on a graph – Isomorphism – Theoretic algorithms – Performance of graph theoretic algorithms – Graph theoretic computer languages.

Activity: Model the college campus as a graph and identify the shortest path between two locations using Dijkstra's algorithm. Compare the results with BFS/DFS traversal.

OPTIMIZATION TECHNIQUES	12 Hours

Linear programming - Basic concepts – Graphical and simplex methods – Big M method - Two phase simplex method - Revised simplex method - Transportation problems – Assignment problems.

Activity: Formulate a production planning problem and solve it using the graphical or simplex method with Excel Solver. Interpret the optimal solution for maximizing profit or minimizing cost.

PROBABILITY AND RANDOM VARIABLES	12 Hours

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Exponential, Normal distributions – Functions of one dimensional random variable.

Activity: Collect sample data on electronic component failures and fit an appropriate probability distribution. Calculate the mean, variance, and reliability measures based on the data.

QUEUEING THEORY	12 Hours

Single and multiple servers - Markovian queuing models - Finite and infinite capacity queues – Finite source model – Queuing applications.

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Activity: Observe a real-life queue such as a canteen or library service counter and record arrival and service times. Analyze the system using an M/M/1 queueing model and suggest ways to reduce waiting time.
Total Periods: 60 Hours

Text Books:	
1	Sankara Rao, K., ―Introduction to Partial Differential Equations‖, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
2	Narasingh Deo, " Graph Theory with Applications to Engineering and Computer Science ", Prentice Hall India,1997.
References:	
1	Walpole R.E., Myer R.H., Myer S.L., and Ye, K., " Probability and Statistics for Engineers and Scientists ", 7th Edition, Pearson Education, Delhi, 2002.
E- resources:	
1	https://archive.nptel.ac.in/courses/117/105/117105137/
2	https://onlinecourses.nptel.ac.in/noc21_ee39/preview

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Use the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering
2	Apply Graph theory concept to solve real world application like routing, TSP/Traffic Control etc…
3	Construct a linear programming model from problem description, and apply the simple method for solving linear programming problems.
4	Apply the ideas of probability and random variables in solving engineering problems.
5	Apply the concept of Queuing Models in real life problems

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	3	1	1	1	-
2	3	3	2	1	1	-
3	3	3	2	1	1	-
4	2	2	1	1	1	-
5	3	3	1	1	1	-
Avg	2.6	2.8	1.4	1	1	-

“3” -High, “2” -Medium, “1” – Low, “-” – No Correlation

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26PES101	ADVANCED DIGITAL SYSTEM DESIGN	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	Understand the principles and design methodologies of synchronous and asynchronous sequential circuits
2	Analyze the operation and performance of sequential digital systems
3	Learn digital circuit testing techniques and fault detection methods
4	Design and implement sequential circuits using programmable devices
5	Acquire proficiency in VHDL-based modeling, simulation, and digital system design

Syllabus:

SEQUENTIAL CIRCUIT DESIGN	**9 Hours**

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.

Activity: Design and simulate a synchronous sequential circuit using ASM charts and state reduction techniques. Verify the state transitions and functionality using a digital simulation tool.

ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN	**9 Hours**

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.

Activity: Design an asynchronous sequential circuit, identify race conditions and hazards, and implement suitable hazard elimination techniques through simulation.

FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS	**9 Hours**

Fault Table Method – Path Sensitization Method – Boolean Difference Method – Kohavi Algorithm – Tolerance Techniques – The Compact Algorithm – Practical PLA's – Fault in PLA – Test Generation – Masking Cycle – DFT Schemes – Built-in Self-Test.

Activity: Perform fault analysis on a combinational or sequential circuit using fault simulation techniques. Generate test vectors to detect stuck-at faults and evaluate fault coverage.

SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES	**9 Hours**

EPROM to Realize a Sequential Circuit – Programmable Logic Devices – Designing a Synchronous Sequential Circuit using a GAL – EPROM – Realization State machine using PLD – FPGA – Xilinx FPGA – Xilinx 2000 - Xilinx 3000.

Activity: Implement a finite state machine on an FPGA or programmable logic device using HDL. Verify its operation through synthesis, simulation, and hardware testing.

SYSTEM DESIGN USING VHDL	**9 Hours**

VHDL Description of Combinational Circuits – Arrays – VHDL Operators – Compilation and Simulation of VHDL Code – Modelling using VHDL – Flip Flops – Registers – Counters – Sequential Machine – Combinational Logic Circuits - VHDL Code for – Serial Adder, Binary Multiplier – Binary Divider – complete Sequential Systems – Design of a Simple Microprocessor.

Activity: Model and simulate sequential digital circuits such as counters, registers, or a simple controller using VHDL. Validate the design using waveform analysis and timing simulation.

Total Periods: 45 Hours

Text Books:

1	Donald G. Givone, "Digital principles and Design", 1st Edition, Tata McGraw Hill, 2012.

2	Charles H. Roth Jr., “Digital System Design using VHDL”, 2nd Edition, Cengage Learning, 2007
References:	
1	Parag K Lala, “Digital System design using PLD” 1st Edition BS Publications, 2003
2	Skahill. K, “VHDL for Programmable Logic” Pearson Education, 1996
E- resources:	
1	https://archive.nptel.ac.in/courses/117/105/117105137/
2	https://onlinecourses.nptel.ac.in/noc21_ee39/preview

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

CO No.	Course Outcomes
1	Apply design methodologies to construct clocked synchronous and asynchronous sequential circuits for simple digital systems
2	Examine and analyze the performance of synchronous and asynchronous sequential circuits in digital systems
3	Demonstrate understanding of basic and advanced digital circuit testing concepts and methodologies
4	Utilize programmable devices to design and implement synchronous sequential circuits
5	Understand VHDL fundamentals and employ VHDL programming for digital circuit design

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	3	-	3	3	2	-
2	2	-	3	3	2	-
3	3	1	2	2	2	1
4	3	-	3	3	3	1
5	2	2	3	3	3	-
Avg	2.6	1.5	2.	2.8	2.4	1

“3” -High, “2” -Medium, “1” – Low, “-” – No Correlation

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26PES102	DESIGN OF EMBEDDED SYSTEMS	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand the fundamentals, architecture, and classifications of embedded systems
2	To distinguish embedded systems from general-purpose computing systems
3	To develop skills for designing embedded systems under practical engineering constraints
4	To apply RTOS concepts in the development of real-time embedded applications
5	To understand the role and applications of embedded systems in industrial and commercial domains

Syllabus:

INTRODUCTION TO EMBEDDED SYSTEMS — **9 Hours**

Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA, Memory management methods- memory mapping, cache replacement concept, Timer and Counting devices, Watchdog Timer, Real Time Clock.

Activity: Install, configure, and create a simple project with a basic IDE to learn project structure.

EMBEDDED NETWORKING AND INTERRUPTS SERVICE MECHANISM — **9 Hours**

Embedded Networking: Introduction, I/O Device Ports & Buses- Serial Bus communication protocols–Parallel bus device protocols- parallel communication- Internet enabled system-Network protocols, wireless and mobile system protocols- ISR concept -multiple interrupts-Context and periods for context switching- Interrupt latency and deadline- Introduction to Basic Concept Device Drivers.

Activity: Write a pseudo-code or library examples of initializing and using a peripheral (LED, LCD, sensor)

RTOS BASED EMBEDDED SYSTEM DESIGN — **9 Hours**

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Pre-emptive and non-pre-emptive scheduling, Task communication, shared memory, message passing-, Interprocess Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion - comparison of commercial RTOS features.

Activity: Design a simple traffic light controller or temperature monitoring system with periodic tasks.

SOFTWARE DEVELOPMENT TOOLS — **9 Hours**

Software Development environment-IDE- assembler, compiler- linker, simulator- debugger, In circuit emulator- Target Hardware Debugging- need for Hardware- Software Partitioning and Co-Design.- UML modelling, UML basic elements Diagram- Modelling techniques, Modelling language Diagrams.

Activity: For a typical simple embedded system examples, students can plan which functions should be implemented in hardware vs. software.

EMBEDDED SYSTEM APPLICATION DEVELOPMENT — **9 Hours**

Objectives, different Phases & Modelling of the Embedded Product Development Life Cycle (EDLC), Case studies on – Smart city: PHEV – Smart street light – intelligent traffic management – Smart Garbage system.

Activity: Group activity - Discuss examples of embedded systems in daily life.

Total Periods: 45 Hours

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Text Books:	
1	Simon Monk, "Make: Action, Movement, Light and Sound with Arduino and Raspberry Pi", O'Reilly Series , SPD,2016
2	Lyla B Das," Embedded Systems-An Integrated Approach",Pearson2013
References:	
1	Rajkamal, 'Embedded system-Architecture, Programming, Design', TMH,2011
2	Bruce Powel Douglass, "Real-Time UML Workshop for Embedded Systems,Elsevier,2011
E- resources:	
1	https://archive.nptel.ac.in/courses/108/102/108102169/

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcome**
1	Explain the design requirements of embedded systems considering safety, manufacturability, and sustainability constraints
2	Compare general-purpose computing systems with embedded systems and classify different embedded system architectures
3	Design and implement real-time embedded systems using RTOS concepts
4	Explain the role and applications of embedded systems in industrial and commercial sectors
5	Analyze embedded system characteristics and select appropriate embedded system classifications for specific applications

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2		2	2	1	2
2	2		3	3	1	
3	3	1	3	3	3	2
4	2		2	2	2	2
5	3		3	3	2	1
Avg	2.4	1	2.6	2.6	1.8	1.75

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26PES103	MICROCONTROLLER BASED SYSTEM DESIGN	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	Introduce the fundamental concepts, architecture, and functional units of processor systems
2	Provide knowledge of RISC processor architecture and its key features for efficient computing
3	Develop skills in hardware interfacing of processors with input/output devices and peripheral components for automation applications
4	Enable students to design and implement software interfaces for processor-based communication and control of peripherals
5	Familiarize students with PIC and ARM microcontrollers and their applications in controlling DC and AC appliances in embedded systems

Syllabus:

PIC MICROCONTROLLER — **9 Hours**

Architecture - memory organization - addressing modes - instruction set - PIC programming in Assembly & C - I/O port, Data Conversion, RAM & ROM Allocation, Timer programming, practice in MP-LAB.

Activity: Install, configure, and create a simple project with a MPLAB IDE to learn project structure.

ARM ARCHITECTURE — **9 Hours**

Architecture - memory organization - addressing modes - The ARM Programmer‘s model - Registers - Pipeline - Interrupts - Coprocessors – Interrupt Structure.

Activity: Perform a coding exercise to configure a timer interrupt on ARM and learn how the vector table directs execution of ISR.

PERIPHERALS OF PIC AND ARM MICROCONTROLLER — **9 Hours**

PIC: ADC, DAC and Sensor Interfacing –Flash and EEPROM memories. ARM: I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication with PC – ADC/DAC Interfacing.

Activity: Perform a coding exercise to read analog input from a potentiometer or sensor via ADC and . control LED brightness using DAC/PWM output.

ARM MICROCONTROLLER PROGRAMMING — **9 Hours**

ARM general Instruction set – Thumb instruction set –Introduction to DSP on ARM – Implementation example of Filters

Activity: Perform a coding exercise with and without Thumb mode and to implement moving average filter in C language.

DESIGN WITH PIC AND ARM MICROCONTROLLERS — **9 Hours**

PIC implementation - Generation of Gate signals for converters and Inverters - Motor Control – Controlling DC/ AC appliances – Measurement of frequency - Standalone Data Acquisition System –ARM Implementation- Simple ASM/C programs- Loops –Look up table- Block copy -Subroutines-Hamming Code.

Activity: Students collaboratively design and prototype small subsystems using PIC and ARM microcontrollers, applying to specific application areas.

Total Periods: 45 Hours

Text Books:

1	Steve Furber, _ARM system on chip architecture‘, Addision Wesley,2010
2	Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield, _ARM System

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	Developer‘s Guide Designing and Optimizing System Software‘, Elsevier 2007
References:	
1	Rajkamal,‖Microcontrollers Architecture, Programming, Interfacing,& System Design,Pearson,2012
2	William Hohl, ARM Assembly Language‘ Fundamentals and Techniques,2009
E- resources:	
1	www.Nuvoton .com

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Interpret the architecture and functional organization of processor systems
2	Analyze the characteristics and advantages of RISC processor architecture
3	Design hardware interfacing circuits between processors and peripheral devices for automation applications
4	Develop software routines for processor-based I/O interfacing and peripheral control
5	Implement embedded control systems using PIC and ARM microcontrollers for real-world appliance control

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2		3	3	2	
2	2		3	3	2	
3	3		3	3	3	1
4	3	1	3	2	3	1
5	3	1	3	3	3	2
Avg	2.6	1	3	2.	2.6	1.33

“3” -High, “2” -Medium, “1” – Low, “-” – No Correlation

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26PES104	IOT FOR SMART SYSTEMS	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	Introduce the fundamental concepts, ecosystem, enabling technologies, and applications of the Internet of Things
2	Provide knowledge of IoT architectures, node design, standards, and system components used in IoT environments
3	Develop an understanding of IoT communication protocols, wireless technologies, and emerging trends in IoT systems
4	Enable students to design and integrate IoT subsystems for developing smart and connected applications
5	Familiarize students with real-world IoT applications and case studies to analyze innovative solutions for societal and industrial challenges

Syllabus:

INTRODUCTION TO INTERNET OF THINGS	**9 Hours**
Definition, elements, and characteristics of IoT. Architectural stack, enabling technologies, challenges, and hardware platforms like Arduino, Raspberry Pi, and ESP boards. **Activity:** Students explore the definition, elements, architecture, and hardware platforms of IoT by designing a small-scale IoT prototype using embedded boards.	
IOT ARCHITECTURE	**9 Hours**
Reference models and architectures, node structure (sensing, processing, communication, power). Networking topologies, IoT standards, cloud and fog computing, and Bluetooth-based solutions. **Activity:** Case study to construct a IoT reference architectures and node structure.	
PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT	**9 Hours**
Overview of protocols: NFC, SCADA, RFID, Zigbee, MIPI family, GSM/CDMA, LTE, and 5G small cells. Wireless standards for IoT including WiFi, Bluetooth, ZigBee, UWB, LoRa, 6LoWPAN, Thread vs. Matter, and proprietary systems. **Activity:** Group activity to perform the selection of protocols for a typical use case.	
IOT SUBSYSTEMS	**9 Hours**
IoT services and attributes: analytics, dependability, interoperability, security, and maintainability. Platforms for data analytics, visualization, virtualization, and IoT application development with emphasis on privacy and security. **Activity:** Compare the performance of various data analytics & visualization tools.	
CASE STUDIES	**9 Hours**
Applications of IoT in industrial systems, smart homes, cities, grids, vehicles, EV charging, agriculture, environment, healthcare, and defense. **Activity:** Each student group can prepare a short report/presentation on different use cases.	
Total Periods: 45 Hours	

Text Books:

1	Cirani, S., Ferrari, G., Picone, M., &Veltri, L. (2018). Internet of things: Architectures, protocols and standards. Wiley
2	Raj, P., & Raman, A. C. (2017). The internet of things: Enabling technologies, platforms, and use cases. CRC Press

References:

1	Bahga, A., &Madisetti, V. (2015). Internet of things: A hands-on approach. Universities

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	Press
2	Greengard, S. (2015). The internet of things. The MIT Press
E- resources:	
1	https://youtu.be/urUBLmXFKl0?si=mAcwX69fnPz0T0TG
2	https://youtu.be/TrFaCBV7joY?si=jl8jLARS57xxAmKb
3	https://youtu.be/VeMDQHyBSaA?si=LfTyMi1PRH_1y28Q

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Explain IoT fundamentals, ecosystem, and technologies
2	Analyze IoT architectures, nodes, and standards
3	Evaluate IoT protocols, wireless technologies, and emerging trends
4	Integrate IoT subsystems in the development of IoT applications
5	Examine IoT case studies to identify innovative solutions for real-world problems.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2		3	2	3	1
2	2		3	3	3	
3	3		3	2	3	1
4	3	1	3	3	3	2
5	3	2	3	2	3	3
Avg	2.6	1.5	3	2.4	3	1.75

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26PES105	SOFTWARE FOR EMBEDDED SYSTEMS	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand the fundamentals and architecture of embedded systems
2	To develop embedded software using the C programming language
3	To gain hands-on experience with embedded hardware and software development tools
4	To study embedded system design paradigms, architectures, and implementation challenges
5	To learn Python programming concepts applicable to embedded and automation applications

Syllabus:

HARDWARE FUNDAMENTALS	**9 Hours**

Buses – DMA – interrupts – Built-ins on the microprocessor – Conventions used on schematics – Microprocessor Architectures – Software Architectures – RTOS Architectures – Selecting Architecture.

Activity: Prepare a brief report comparing different embedded architectures in basis of buses, interrupts, DMA, memory, and software architecture.

EMBEDDED PROGRAMMING	**9 Hours**

C and Assembly - Programming Style - Declarations and Expressions - Arrays, Qualifiers and Reading Numbers - Decision and Control Statements - Programming Process - Control Statements - Variable Scope and Functions - C Preprocessor - Advanced Types – Simple Pointers- Debugging and Optimization – In-line Assembly.

Activity: Develop and debug an embedded C program using pointers, functions, and interrupt handling. Optimize the program and compare execution time and memory usage.

EMBEDDED C	**9 Hours**

Adding Structure to 'C' Code: Object oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism -Creating loop timeouts - Creating hardware timeouts.

Activity: Design a modular embedded C project using header files and reusable drivers. Implement hardware timer-based timeout mechanisms and evaluate timing accuracy.

EMBEDDED SOFTWARE DEVELOPMENT TOOLS	**9 Hours**

Adding Structure to 'C' Code: Object oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism -Creating loop timeouts - Creating hardware timeouts.

Activity: Configure an embedded IDE to build, debug, and profile an application. Use version control and code analysis tools to improve software quality.

PYTHON PROGRAMMING	**9 Hours**

Basics of PYTHON Programming Syntax and Style – Python Objects– Dictionaries- comparison with C programming on Conditionals and Loops – Files – Input and Output – Errors and Exceptions –Functions – Modules – Classes and OOP – Execution Environment.

Activity: Develop a Python program to interface with an embedded board for sensor data acquisition. Visualize the collected data and automate basic analysis using Python libraries.

Total Periods: 45 Hours

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Text Books:	
1	Rajkamal, ―embedded system architecture, programming and design Tata McGraw hill, 2003
2	Mark J.Guzdial," introduction to computing and programming in python – a Multimedia approach ,4th edition, Pearson Education, 2015
References:	
1	Christian Hill, Learning Scientific Programming with Python , Cambridge University Press ,2016
2	Michael J Pont, "Embedded C", Pearson Education, 2007
E- resources:	
1	www.ti.com/design-development/embedded-development.html?utm_source
2	github.com/topics/embedded-systems?utm_source

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Describe the fundamentals, architecture, and operational principles of embedded systems
2	Develop embedded software applications using the C programming language
3	Employ appropriate hardware and software development tools for embedded system design and implementation
4	Analyze embedded system architectures, design methodologies, and associated hardware and software challenges
5	Apply Python programming concepts to solve basic embedded system and automation problems

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2		3	3	2	
2	3	1	3	3	3	
3	3	1	3	3	3	1
4	3	2	3	2	3	1
5	2	2	3	2	3	2
Avg	2.6	1.5	3	2.6	2.8	1.33

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26PES106	EMBEDDED PROGRAMMING LABORATORY	T	L	T	P	J	C
			0	0	4	0	2

Course Objectives:

1	Provide hands-on experience in programming processor and microcontroller-based systems using simulation and development tools.
2	Develop skills in processor interfacing, digital control, arithmetic, logic, and signal processing applications
3	Enable students to design and implement real-time embedded system solutions
4	Familiarize students with modern software tools for program development, compilation, debugging, and testing
5	Expose students to current trends in embedded processors and programmable interfacing technologies relevant to industrial applications

Syllabus:

Experiments using 8-bit microcontroller:

1. Lamp control using Timer/Counter using
2. Direction and Speed control of DC motor
3. USART - Transmission and Reception of a byte using on chip serial port
4. Controlling PWM period with analogue input (POT)

Experiments using LPC2148:

5. LED and Switch interfacing
6. Keypad and LCD interfacing
7. Waveform generation using DAC
8. Read the temperature sensor value using ADC
9. Direction and Speed control of Stepper motor
10. Displaying the Date and Time using RTC
11. USART - Transmission and Reception of a byte using on chip serial port
12. Data Transmission and Reception using I2C
13. Date Transmission and Reception using SPI

Total Periods: 60 Hours

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

CO No.	Course Outcomes
1	Implement processor-based programs and peripheral interfacing using simulation tools and processor development boards
2	Design and evaluate arithmetic, logic, filtering, and signal analysis applications using embedded development tools
3	Develop real-time embedded system solutions for practical engineering applications
4	Apply programming, compilation, debugging, and testing techniques using modern embedded software tools
5	Assess emerging trends in commercial embedded processors and interfacing technologies for professional and entrepreneurial development

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CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	3	1	3	3	3	
2	3	1	3	3	3	1
3	3	1	3	3	3	2
4	3	2	3	2	3	1
5	3	2	3	3	3	2
Avg	3	1.4	3	2.8	3	1.5

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26PES201	EMBEDDED SYSTEM NETWORKING	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand embedded communication protocols and networking fundamentals.
2	To learn USB and CAN bus architectures and their interfacing techniques.
3	To study CAN-based communication systems and CANopen implementation.
4	To understand Ethernet-based embedded networking using TCP/IP protocols and network services.
5	To gain knowledge of wireless sensor networks and energy-efficient communication protocols.

Syllabus:

EMBEDDED COMMUNICATION PROTOCOLS	9 Hours

Embedded Networking: Introduction–Serial / Parallel Communication–Seri al communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols - Serial Peripheral Interface (SPI) – Inter Integrated Circuits, (I2C) – PC Parallel port programming -ISA/PCI Bus protocols – Firewire.

Activity: Interface an embedded controller with SPI and I²C peripherals and compare their communication performance. Analyze data transfer using a logic analyzer or simulation tool.

USB AND CAN BUS	9 Hours

USB bus – Introduction – Speed Identification on the bus – USB States – USB bus communication Packets –Data flow types –Enumeration –Descriptors –PI C 18 Microcontroller USB Interface – C Programs –CAN Bus – Introduction - Frames –Bit stuffing –Types of errors –Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN.

Activity: Develop a USB or CAN-based embedded application for data communication between two nodes. Verify packet transmission and error handling through debugging tools.

CONTROLLER AREA NETWORK	9 Hours

Controller Area Network – Underlying Technology, CAN Overview – Selecting a CAN Controller – CAN development tools. Implementing CAN open Communication layout and requirements – Comparison of implementation methods – Micro CAN open – CAN open source code – Conformance test – Entire design life cycle.

Activity: Configure a CAN network using suitable development tools and implement message exchange between multiple embedded nodes. Evaluate network performance and communication reliability.

EMBEDDED ETHERNET	9 Hours

Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

Activity: Develop an embedded TCP/UDP application to exchange data over Ethernet. Host a simple web page with dynamic sensor data and test client-server communication.

WIRELESS EMBEDDED NETWORKING	9 Hours

Wireless sensor networks – Introduction – Applications – Network Topology – Localization – Time Synchronization - Energy efficient MAC protocols –SMAC – Energy Efficient and robust routing – Data Centric routing.

Activity: Simulate or implement a wireless sensor network for environmental monitoring. Analyze network topology, routing, and energy-efficient communication protocols.

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Total Periods: 45 Hours

Text Books:	
1	Frank Vahid, Givargis ‘Embedded Systems Design: A Unified Hardware/ Software Introduction’, Wiley Publications
References:	
1	Jan Axelson ‘Embedded Ethernet and internet complete’, Penram publications.
2	Bhaskar Krishnamachari, ‘networking wireless sensors’, Cambridge press, 2005.
3	Glaf P Feiffer, Andrew Ayre and Christian Keyold, “embedded networking with can and can open”, embedded system academy 2005.
E- resources:	
1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee01
2	https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee105

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

CO No.	Course Outcomes
1	Explain embedded communication protocols such as RS232, RS485, SPI, I2C, and bus architectures.
2	Analyze USB and CAN bus communication protocols and their embedded system interfaces.
3	Implement CAN and CANopen-based communication systems for embedded networking applications.
4	Apply TCP/IP, UDP, FTP, and web technologies in Ethernet-enabled embedded systems.
5	Design wireless sensor network applications using energy-efficient MAC and routing protocols.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	-	3	3	2	-
2	3	-	3	3	3	-
3	3	1	3	3	3	1
4	3	1	3	2	3	2
5	3	2	3	2	3	3
Avg	2.8	1.33	3	2.6	2.8	2

“3” -High, “2” -Medium, “1” – Low, “-” – No Correlation

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26PES202	EMBEDDED CONTROL SYSTEM	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To impart knowledge of control system fundamentals, stability analysis, and controller design techniques.
2	To introduce model-based design approaches and verification methodologies for embedded control systems.
3	To develop the ability to analyze and implement induction motor control using modern control and hardware platforms.
4	To enable the design and evaluation of BLDC motor control systems using ARM processors and intelligent control techniques.
5	To familiarize students with advanced SRM control strategies employing FPGA and AI-based approaches for industrial applications.

Syllabus:

CONTROL SYSTEM FUNDAMENTALS **9 Hours**

Overview of open loop control - closed loop control - analysis of simple control loops - stability - time and frequency domain specifications of control system performance - simple approaches for controller design – discretization - practical realization of a control loop.

Activity: Students analyze a given real-world system (e.g., temperature or speed control) to identify open-loop and closed-loop components and discuss stability and performance parameters.

MODEL BASED CONTROL SYSTEM **9 Hours**

Model Based Control System Design – discrete systems, notion of state, Finite State Machines, Extended State Machines, Model based design, code generation, verification and validation, HIL, MIL, SIL, PIL. Performance assessment of control algorithms on the target implementation architectures.

Activity: Students map the complete model-based design flow (modeling → code Generation → MIL/SIL/PIL/HIL) for a simple control application using a block diagram.

INDUCTION MOTOR CONTROL **9 Hours**

Types- Speed control methods-PWM techniques- VSI fed three-phase induction motor- Fuzzy logic Based speed control for three phase induction motor-FPGA based three phase induction motor control.

Activity: Students compare different PWM techniques for induction motor speed Control and justify the choice for a given operating condition.

BLDC MOTOR CONTROL **9 Hours**

Overview of BLDC Motor -Speed control methods –PWM techniques- ARM processor based BDLC motor control- ANN for BLDC Motor control and operation.

Activity: Students select an appropriate BLDC motor control method and controller (ARM/ANN-based) for an application such as EV or drone propulsion and explain their choice.

SRM MOTOR CONTROL **9 Hours**

SRM Motor Control: Overview of SRM Motor -Speed control methods –PWM techniques- FPGA based SRM motor control- DNN for SRM Motor control and operation.

Activity: Students discuss how FPGA-based control and DNN can improve SRM Performance and list advantages over conventional control methods.

Total Periods: 45 Hours

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Text Books:	
1	Tim Wiscott, “Applied control for embedded systems”, Elsevier Publications, 2011,1st Edition.
2	Jim Ledin, “Embedded control systems in C/C++”, CRC Press, 2003, 1st Edition.
References:	
1	Karl Johan Astrom, Bjorn Wittenmark, “Computer Controlled Systems”, Dover Publications, 2011.
2	Jim Ledin, “Embedded control systems in C/C++”, CRC Press, 2003, 1st Edition.
E- resources:	
1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee01
2	https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee105

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

CO No.	Course Outcomes
1	Analyze open-loop and closed-loop control systems using time-domain and frequency domain performance specifications
2	Apply model-based control system design methodologies including state models, FSMs, and validation techniques such as MIL, SIL,PIL, and HIL.
3	Design and evaluate induction motor speed control schemes using PWM techniques and intelligent controllers.
4	Analyze and implement BLDC motor control strategies using ARM-based platforms and AI techniques such as ANN.
5	Develop control strategies for SRM drives using FPGA-based architectures and advanced learning methods such as DNN.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	-	3	2	2	1
2	3	1	3	3	3	1
3	3	1	3	3	3	1
4	3	1	3	3	3	2
5	3	2	3	3	3	2
Avg	2.8	1.25	3	2.8	2.8	1.6

“3” -High, “2” -Medium, “1” – Low, “-” – No Correlation

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26PES203	VLSI DESIGN AND RECONFIGURABLE ARCHITECTURE	T	L	T	P	J	C
			3	0	0	0	3

Course Objective:	
1	To understand advanced digital system design and sequential circuit concepts.
2	To learn CMOS technology, IC fabrication, and VLSI layout design techniques
3	To apply ASIC, reconfigurable processor, and SoC design methodologies.
4	To design and analyze analog VLSI circuits and CMOS operational amplifiers.
5	To develop and verify digital systems using VHDL modeling and simulation tools.

Syllabus:

Introduction to Advanced Digital System Design	**9 Hours**
Modeling and design of synchronous and asynchronous sequential circuits. Includes vending machine controller design, hazards (static, dynamic, essential), and methods for hazard-free circuit implementation. **Activity:** Perform a simulation to design combination circuits using ModelSim / Xilinx Vivado / Quartus and verify with testbench.	
CMOS Basics & IC Fabrication	**9 Hours**
MOSFET scaling, transistor models, CMOS logic design, BiCMOS, low-power techniques, and fabrication methods. Emphasizes stick diagrams, layout design rules, and IC implementation basics. **Activity:** Study MOSFET logic design, scaling effects, and apply stick diagrams with layout rules to connect theory and fabrication.	
ASIC and Reconfigurable Processor and Soc Design	**9 Hours**
ASIC design flow, programmable ASICs, reconfigurable processor architecture, SoC overview, embedded FPGA, and applications such as DC motor control. **Activity:** Compare traffic light controller implementation across ASIC simulation, FPGA/reconfigurable processor, and SoC co-design.	
Analog VLSI Design	**9 Hours**
CMOS op-amp design (two/three-stage), highspeed/frequency op-amps, Super MOS, analog primitive cells, and introduction to FPAA concepts. **Activity:** Design a two-stage CMOS op-amp using a circuit simulator and measure its key parameters.	
HDL programming	**9 Hours**
VHDL-based digital design: structural, dataflow, behavioral modeling. Logic synthesis and simulation for adders, multipliers, ALUs, shift registers, and test benches. **Activity:** Design a 4-bit ALU in VHDL with add, subtract, increment, AND, OR Operations, and verify using an automated test bench.	
Total Periods: 45 Hours	

Text Books:	
1	Givone, D. G. (2002). Digital principles and design. Tata McGraw Hill.
2	Nurmi, J. (Ed.). (2007). Processor design system-on-chip computing for ASICs and FPGAs. Springer.
References:	
1	Ismail, M., & Fiez, T. (Year unknown). Analog VLSI signal and information processing. McGraw Hill International Editions.

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2	Dally, W. J., Harting, C., & Aamodt, T. M. (2015). Digital design using VHDL: A systems approach. Cambridge University Press.
E- resources:	
1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee66
2	https://nptel.ac.in/courses/108106370

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Examine the Model synchronous/asynchronous circuits and remove hazards.
2	Examine CMOS issues, low-power methods, and layouts.
3	Evaluate ASIC vs. reconfigurable SoC architectures.
4	Analyze the analog VLSI blocks for high-frequency use.
5	Apply the Simulate tools and verify digital circuits with HDL.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	-	3	3	2	-
2	3	1	3	3	3	-
3	3	2	3	3	3	1
4	3	1	3	2	3	2
5	3	2	3	2	3	3
Avg	2.8	1.5	3	2.6	2.8	2

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26PES204	REAL-TIME EMBEDDED SYSTEMS	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand embedded system fundamentals, software development process, and Embedded C programming.
2	To learn the concepts and operation of Real-Time Operating Systems (RTOS).
3	To understand inter-task synchronization and communication mechanisms in embedded systems.
4	To gain knowledge of interrupt handling and I/O subsystem management in embedded applications.
5	To develop embedded software using memory management and application modularization techniques.

Syllabus:

PROGRAMMING LANGUAGE AND TOOLS FOR EMBEDDED SOFTWARE DEVELOPMENT	**9 Hours**

Fundamentals of Embedded Systems – Embedded Software Development Process: Programming Languages - Embedded C Building Blocks – Mixing of Assembly and C – Pre-processor - Compiler – Assembler - Linker and Loader - Cross Platform Development - Compiler Optimization Techniques – Executable File Formats-Concept of Make Utility - Super Loop based Design Approach.

Activity: Develop a modular Embedded C application using a cross-compiler and Make utility. Analyze the effect of compiler optimization on code size and execution speed.

REAL-TIME OPERATING SYSTEMS	**9 Hours**

Basic Terminologies of Real-Time Embedded Systems – Concepts of OS-based Software Development – Real-Time Operating Systems: Definition, Characteristics and Structure – Task Management: Definition, Classification, Structure, States, and Scheduling – Concept of Pseudo Multitasking and True Multitasking.

Activity: Create multiple RTOS tasks with different priorities and scheduling policies. Observe task execution and compare pseudo multitasking with true multitasking.

INTER-TASK SYNCHRONIZATION AND COMMUNICATION	**9 Hours**

Critical Sections – Atomic Operation – Concept of Reentrancy – Semaphores – Event Flag Registers - Inter-task Communication Methods: Shared Memory Technique, Mailbox, Message Queues, and Pipes – Common Design Problems: Premature Task Deletion, CPU Starvation, Deadlocks, and Unbounded Priority Inversion.

Activity: Implement inter-task communication using semaphores, message queues, or mailboxes in an RTOS. Analyze synchronization issues such as deadlocks and priority inversion.

INTERRUPT MANAGEMENT, I/O SUBSYSTEMS	**9 Hours**

Exceptions and Interrupts – Processing of Exceptions and Interrupts – I/O Sub-systems.

Activity: Develop an interrupt-driven embedded application to interface with an external peripheral. Compare interrupt-based and polling-based I/O methods in terms of response time.

MEMORY MANAGEMENT	**9 Hours**

Memory Management – Dynamic Memory Allocation and Fixed-size Memory Allocation in Embedded Systems - Application Modularization for Concurrency: Outside-In Approach – UML Diagrams- Design Examples.

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Activity: Implement dynamic and fixed-size memory allocation in an embedded application and compare their memory utilization. Prepare UML diagrams to illustrate concurrent software architecture.
Total Periods: 45 Hours

Text Books:	
1	Qing Li, "Real-Time Concepts for Embedded Systems", CMP Books, 2003.
2	Insup Lee, Joseph Leung, and Sang Son, "Handbook of Real-Time Systems", Chapman and Hall, 2008.
References:	
1	Albert Cheng, "Real-Time Systems: Scheduling, Analysis and Verification", Wiley Interscience, 2002.
2	Bernd Bruegge, Allen Dutoit, "Object-oriented Software Engineering – Using UML, Patterns and Java", Prentice Hall, USA, 2010.
3	David E. Simon, "An Embedded Software Primer", Pearson, 2002.
E- resources:	
1	https://nptel.ac.in/courses/117105082
2	https://nptel.ac.in/courses/108106165

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Apply Embedded C and software development tools for embedded system design.
2	Analyze RTOS concepts, task management, and scheduling techniques.
3	Implement inter-task synchronization and communication mechanisms in real-time systems.
4	Analyze interrupt handling and I/O subsystem operations in embedded systems.
5	Design embedded applications using memory management and modular software design approaches.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	-	2	2	1	2
2	2	-	3	3	1	-
3	3	1	3	3	3	2
4	2	-	2	2	2	2
5	3	-	3	3	2	1
Avg	2.4	1	2.6	2.6	1.8	1.75

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26PES205	EMBEDDED SYSTEM LABORATORY	T	L	T	P	J	C
			0	0	4	0	2

Course Objectives:

1	To Develop embedded programs using Raspberry Pi, Arduino, DSP processors, and ESP32 platforms.
2	To Interface input/output devices, sensors, and communication peripherals with embedded controllers.
3	To Apply timer, interrupt, serial communication, and real-time operating system concepts in embedded applications.
4	To Implement IoT-based and CAN communication applications using embedded hardware platforms.
5	To Analyze and debug embedded system programs using development tools such as cross-compilers, debuggers, and in-circuit emulators.

Syllabus:

1. Programming with Rasberry Pi Microcontroller Board: Study on incircuit Emulators, cross compilers, debuggers
2. I/O Programming with Arduino PWM Generation/ Motor Control/ADC/DAC/ LCD/ RTC
3. Rasberry Pi Microcontroller Boards I/O Interfacing: Interfacing/ Sensor Interfacing/IoT Applications
4. Timers/ Interrupts/ Serial port programming
5. Programming with DSP processors
6. Study of one type of Real Time Operating Systems (RTOS)
7. CAN Interfacing using Loopback mode using ESP32 microcontroller

Total Periods: 60 Hours

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

CO No.	Course Outcomes
1	Develop and debug embedded programs using Raspberry Pi, Arduino, DSP processors, and ESP32 development boards with appropriate software development tools.
2	Interface sensors, actuators, displays, and communication peripherals to design embedded and IoT-based applications.
3	Implement timer, interrupt, serial communication, and RTOS-based applications for embedded systems.
4	Analyze the performance of embedded applications involving DSP programming and CAN communication using loopback mode.
5	Evaluate and troubleshoot embedded system hardware and software for reliable real-time operation and communication.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	3	1	3	3	2	-
2	3	1	3	3	2	2
3	3	1	3	3	2	1
4	3	2	3	3	2	1
5	3	2	3	3	2	2
Avg	3	1.4	3	3	2	1.5

“3” -High, “2” -Medium, “1” – Low, “-” – No Correlation

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26CSP921	PYTHON PROGRAMMING FOR MACHINE LEARNING	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand and apply fundamental Python programming concepts including control structures, functions, recursion, and basic data structures.
2	To develop skills in handling data using lists, dictionaries, files, and images, and in implementing programs using Python.
3	To introduce machine learning concepts and enable students to formulate and implement basic machine learning solutions using Python through practice and exercises.
4	To understand the classification of ML and Clustering concepts.
5	To introduce the Neural Networks and Embedded Machine learning.

Syllabus:

INTRODUCTION TO MACHINE LEARNING AND PYTHON	9 Hours

Introduction to Machine Learning: Significance, Advantage and Applications – Categories of Machine Learning – Basic Steps in Machine Learning: Raw Data Collection, Pre-processing, Training a Model, Evaluation of Model, Performance Improvement.

Introduction to Python and its significance – Difference between C, C++ and Python Languages; Compiler and Interpreters – Python3 Installation & Running – Basics of Python Programming Syntax: Variable Types, Basic Operators, Reading Input from User – Arrays/List, Dictionary and Set – Conditional Statements – Control Flow and loop control statements

Activity: Write a simple Python program and map the steps of a machine learning Workflow using a real-world example.

PYTHON FUNCTIONS AND PACKAGES	9 Hours

File Handling: Reading and Writing Data – Errors and Exceptions Handling – Functions & Modules – Package Handling in Python – Pip Installation & Exploring Functions in python package – Installing the Numpy Library and exploring various operations on Arrays: Indexing, Slicing, Multidimensional Arrays, Joining Numpy Arrays, Array intersection and Difference, Saving and Loading Numpy Arrays – Introduction to SciPy Package & its functions - Introduction to Object Oriented Programming with Python

Activity: Perform file handling and array operations using NumPy and SciPy on a sample dataset.

IMPLEMENTATION OF MACHINE LEARNING USING PYTHON	9 Hours

Description of Standard Datasets: Coco, Image Net, MNIST (Handwritten Digits) Dataset, Boston Housing Dataset – Introducing the concepts of Regression – Linear, Polynomial & Logistic Regression with analytical understanding - Introduction to SciPy Package & its functions – Python Application of Linear Regression and Polynomial Regression using SciPy – Interpolation, Over fitting and Under fitting concepts & examples using SciPy.

Activity: Implement and compare linear and polynomial regression models using a standard dataset.

CLASSIFICATION AND CLUSTERING CONCEPTS	9 Hours

Introduction to ML Concepts of Clustering and Classification – Types of Classification Algorithms – Support Vector Machines (SVM) - Decision Tree - Random Forest – Introduction to ML using scikit- learn – Using scikit-learn, loading a sample dataset, Learning & prediction, interpolation & fitting, Multiclass fitting - Implementation of SVM using Blood Cancer Dataset, Decision Tree using data from csv. Types of Clustering Algorithms & Techniques – K-means Algorithm, Mean Shift Algorithm & Hierarchical Clustering Algorithm – Introduction to Python Visualization using Matplotlib: Plotting 2- dimensional, 3-dimensional graphs; formatting axis values; plotting multiple rows of data in same graph –

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Implementation of K-means Algorithm and Mean Shift Algorithm using Python. **Activity:** Train a classification model and perform clustering on a dataset, then visualize the results using Matplot lib.	
INTRODUCTION TO NEURAL NETWORKS AND EMBEDDED MACHINE LEARNING	**9 Hours**
Introduction to Neural Networks & Significance – Neural Network Architecture – Single Layer Perceptron & Multi-Layer Perceptron (MLP) – Commonly Used Activation Functions - Forward Propagation, Back Propagation, and Epochs – Gradient Descent – Introduction to Tensor flow and Keras ML Python packages – Implementation of MLP Neural Network on Iris Dataset – Introduction to Convolution Neural Networks – Implementation of Digit Classification using MNIST Dataset ML for Embedded Systems: Comparison with conventional ML – Challenges & Methods for Overcoming – Tiny ML and Tensor flow Lite for Microcontrollers – on Board AI – ML Edge Devices: Arduino Nano BLE Sense, Google Edge TPU and Intel Movidius. **Activity:** Build a simple neural network for digit classification and discuss its deployment on an edge device.	
Total Periods: 45 Hours	

Text Books:	
1	Frank Vahid, Givargis ‘Embedded Systems Design: A Unified Hardware/ Software Introduction’, Wiley Publications
References:	
1	Zelle, John “M. Python Programming: An Introduction to Computer Science.”, Franklin Beedle & Associates, 2003
2	Andreas C. Müller, Sarah Guido, “Introduction to Machine Learning with Python”, O'Reilly,2016
3	Sebastian Raschka , VahidMirjalili, “Python Machine Learning - Third Edition”, Packt, December 2019.
E- resources:	
1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee01
2	https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee105

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

CO No.	Course Outcomes
1	Explain basic machine learning concepts, workflows, and implement fundamental Python programs.
2	Apply the Python functions, packages, and numerical libraries to process and analyze data.
3	Implement regression models and analyze overfitting and underfitting using standard datasets.
4	Apply classification and clustering algorithms using scikit-learn and visualize results.
5	Analyze the basic neural network models and understand embedded machine learning and TinyML concepts.

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CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	2	2	1	-	-
2	3	2	2	2	1	-
3	2	2	2	2	-	-
4	3	2	2	2	1	1
5	3	2	2	2	1	1
Avg	2.6	2	2	1.8	1	1

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ECP701	DISTRIBUTED EMBEDDED COMPUTING	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To Understand the hardware infrastructure required for distributed embedded systems, including networking technologies, communication standards, network management, security mechanisms, and cluster computing.
2	To learn knowledge of Internet technologies such as web protocols, HTML, XML, web page design, and the integration of Internet-based applications with enterprise databases.
3	To Develop distributed applications using Java, employing concepts such as I/O streams, object serialization, networking, multithreading, Remote Method Invocation (RMI), multicasting, and distributed databases.
4	To Understand embedded agents by understanding agent architectures, design criteria, coordination mechanisms, behavior-based and functionality-based approaches, and their applications in mobile robotic systems.
5	Apply integrated hardware, software, networking, and intelligent-agent concepts to design and evaluate complex distributed embedded systems for real-world applications.

Syllabus:

Unit 1- The Hardware Infrastructure — **9 Hours**

Broad Band Transmission facilities – Open Interconnection standards – Local Area Networks – Wide Area Networks – Network management – Network Security – Cluster computers.

Activity: Study the architecture of a distributed embedded network and compare LAN, WAN, and cluster computing for embedded applications. Present the findings with a suitable network topology.

Unit 2- Internet Concepts — **9 Hours**

Capabilities and limitations of the internet – Interfacing Internet server applications to corporate databases HTML and XML Web page design and the use of active components.

Activity: Develop a simple web interface using HTML/XML to display data from an embedded application. Demonstrate communication between the web page and a local server or database.

Unit 3- Distributed Computing Using JAVA — **9 Hours**

IO streaming – Object serialization – Networking – Threading – RM I – multicasting – distributed databases – embedded java concepts – case studies.

Activity: Develop a Java application using multithreading and socket programming for distributed communication. Demonstrate object serialization and data exchange between networked systems.

Unit 4- Embedded Agent — **9 Hours**

Introduction to the embedded agents – Embedded agent design criteria – Behaviour based, Functionality based embedded agents – Agent co-ordination mechanisms and benchmarks embedded-agent. Case study: Mobile robots.

Activity: Design and simulate a behavior-based embedded agent for an autonomous application such as a mobile robot. Evaluate its coordination and decision-making performance.

Unit 5- Embedded Computing Architecture — **9 Hours**

Synthesis of the information technologies of distributed embedded systems – analog/digital co-design – optimizing functional distribution in complex system design – validation and fast prototyping of multiprocessor system-on-chip – a new dynamic scheduling algorithm for real-time multiprocessor systems.

Activity: Analyze a multiprocessor System-on-Chip (MPSoC) architecture and propose an efficient task scheduling strategy. Compare the performance of different scheduling

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approaches for real-time applications.
Total Periods: 45 Hours

Text Books:	
1	"Architecture and Design of Distributed Embedded Systems", edited by Bernd Kleinjohann C-lab, Universitat Paderborn, Germany, Kluwer Academic Publishers, Boston, April 2001.
2	Sape Mullender, "Distributed Systems", Addison-Wesley, 1993.
References:	
1	Dietel & Dietel, "JAVA how to program", Prentice Hall 1999. ACC.NO: B112846
2	George Coulouris and Jean Dollimore, "Distributed Systems – con cepts and design",Addison – Wesley 1988.
E- resources:	
1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_cs87
2	https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_cs130

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

CO No.	Course Outcomes
1	Explain the concepts of broadband transmission facilities, LAN, WAN, and cluster computing
2	Apply HTML and XML for designing web pages and representing structured data.
3	Apply networking concepts such as sockets, multicasting, and Remote Method Invocation (RMI).
4	Analyze embedded agent architectures and design criteria.
5	Analyze distributed embedded system architectures and their synthesis.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	3	2	2	2	2	1
2	3	2	2	2	2	1
3	3	3	2	2	2	1
4	3	2	2	2	2	1
5	3	3	3	2	2	1
Avg	3	2.4	2.2	2	2	1

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ECP702	VIRTUAL INSTRUMENTATION	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	Understanding the difference between conventional and graphical programming.
2	Introducing the basics of Lab VIEW and programming concepts.
3	Differentiating the real time and virtual instrument.
4	Represent and review signals acquire process in digital domain.
5	Analyzing the basics of data acquisition and learning the concepts of data acquisition with Lab VIEW.

Syllabus:

Unit 1- Fundamentals of Virtual Instrumentation **9 Hours**

Fundamental Concepts of Virtual Instrumentation (VI) and Graphical Programming - Virtual instruments and Traditional instruments, Hardware and Software in virtual instrumentation, Data Flow Programming - Data Types – Customization of VI Properties - VI Documentation.
Activity: Develop a basic LabVIEW Virtual Instrument (VI) for signal generation and measurement. Customize the front panel and document the VI using appropriate controls and indicators.

Unit 2- VI Programming Structures **9 Hours**

Software Environment - Modular programming - Formula Nodes - Loops - Shift Registers - Local and Global Variables – Case and Sequence Structures - Arrays and Clusters - Graphs and Charts - State Machines - String and File I/O.
Activity: Design a modular LabVIEW application using loops, case structures, arrays, and file I/O. Demonstrate data acquisition and visualization using graphs and charts.

Unit 3- Data Acquisition And Interfacing Standards **9 Hours**

PC based data acquisition – DAQ hardware and software architecture – DAQ hardware configuration, sampling methods and grounding techniques, analog I/O, digital I/O, counter/timer - Communication: Interfacing of external instruments to a PC - RS232 - RS485 - GPIB – System Interface Buses: USB- PCI, PXI; Introduction to bus protocols of MOD bus and CAN bus - Industrial Ethernet.
Activity: Interface a DAQ device with external sensors and acquire analog and digital signals using LabVIEW. Analyze the acquired data and compare different communication interfaces.

Unit 4- Advanced Programming **9 Hours**

Introduction, Definition of State Machine, A Simple State Machine, Event Structures. File Input / Output: Introduction, File Formats, File I/O Functions, Path Functions, Sample VIs to Demonstrate File WRITE and READ Function String Handling: Introduction, String Functions, Lab VIEW String Formats, Typical examples Use of analysis tools and application of VI: Fourier transforms, Power spectrum.
Activity: Develop a state machine-based LabVIEW application with event handling and file management. Apply built-in analysis tools to perform FFT and power spectrum analysis on acquired signals.

Unit 5- Case Studies **9 Hours**

Temperature Monitoring System using PC based Data Acquisition System - Machine vision, Motion control, Configuration of Real-Time I/O Hardware in MAX - Host & Target VI – Prioritization of Tasks – Timed Programming Structures in Lab VIEW – Real-Time Application Deployment using my RIO – Run-time Interaction with Deployed Applications .
Activity: Implement a real-time temperature monitoring system using LabVIEW and DAQ hardware. Deploy the application on a real-time target or myRIO and monitor system performance.

Total Periods: 45 Hours

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Text Books:	
1	Jovitha Jerome, ―Virtual Instrumentation using Lab VIEW‖, PHI Learning Pvt. Ltd., 2010.
2	Rick Bitter, Taqi Mohiuddin and Matt Nawrocki, "Lab VIEW Advanced Programming Techniques", CRC Press, 2009.
References:	
1	Lisa. K. Wills, "Lab VIEW for Everyone", Prentice Hall of India, 2nd Edition, 2008.
2	Gary Johnson and Richard Jennings, ―Lab VIEW Graphical Programming, McGraw Hill Inc., Fourth Edition, 2006.
3	Sanjay Gupta and Joseph John, "Virtual Instrumentation Using Lab VIEW", Tata McGraw Hill, 2008.
E- resources:	
1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee01
2	https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee105

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Explain the fundamentals of virtual instrumentation, graphical programming concepts, data flow programming, and virtual instrument development in LabVIEW.
2	Explain the difference between the traditional and virtual instrumentation.
3	Apply data acquisition techniques and interfacing standards to configure and integrate measurement systems using DAQ hardware and communication protocols.
4	Analyze advanced LabVIEW programming concepts including event-driven programming, state machines, file handling, signal analysis tools, Fourier transforms, and power spectrum analysis.
5	Analyze and implement real-time virtual instrumentation applications involving data acquisition, machine vision, motion control, and embedded deployment using myRIO platforms.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	2	2	2	2	1
2	2	2	2	2	2	1
3	3	3	2	2	2	1
4	3	2	2	2	2	1
5	3	3	3	2	2	1
Avg	2.6	2.4	2.2	2	2	1

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ECP703	WIRELESS AND MOBILE COMMUNICATION	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand the fundamental concepts of cellular systems including frequency reuse, channel allocation, handoff strategies, and interference management techniques used in wireless communication networks.
2	To study various mobile radio propagation models and analyze large-scale and small-scale fading effects in different wireless environments.
3	To compare and evaluate multiple access techniques such as FDMA, TDMA, and CDMA and understand the architecture and operation of wideband CDMA systems.
4	To analyze IP mobility concepts and wireless network protocols including DHCP, DNS, IPv6 mobility, and security mechanisms for mobile communication systems.
5	To develop analytical skills in designing and evaluating cellular and mobile communication systems for improving coverage, capacity, and Quality of Service (QoS).

Syllabus:

Unit 1- The Cellular Concept	**9 Hours**

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

Activity: Allocate frequencies on a cellular map and simulate handoff scenarios to study interference and coverage.

Unit 2- Mobile Radio Propagation - Large-Scale Path Loss	**9 Hours**

Propagation, Free Space Propagation Model, Relating Power to Electric Field, Diffraction-Fresnel Zone Geometry, Knife edge Diffraction Model, Multiple knife edge Diffraction, Scattering, Outdoor Propagation Models-Longley-Ryce Model, Okumura Model, Hata Model, Indoor Propagation Models-Partition losses, Partition losses between Floors, Log-distance path loss model, Ericsson Multiple Breakpoint Model, Attenuation Factor Model, Signal penetration into buildings, Ray Tracing and Site Specific Modelling.

Activity: Measure or simulate signal strength over distance and apply diversity Techniques to improve reliability.

Unit 3- Mobile Radio Propagation	**9 Hours**

Small –Scale Fading and Multipath: Small Scale Multipath propagation-Factors influencing small scale fading, Doppler shift, Impulse Response Model of a multipath channel-Relationship between Bandwidth and Received power, Small-Scale Frequency Domain Channels Sounding, Parameters of Mobile Multipath Channels-Time Dispersion Parameters, Coherence Bandwidth, Doppler Spread and Coherence Time, Types of Small-Scale Fading-Fading effects Due to Multipath Time Delay Spread, Flat fading, Frequency selective fading, Fading effects Due to Doppler Spread-Fast fading, slow fading, Fundamentals of Equalization, Training A Generic Adaptive Equalizer, Equalizers in a communication Receiver, Linear Equalizers, Nonlinear Equalization

Activity: Simulate multiple users transmitting simultaneously and observe how spreading codes separate signals.

Unit 4- Wideband Code Division Multiple Access	**9 Hours**

CDMA system overview -air interface –physical and logical channel–speech coding, multiplexing and channel coding spreading and modulation: frame structure, spreading codes-uplink-downlink physical layer procedures: cell search and synchronization-establishing a connection-power control- handover-overload control.

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Activity: Compare TDMA, FDMA, and CDMA methods in a table and discuss best fit scenarios.	
Unit 5- IP Mobility Framework	**9 Hours**
Challenges of IP Mobility -Address Management -Dynamic Host Configuration Protocol and Domain Name Server Interfaces –Security Mobility-Based AAA Protocol -IP Mobility Architecture Framework -X Access Network -IPv6 Challenges for IP Mobility. **Activity:** Configure a small IP-based mobile network using a simulator and analyze mobility and QoS issues.	
Total Periods: 45 Hours	

Text Books:	
1	Gottapu Sasibhushana Rao, "Mobile Cellular Communication", Pearson Education, 2012.
2	Schiller, Jochen H, "Mobile communications", Pearson, 2nd Edition, 2007.
References:	
1	Theodore, S. Rappaport, "Wireless Communications, Principles, Practice", 2nd Ed., 2002, PHI.
2	Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.
3	William Stallings, "Wireless Communication and Networking", PHI, 2003.
E- resources:	
1	https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee66
2	https://nptel.ac.in/courses/108106370

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Explain the fundamentals of cellular system design including frequency reuse, channel assignment strategies, handoff techniques, trunking, and interference management in wireless networks.
2	Analyze the impact of co-channel and adjacent channel interference and apply techniques such as power control, cell splitting, and sectoring to improve cellular system capacity and coverage.
3	Analyze large-scale and small-scale radio propagation models including path loss, diffraction, scattering, fading, Doppler effects, and equalization techniques in mobile communication systems.
4	Compare and evaluate multiple access techniques such as FDMA, TDMA, and CDMA and explain wideband CDMA system architecture including spreading, modulation, and channel coding procedures.
5	Apply IP mobility concepts and frameworks including DHCP, DNS, IPv6 mobility, and AAA protocols to design and analyze mobile IP-based network architectures.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	3	2	2	2	2	2
2	3	2	2	2	2	2
3	3	2	2	2	2	2
4	3	2	2	2	2	2
5	3	2	2	2	2	2
Avg	3	2	2	2	2	2

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ECP704	MEMS AND NEMS TECHNOLOGY	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand the fundamental concepts of MEMS and NEMS, including their evolution, scaling laws, and mechanical behavior such as stress, strain, and beam deflection analysis.
2	To study the materials, properties, and micro fabrication techniques used in MEMS devices, including bulk micromachining, surface micromachining, photolithography, etching, and thin-film deposition processes.
3	To analyze the working principles, design, and fabrication of MEMS sensors and actuators such as capacitive sensors, comb drives, micro grippers, and micro motors.
4	To explore advanced MEMS devices based on piezoelectric, thermal, magnetic, and shape memory alloy principles, and understand their applications in real-world systems.
5	To understand MEMS packaging techniques and their importance in device protection, reliability, and performance improvement in micro and nano systems.

Syllabus:

Unit 1- Introduction — **9 Hours**

Definition and overview of MEMS and NEMS-History and evolution of microsystems. Intrinsic characteristic of MEMS-Scaling laws in miniaturization. Semiconductor conductivity and resistivity – Stress and strain analysis – Flexural beam bending- Torsional deflection.

Activity: In-class discussion with problem-solving (e.g., calculate scaling effects, analyse mechanical stress/strain).

Unit 2- Microfabrication — **9 Hours**

Semiconductors, Metals, Metal Alloys, thin metal films, Polymers, Glass and Quartz substrates, diamond, piezoelectric and magnetic compounds, Microfabrication and Micromachining of Micro devices, Bulk Micromachining- Surface micro-machining-High-Aspect-Ratio (LIGA) Technology Photolithography, Etching,Sputtering, Evaporation.

Activity: Students create 3D or CAD models of a micromachining process (e.g., photolithography, LIGA).

Unit 3- Sensors And Actuators - I — **9 Hours**

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators – Applications – Inter digitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors.

Activity: Demonstrate a comb drive or interdigitated finger capacitor using cardboard, 3D printed parts, or simple circuit setups.

Unit 4- Sensors And Actuators – II — **9 Hours**

Piezoelectric effect – cantilever piezo electric actuator model – properties of piezo electric materials Applications. Thermal Sensing and Actuation – Magnetic Actuators – Micro magnetic components – Actuation using Shape Memory Alloys – Piezo resistive sensors.

Activity: Students present on Shape Memory Alloy actuators or magnetic MEMS devices.

Unit 5- Packaging — **9 Hours**

Types of packaging, Ceramic, Metal, Molded plastic, Hermetic packaging, Die-attach process, Interconnects, Encapsulation.

Activity: Groups design posters on MEMS Packaging Techniques.

Total Periods: 45 Hours

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Text Books:	
1	Chang Liu, "Foundations of MEMS", Pearson International Edition, 2nd Edition, 2012.
2	Marc J. Madou, "Fundamentals of Microfabrication and Nanotechnology", 3rd Edition, CRC Press, 2011.
References:	
1	Tai-Ran Hsu,"MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering", 2nd Edition, Wiley, 2008.
2	Stephen D. Senturia, "Microsystem Design", Kluwer Academic Publishers, 1st Edition, 2001.
E- resources:	
1	https://nptel.ac.in/courses/117105082
2	https://nptel.ac.in/courses/108106165

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

CO No.	Course Outcomes
1	Explain the fundamental concepts of MEMS and NEMS, including scaling laws, mechanical behavior, stress–strain analysis, and beam deflection in microstructures.
2	Analyze materials and micro fabrication processes such as bulk micromachining, surface micromachining, photolithography, etching, and thin-film deposition techniques used in MEMS fabrication.
3	Apply the design principles of MEMS sensors and actuators such as capacitive sensors, comb drives, micro grippers, and micro motors for engineering applications.
4	Analyze advanced MEMS devices based on piezoelectric, thermal, magnetic, and shape memory alloy effects and evaluate their performance in practical applications.
5	Explain MEMS packaging techniques and assess their role in device reliability, protection, and system integration in micro electro mechanical systems.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	2	2	2	2	2
2	3	3	2	2	2	2
3	2	2	2	2	2	2
4	2	2	2	2	2	2
5	3	2	2	2	2	2
Avg	2.4	2.2	2	2	2	2

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ESP705	DSP BASED SYSTEM DESIGN	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand various representation methods of DSP system
2	To provide insight about different DSP algorithms
3	To familiarize the various architectures of DSP system
4	To perform analysis of DSP architectures and to learn the implementation of DSP system in programmable hardware
5	To learn the details of DSP system interfacing with other peripherals

Syllabus:

REPRESENTATION OF DSP SYSTEM	**9 Hours**
Single Core and Multicore, Architectural requirement of DSPs - high throughput, low cost, low power, small code size, embedded applications. Representation of digital signal processing systems – block diagrams, signal flow graphs, data-flow graphs, dependence graphs. Techniques for enhancing computational throughput - parallelism and pipelining. **Activity:** Draw and compare block diagrams, signal-flow graphs, and data-flow graphs for a simple DSP system and discuss parallelism and pipelining.	
DSP ALGORITHMS	**9 Hours**
DSP algorithms - Convolution, Correlation, FIR/IIR filters, FFT, adaptive filters, sampling rate converters, DCT, Decimator, Expander and Filter Banks. DSP applications. Computational characteristics of DSP algorithms and applications, Numerical representation of signals-word length effect and its impact, Carry free adders, Multiplier. **Activity:** Manually compute and compare the steps of FIR filtering and FFT for a given input signal to understand computational characteristics	
SYSTEM ARCHITECTURE	**9 Hours**
Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Features for External Interfacing. VLIW architecture. Basic performance issue in pipelining, Simple implementation of MIPS, Instruction Level Parallelism, Dynamic Scheduling, Dynamic Hardware Prediction, Memory hierarchy. Study of Fixed point and floating point DSP architectures. **Activity:** Analyze a DSP processor architecture diagram and identify memory, bus, addressing modes, and pipelining features.	
ARCHITECTURE ANALYSIS ON PROGRAMMABLE HARDWARE	**9 Hours**
Analysis of basic DSP Architectures on programmable hardware's. Algorithms for FIR, IIR, Lattice filter structures, architectures for real and complex fast Fourier transforms, 1D/2D Convolutions, Wino grad minimal filtering algorithm. FPGA: Architecture, different sub-systems, design flow for DSP system design, mapping of DSP algorithms onto FPGA. **Activity:** Map a basic FIR or FFT algorithm onto an FPGA block diagram and explain the design flow.	
SYSTEM INTERFACING	**9 Hours**
Examples of digital signal processing algorithms suitable for parallel architectures such as GPUs and Multi GPUs. Interfacing: Introduction, Synchronous Serial Interface CODE, A CODEC Interface Circuit, ADC interface. **Activity:** Illustrate the interfacing of a DSP processor with ADC, CODEC, or GPU and explain the data flow.	
Total Periods: 45 Hours	

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References:	
1	K. K. Parhi - VLSI Digital Signal Processing Systems - Wiley – 1999.
2	Keshab K Parhi, "VLSI Digital Signal Processing Systems: Design and Implementation", student Edition, Wiley, 1999.
3	Sen M Kuo, Woon Seng S Gan, "Digital Signal Processors – Architectures, Implementations, and Applications", Pearson Education, 2005.
4	Peter Pirsch, "Architectures for Digital Signal Processing", John Weily, 2007
E- resources:	
1	www.ti.com/tool/training
2	www.mathworks.com

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

CO No.	Course Outcomes
1	Explain the representation of DSP systems using block diagrams, signal-flow graphs, data-flow graphs, dependence graphs, and describe the architectural requirements of single-core and multicore DSP processors.
2	Apply DSP algorithms such as convolution, correlation, FIR/IIR filtering, FFT, DCT, adaptive filtering, decimation, interpolation, and filter banks to solve signal processing problems.
3	Analyze the computational characteristics of DSP algorithms, including throughput, numerical representation, word-length effects, and arithmetic units such as carry-free adders and multipliers.
4	Analyze DSP processor architectures with respect to memory organization, bus architecture, addressing modes, pipelining, instruction-level parallelism, VLIW architecture, and performance optimization techniques.
5	Implement and map DSP algorithms on programmable hardware platforms such as FPGAs using appropriate architectural and design-flow methodologies.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	3	3	-	2	1	-
2	3	3	3	3	2	-
3	2	2	1	1	1	-
4	2	3	2	1	1	-
5	2	2	2	1	2	-
Avg	2.4	2.6	1.6	1.6	1.4	-

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ESP706	EMBEDDED SYSTEMS SECURITY	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand the threat landscape and attack surfaces in embedded systems.
2	To study secure coding practices and memory protection mechanisms like DEP, ASLR, and MPU.
3	To understand secure key management and intrusion detection techniques in embedded networks.
4	To understand secure hardware design principles and counter measures against hardware attacks.
5	To develop the ability to identify attack vectors and propose appropriate defense mechanisms.

Syllabus:

FUNDAMENTALS OF EMBEDDED SYSTEMS AND SECURITY	9 Hours

Embedded systems: architecture and applications; Characteristics of embedded systems; Threat landscape for embedded systems; Security goals: confidentiality, integrity, availability, authenticity; Security models and policies; Attack surfaces in embedded systems; Real-world case studies of embedded system breaches.

Activity: Identify a real-world embedded system breach and map the violated security goals (CIAA).

FIRMWARE AND SOFTWARE SECURITY	9 Hours

Firmware reverse engineering and vulnerability analysis; Secure coding practices for embedded software; Common vulnerabilities: buffer overflows, format string attacks; Memory protection mechanisms: DEP, ASLR,MPU; Firmware update mechanisms and secure boot loaders; Secure firmware deployment: digital signatures, encryption; Anti-debugging and obfuscation techniques.

Activity: Analyze a sample embedded C code to identify vulnerabilities such as buffer overflow and suggest fixes.

COMMUNICATION AND NETWORK SECURITY IN EMBEDDED SYSTEMS	9 Hours

Protocols used in embedded systems (CAN, SPI, I2C, Modbus, Zigbee); Wireless embedded systems vulnerabilities (BLE, Wi-Fi); Cryptographic techniques for embedded communication; Lightweight cryptography and constraints of embedded devices; Secure communication protocols (TLS, DTLS, IP sec for embedded); Secure key management in embedded systems; Intrusion detection in embedded networks.

Activity: Design a secure communication flow diagram for an embedded protocol(CAN/Zigbee) highlighting encryption and key management.

HARDWARE VULNERABILITIES AND COUNTERMEASURES	9 Hours

Hardware attack models: invasive, non-invasive, semi-invasive; Side-channel attacks: power analysis, timing attacks, EM analysis; Fault injection attacks: voltage glitching, clock glitching, laser attacks; Physical tampering and reverse engineering; Hardware-based security primitives: PUFs (Physically Unclonable Functions); Trusted Platform Modules (TPMs) and secure boot; Design-for-security in hardware.

Activity: Analyze a side-channel or fault-injection attack scenario and propose suitable hardware counter measures.

SYSTEM LEVEL SECURITY AND CASE STUDIES	9 Hours

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Embedded operating system – Security lifecycle management - Embedded operating system security - Secure boot and measured boot - Remote attestation; Supply chain threats and mitigation – Overview of IoT and CPS security - Case studies - IoT- Hackable Cardiac Devices, Mirai botnet, Owlet WiFi Baby Heart Monitor. **Activity:** Present a case study analysis of an IoT attack (e.g., Mirai) identifying attack vectors and defense mechanisms.
Total Periods: 45 Hours

References:	
1	David Kleidermacher & Mike Kleidermacher, "Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development", Elsevier / Newnes, 1st Edition, 2012.
2	Ross J. Anderson, "Security Engineering: A Guide to Building Dependable Distributed Systems", John Wiley & Sons, 3rd Edition, 2021.
E- resources:	
1	https://www.nist.gov/cyberframework
2	https://www. developer.arm.com

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Understand the fundamentals of embedded systems and recognize the associated security challenges
2	Gain practical knowledge of securing embedded firmware/software and protecting it against exploitation
3	Understand how to secure data in transit and protect communication interfaces in embedded platforms.
4	Analyze threats to hardware components and understand the mechanisms to secure them.
5	Integrate various aspects of embedded systems security into a system-level understanding and analyze real-world attacks and defenses.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	3	2	1	2	2	-
2	3	3	3	3	2	-
3	2	3	3	2	2	-
4	3	2	2	2	1	-
5	2	2	2	3	1	-
Avg	2.6	2.4	2.2	2.6	1.6	-

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ESP707	ROBOTICS AND AUTOMATION	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To teach the need of embedded system technology for robot building.
2	To study the Various Parts of Robots and Fields of Robotics.
3	To study the Various Kinematics and Inverse Kinematics of Robots.
4	To study the Trajectory Planning for Robot.
5	To developing and simulating robotic applications using modern tools.

Syllabus:

INTRODUCTION TO ROBOTICS & AUTOMATION	9 Hours

Overview of Robotics & Automation – Principles and Strategies of Automation System – Hardware and software for Automation- Embedded Processors for Automation-Different Types of Robots –Various Generations of Robots - Asimov's Laws of Robotics – Key components of a robot - Design Criteria for Selection of a Robot – Role of embedded system in Robotics and Automation - Recent trends.

Activity: Identify a real-world robotic system and map its components, control strategy, and application domain.

SENSORS AND DRIVE SYSTEMS	9 Hours

Hydraulic, Pneumatic And Electric Drive Systems – Understanding how motor power, current torque, friction co-efficient affect the design of a Robot - Determination of Motor HP and Gearing Ratio – Variable Speed Arrangements. Sensors – Classification based on sensing type (including Optical, Acoustic, Magnetic) - Proximity Sensors – Ranging Sensors – Speed & Displacement Sensing - Tactile Sensors – Vision Sensing - Smart Sensors – MEMS sensors.

Activity: Calculate motor power and gearing for a given robotic application and justify sensor selection.

MANIPULATORS AND GRIPPERS	9 Hours

Introduction to Manipulators - Joints and Degrees of Freedom - Construction of Manipulators – Manipulator Dynamics and Force Control – Electronic and Pneumatic Manipulator Control Circuits – End Effectors – Various N types of grippers – Design Considerations.

Activity: Analyze the degrees of freedom and gripper type for a specified industrial robot task.

KINEMATICS AND PATH PLANNING	9 Hours

Kinematic Equations – Forward and Inverse Kinematics - Solution Of Inverse Kinematics Problem – Jacobian based Velocity Kinematics– Various Path Planning Algorithms – Hill Climbing Techniques – Robot Operating System - Simulation and modeling of a simple Path Planning application. Introduction to SLAM.

Activity: Solve a simple forward/inverse kinematics problem and simulate a basic robot path.

INTRODUCTION TO ROS2 PROGRAMMING	9 Hours

Overview of Robot Operating System 2 (ROS2) and its evolution from ROS – ROS2 architecture and middleware (DDS) –Installation and workspace setup – ROS2 file system and package structure – Nodes, topics, publishers, subscribers, messages, and services – Parameters and launch files – ROS2 communication model (QoS concepts – basic overview) –Introduction to ROS2 tools (rqt, rviz2, ros2 CLI) – Simulation using Gazebo / Ignition – Developing a simple ROS2 application (publisher–subscriber example).

Activity: Demonstrate a ROS 2 publisher–subscriber example and visualize data using ROS2 tools.

Total Periods: 45 Hours

References:	
1	Khushdeep Goyal & Deepak Bhandari, "Automation And Robotics", S.K. Kataria & Sons, 3rd Ed., 2012
2	T. Bräunl, "Embedded Robotics: From Mobile Robots to Autonomous Vehicles with Raspberry Pi and Arduino", Springer, 4th Ed., 2022.
3	John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 3rd Ed.Pearson Education India, 2008.
E- resources:	
1	https://ocw.mit.edu
2	https://www.mathworks.com/solutions/industrial-automation-machinery.html?s_tid=srchtitle_site_search_1_robotics%2520and%2520automation

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Explain the principles of robotics and automation and identify suitable robots for industrial and service applications.
2	Analyze and select appropriate sensors, actuators, and drive systems for robotic system design.
3	Describe manipulator structures, grippers, and apply basic force and motion concepts
4	Solve forward and inverse kinematics problems and explain path planning and SLAM concepts.
5	Develop and simulate a simple robotic application using ROS 2 tools and communication concepts.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	1	-	-	-	-	-
2	3	2	2	2	1	-
3	3	2	-	2	1	-
4	2	2	2	1	1	-
5	2	3	-	1	1	-
Avg	2.2	2.25	2	1.5	1	-

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ESP708	ENTREPRENEURSHIP AND EMBEDDED PRODUCT DEVELOPMENT	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To develop an understanding on business promotion process.
2	To expose students on the skills required for success in business.
3	To impart embedded system technology based entrepreneurship. Architecture.
4	Creative thinking in developing automation into consumer products of market value.
5	Developing an embedded product with hardware-software components.

Syllabus:

INTRODUCTION TO ENTREPRENEURSHIP — **9 Hours**

Entrepreneurial culture and structure -theories of entrepreneurship - entrepreneurial motivation -establishing entrepreneurial systems - financial information and intelligence, rewards and motivation -concept bank -Role of industrial Fairs- challenges in entrepreneurship.

Activity: Case Study Analysis: Study the entrepreneurial journey of an embedded systems startup (e.g., IoT, robotics, wearable devices) and identify the factors contributing to its success.

RESPONSIBILITIES IN ENTREPRENEURSHIP — **9 Hours**

Steps for starting a small industry -selection of type of organization -Incentives and subsidies – Central Govt. schemes and State Govt. Schemes -incentives to SSI -registration, Registration and Licensing requirements for sales tax, CST, Excise Duty -Power -Exploring export possibilities- incentives for exports -import of capital goods and raw materials- Entrepreneurship development programmes in India- Role and Improvement in Indian Economy.

Activity: Develop a flowchart showing the steps involved in registering a small embedded systems enterprise, including licenses, subsidies, and funding sources.

CONCEPTS OF PRODUCT DEVELOPMENT — **9 Hours**

Generic product Development Phases- Product Development Process Flows- Basics of Concept Generation-Five Step Method- Creative thinking methods and problem solving- design concepts– Product Architecture- component standardization –Bill of materials-Product development management- Portfolio Architecture- Benchmarking.

Activity: Identify the hardware and software components required for the proposed product and prepare a basic BOM with estimated costs.

APPROACHES FOR NEW PRODUCT DEVELOPMENT — **9 Hours**

Idea Generation- Industrial Design -Brainstorming Methods - SWOT Analysis-Concept Development &

Testing- Risk Management Process- Critical Path Analysis & PERT- Reverse Engineering Methodology- need for Involving CAE, CAD, CAM tools -Prototype basics - Rapid Prototyping - Prototyping Techniques - Planning for prototypes- Economic & Cost Analysis.

Activity: Conduct a brainstorming session to generate innovative embedded product ideas and perform SWOT analysis for the selected concept.

SCOPE IN EMBEDDED SYSTEM FIELD — **9 Hours**

Entrepreneurship opportunities in Embedded system technologies - Embedded system Product development -Entrepreneurial skills for embedded system hardware and software architecture, software and hardware co-design and challenges; problems of entrepreneurship in Embedded system field- case studies: Mobile phone development- automation components-Washing

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machine- Food Processing system and devices- High Performance embedded computers- Industrial Controllers. **Activity:** Study one embedded systems company/startup and present its products, business model, technologies used, and market opportunities.
Total Periods: 45 Hours

References:	
1	Thomas Zimmerer et.al., Essentials of Entrepreneurship and small business Management 3rd Ed. Pearson Education, 2002.
2	Jeffry Timmons, New Ventrure creation, McGraw Hill, 1999.
3	James K.peckol ," Embedded Systems: A contemporary Design Tool", Wiley,2014
E- resources:	
1	https://www.startupindia.gov.in
2	https://aim.gov.in

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Analyze the internal/external factors affecting a business/organization to evaluate business opportunities.
2	Demonstrate extemporaneous speaking skills developed through in-class discussion of text Materials, case study analyses, and current entrepreneurship-related issues.
3	Apply and Relate Key concepts underpinning entrepreneurship and its application in the Recognition and exploitation of product/ service/ process opportunities.
4	Interpret various aspects of design such as industrial design, design of Consumer specific product , its Reverse Engineering manufacture ,economic analysis through
5	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	1	2	1	1	1
2	1	3	2	-	1	-
3	3	2	2	2	1	1
4	2	1	2	2	2	-
5	2	2	1	2	1	1
Avg	2	1.8	1.8	1.75	1.2	1

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ESP709	SMART GRID	T	L	T	P	J	C
			3	0	0	0	3
Course Objectives:							
1	To Study about Smart Grid technologies, different smart meters and advanced metering Infrastructure.						
2	To know about the function of smart grid.						
3	To familiarize the power quality management issues in Smart Grid.						
4	To familiarize the high performance computing for Smart Grid applications						
5	To get familiarized with the communication networks for Smart Grid applications						

Syllabus:

INTRODUCTION TO SMART GRID	9 Hours
Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study. **Activity:** Prepare a comparative study of conventional power grids, smart grids, and micro grids highlighting their features, advantages, and challenges.	
SMART GRID TECHNOLOGIES	**9 Hours**
Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts. **Activity:** Analyze Grid-to-Vehicle (G2V) and Vehicle-to-Grid (V2G) charging concepts through case studies and performance comparison.	
SMART METERS AND ADVANCED METERING INFRASTRUCTURE	**9 Hours**
Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing. **Activity:** Demonstrate the operation of a smart energy meter and record electrical parameters such as voltage, current, power, and energy consumption.	
Power Quality Management in Smart Grid	**9 Hours**
Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. **Activity:** Conduct a web-based power quality monitoring exercise and prepare a simple power quality audit report for a selected facility.	
High Performance Computing for Smart Grid Applications	**9 Hours**
Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid. **Activity:** Configure a simple IoT-based smart grid monitoring system using cloud platforms (Thing	

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Speak/ Blynk) for real-time data visualization.
Total Periods: 45 Hours

References:	
1	Recommend suitable communication networks for smart grid applications
2	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3	Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
E- resources:	
1	https://www.mathworks.com
2	https://smartgrid.ieee.org

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Relate with the smart resources, smart meters and other smart devices.
2	Explain the function of Smart Grid.
3	Experiment the issues of Power Quality in Smart Grid.
4	Analyze the performance of Smart Grid.
5	Recommend suitable communication networks for smart grid applications

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	2	1	1	1	-
2	2	1	1	2	1	-
3	2	2	1	1	1	-
4	2	2	1	1	1	-
5	2	1	1	1	1	-
Avg	2	1.6	1	1.2	1	-

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ESP710	AUTOMOTIVE EMBEDDED SYSTEM	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To expose the students to the fundamentals and building of Electronic Engine Control systems.
2	To teach on functional components and circuits for vehicles.
3	To discuss on programmable controllers for vehicles management systems.
4	To teach logics of automation & commercial techniques for vehicle communication.
5	To introduce the embedded systems concepts for E-vehicle system development.

Syllabus:

BASIC OF ELECTRONIC ENGINE CONTROL SYSTEMS — **9 Hours**

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; automotive microcontrollers- Electronic control Unit- Hardware & software selection and requirements for Automotive applications – open source ECU- RTOS - Concept for Engine management-Standards; Introduction to AUTOSAR and Introduction to Society SAE- Functional safety ISO 26262- Simulation and modeling of automotive system components.

Activity: Study and identify the components of an Electronic Control Unit (ECU) using simulation or hardware images.

SENSORS AND ACTUATORS FOR AUTOMOTIVE — **9 Hours**

Review of sensors- sensors interface to the ECU, conventional sensors and actuators, Modern sensor and actuators - LIDAR sensor- smart sensors- MEMS/NEMS sensors and actuators for automotive applications.

Activity: Demonstrate the working of MEMS sensors using simulation or available sensor modules.

VEHICLE MANAGEMENT SYSTEMS — **9 Hours**

Electronic Engine Control-engine mapping, air/fuel ratio spark timing control strategy, fuel control, electronic ignition- Adaptive cruise control - speed control-anti-locking braking system-electronic suspension - electronic steering, Automatic wiper control- body control system. Energy Management system for electric vehicles- Battery management system- electrically assisted power steering system- Adaptive lighting system.

Activity: Analyze the Battery Management System (BMS) architecture used in electric vehicles through case studies.

ONBOARD DIAGNOSTICS AND TELEMATICS — **9 Hours**

On board diagnosis of vehicles -System diagnostic standards and regulation requirements Vehicle communication protocols Bluetooth, CAN, LIN, FLEXRAY, MOST, KWP2000 and recent trends in vehicle communications- Navigation- Connected Cars technology – Tracking- Security for data communication- dashboard display and Virtual Instrumentation, multimedia electronics- Role of IOT in Automotive systems.

Activity: Demonstrate CAN bus communication using Arduino/CAN modules or simulation software.

ELECTRIC VEHICLES — **9 Hours**

Electric vehicles –Components- Plug in Electrical vehicle- Charging station – Aggregators- Fuel cells / Solar powered vehicles- Autonomous vehicles.

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Activity:: Present a case study on autonomous vehicles, fuel-cell vehicles, or solar-powered vehicles, highlighting current technologies and future challenges.
Total Periods: 45 Hours

References:	
1	William B. Ribbens ,"Understanding Automotive Electronics", Elseiver,2012
2	L.Vlacic, M. Parent, F.Harahima," Intelligent Vehicle Technologies", SAE International, 2001
3	Jack Erjavec, JeffArias, "Alternate Fuel Technology-Electric, Hybrid& Fuel Cell Vehicles", Cengage ,2012.
4	Automotive Electricals / Electronics System and Components, Tom Denton, 3rd Edition, 2004.
E- resources:	
1	https://www.nxp.com/support/training-events
2	https://www.autosar.org

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

CO No.	Course Outcomes
1	Insight into the significance of the role of embedded system for automotive applications.
2	Illustrate the need, selection of sensors and actuators and interfacing with ECU
3	Develop the Embedded concepts for vehicle management and control systems.
4	Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs
5	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	-	-	-	-	-	-
2	2	2	2	2	1	-
3	2	3	2	1	1	-
4	2	2	-	2	1	-
5	2	2	-	3	2	1
Avg	2	2.25	2	2	1.25	1

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26CSP922	MACHINE LEARNING AND DEEP LEARNING	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	Understanding about the learning problem and algorithms
2	Providing insight about neural network
3	Introducing the machine learning fundamentals and significance
4	Enabling the students to acquire knowledge about pattern recognition.
5	Motivating the students to apply deep learning algorithms for solving real life problems.

Syllabus:

LEARNING PROBLEMS AND ALGORITHMS	**9 Hours**
Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms. **Activity:** Explore a real-world dataset and identify supervised, unsupervised, and semi-supervised learning applications.	
NEURAL NETWORKS	**9 Hours**
Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps.. **Activity:** Simulate a Multilayer Perceptron (MLP) with backpropagation for pattern classification.	
MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS	**9 Hours**
Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering. **Activity:** Perform data preprocessing including normalization, feature selection, and dimensionality reduction using Scikit-learn.	
DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS	**9 Hours**
Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs. **Activity:** Experiment with different activation functions, optimizers, pooling layers, and dropout techniques to compare model performance.	
DEEP LEARNING: RNNS, AUTO ENCODERS AND GANS	**9Hours**
State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs. **Activity:** Implement an LSTM or GRU model for sentiment analysis or time-series prediction.	
Total Periods: 45 Hours	

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References:	
1	J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2	Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3	The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
4	Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
5	Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.
E- resources:	
1	https://pytorch.org
2	https://www.tensorflow.org

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Illustrate the categorization of machine learning algorithms.
2	Compare and contrast the types of neural network architectures, activation functions
3	Acquaint with the pattern association using neural networks
4	Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks
5	Construct different feature selection and classification techniques and advanced neural Network architectures such as RNN, Auto encoders, and GANs.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	2	1	2	1	-
2	2	2	1	2	1	-
3	3	2	2	2	1	-
4	3	2	2	2	1	-
5	2	3	3	2	1	-
Avg	2.4	2.2	1.8	2	1	-

“3” -High, “2” -Medium, “1” – Low, “-” – No Correlation

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26ESP711	MULTIMEDIA COMMUNICATION	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To define the Multimedia Communication Models
2	To explain Multimedia Transport in Wireless Networks
3	To Solve the Security issues in multimedia networks
4	To Illustrate real-time multimedia network applications.
5	To explain different network layer based application

Syllabus:

INTRODUCTION TO MULTIMEDIA COMMUNICATIONS — **9 Hours**

Introduction, multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology, network QoS and application QoS, Digitization principles. Text, images, audio and video.

Activity: Capture and compare text, image, audio, and video files before and after digitization using multimedia tools.

COMPRESSION TECHNIQUES FOR TEXT AND IMAGE — **9 Hours**

Text and image compression, compression principles, text compression- Run length, Huffman, LZW, Document Image compression using T2 and T3coding, image compression- GIF, TIFF and JPEG.

Activity: Compress images using JPEG and compare with GIF and TIFF formats in terms of compression ratio and image quality.

COMPRESSION TECHNIQUES FOR AUDIO AND VIDEO — **9 Hours**

Audio and video compression, audio compression – principles, DPCM, ADPCM, Adaptive and Linear predictive coding, Code-Excited LPC, Perceptual coding, MPEG and Dolby coders video compression, video compression principles.

Activity: Compress video files using MPEG/H.264 codecs and analyze compression ratio and playback quality.

STANDARDS AND FRAMEWORK — **9Hours**

Video compression standards: H.261, H.263, MPEG, MPEG 1, MPEG 2, MPEG-4 and Reversible VLCs, MPEG 7 standardization process of multimedia content description, MPEG 21 multimedia framework.

Activity: Present a case study on the MPEG-21 multimedia framework and its applications in digital media services.

SYNCHRONIZATION AND MANAGEMENT — **9Hours**

Notion of synchronization, presentation requirements, reference model for synchronization, Introduction to SMIL, Multimedia operating systems, Resource management, process management techniques.

Activity: Demonstrate synchronization of audio, video, and subtitles in a multimedia application.

Total Periods: 45 Hours

References:

1	Fred Halsall, “Multimedia Communications”, Pearson education, 2001.
2	Raif Steinmetz, Klara Nahrstedt, “Multimedia: Computing, Communications and Applications”, Pearson education, 2002.

E- resources:	
1	https://developer.mozilla.org
2	https://www.netacad.com

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Deploy the right multimedia communication models.
2	Apply QoS to multimedia network applications with efficient routing techniques
3	Solve the security threats in the multimedia networks
4	Develop the real-time multimedia network application
5	Improve to synchronize and manage the multimedia systems.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	3	2	1	1	2	-
2	2	2	1	1	1	-
3	2	2	1	2	1	-
4	2	1	1	1	1	-
5	2	1	1	1	1	-
Avg	2.2	1.6	1	1.2	1.2	-

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

26ESP712	ELECTRIC VEHICLES AND POWER MANAGEMENT	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand the concept of electric vehicles and its operations
2	To present an overview of Electric Vehicle (EV), Hybrid Electric vehicle (HEV) and their architecture
3	To understand the need for energy storage in hybrid vehicles
4	To provide knowledge about various possible energy storage technologies that can be used in electric vehicles
5	To analyze the role of proton exchange membrane and fuel cell for E-mobility

Syllabus:

INTRODUCTION TO ELECTRIC VEHICLES	9 Hours

EV evolution and classification (BEV, HEV, PHEV, FCEV) - EV configurations and architecture -Vehicle dynamics: tractive effort, energy consumption, gradability - Driving cycles: EPA, NEDC, WLTP, and custom profiles

Activity: Quiz on BEV, HEV, PHEV, FCEV features Team design activity: Design its architecture (battery, motor, converter, controller layout)

ELECTRIC PROPULSION AND DRIVE SYSTEMS	9 Hours

Types of electric motors used in EVs: PMSM, BLDC, IM, SRM - Motor characteristics and drive selection - Motor control strategies: Field-Oriented Control (FOC), Direct Torque Control (DTC- Regenerative braking – Torque Vs. Speed Control.

Activity: Group Discussion/Debate: Types of electric motors used in EVs Simulation: Run and observe simulations for Field-Oriented Control (FOC) vs. Direct Torque Control (DTC)

ENERGY STORAGE SYSTEMS AND BATTERY MANAGEMENT	9 Hours

Battery types: Li-ion, NiMH, And Lead-acid – comparison and characteristics - Battery modeling and performance parameters - Battery Management Systems (BMS): SoC, SoH, cell balancing- Super capacitors and hybrid storage systems.

Activity: Technical seminar: Compare Li-ion, NiMH, and Lead-acid batteries based on key parameters Modelling: Estimate required battery size, discharge rate, and range for an EV

POWER ELECTRONICS AND ENERGY CONVERSION	9 Hours

DC-DC converters, inverters, and onboard chargers - Bidirectional power flow and energy recuperation - Charging infrastructure: AC vs DC, wireless charging, V2G systems - Safety, thermal management, and EMI issues.

Activity: Simulation: Simulation or flowchart design during drive and regenerative braking (e.g., motor↔ battery ↔ grid) Group Discussion/Debate: Compare AC charging vs DC fast charging (e.g., speed, efficiency, cost, grid impact)

POWER MANAGEMENT STRATEGIES AND FUTURE TRENDS	9 Hours

Power flow optimization and energy scheduling in EVs - Smart energy management using AI and predictive algorithms - Integration with smart grids and renewable sources - Trends in EV policy, standardization, and sustainable mobility.

Activity: Case Study: Analyze and optimize power flow between battery, motor, regenerative braking,and auxiliary systems during different drive conditions Team design activity: Propose an EV charging solution using solar/wind, including storage and grid backup.

Total Periods: 45 Hours

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References:	
1	"Advanced Electric Drive Vehicles", Authors: Ali Emadi, Mehrdad Ehsani, John M. Miller, Publisher:CRC Press, Published Year:2014.
2	Modern Electric Vehicle Technology", Authors: C.C. Chan, K.T. Chau, Publisher: Oxford University Press, Published Year: 2001.
3	"Battery Management Systems for Large Lithium-Ion Battery Packs", Author: Philip Weicker, Publisher: SAE International, Published Year:2013.
4	"Power Electronics for Electric Vehicles and Energy Storage Systems", Author: Shuai Jiang, Publisher: Springer, Published Year:2022.
5	"Electric and Hybrid Vehicles: Technologies, Modeling and Control – A Mechatronics Approach", Authors: Amir Khajepour, M. SaberFallah, Avesta Goodarzi, Publisher: Wiley, Published Year:2014.
E- resources:	
1	https://www.ieee-pes.org
2	https://www.mathworks.com

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

CO No.	Course Outcomes
1	Understand the architecture of EV powertrains and identify the role of various subsystems in power and energy flow management.
2	Analyze battery systems, charging infrastructure, and battery management techniques to ensure safety, efficiency, and longevity of EVs.
3	Apply power electronics converters and control strategies for energy conversion, bidirectional charging, and regenerative braking in electric vehicles.
4	Evaluate real-time power management strategies under different driving conditions using performance metrics such as efficiency, thermal stability, and cost-effectiveness.
5	Design intelligent energy management systems using rule-based, fuzzy logic, and optimization-based algorithms for hybrid and battery electric vehicles.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	2	1	2	2	-
2	3	1	1	2	1	-
3	2	2	1	2	1	-
4	3	2	1	2	2	-
5	2	2	1	2	1	-
Avg	2.4	1.8	1	2	1.4	-

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ESP713	RECONFIGURABLE PROCESSOR AND SOC DESIGN	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To familiarize the need and role of Reconfigurable Processor for embedded system applications.
2	To introduce the Reconfigurable Processor technologies
3	To teach the salient features and architecture of FPGA
4	To provide an insight and architecture significance of SoC.
5	To impart the knowledge of Reconfigurable embedded Processor for real time applications

Syllabus:

INTRODUCTION	9 Hours

Introduction to reconfigurable processor- Reconfigurable Computing-Programming elements and Programming Tools for Reconfigurable Processors, ASIC design flow-Hardware/Software Co-design- FPAA Architecture overview recent trends in Reconfigurable Processor & SoC.

Activity: Analyze a reconfigurable processor and identify its programming elements and potential applications.

FPGA TECHNOLOGIES	9 Hours

FPGA Programming technology - Alternative FPGA architectures: MUX Vs LUT based logic blocks – CLB Vs LAB Vs Slices- Fast carry chains- Embedded RAMs- Routing for FPGAs-Circuits and Architectures for Low- Power FPGAs- Physical Design.

Activity: Compare LUT-based and MUX-based FPGA architectures and evaluate routing and embedded RAM usage in a given design.

FPGA ARCHITECTURE	9 Hours

FPGA architecture overview- Challenges of FPGA processor design-Opportunities of FPGA processor design- Designing Soft Core Processors – Designing Hardcore Processors – hardware/software co-simulation- FPGA to multi core embedded computing- FPGA based on-board computer system.

Activity: Case study - Design a simple soft-core processor using FPGA simulation tools and analyzes hardware/software co-design trade-offs.

RECONFIGURABLE SOC PROCESSORS	9 Hours

SoC Overview –Architecture and applications of Virtex II pro ,Zynq-7000, Excalibur, Cyclone V - A7, E5- FPSLIC- Multicore SoCs.

Activity: Compare Virtex II Pro, Zynq-7000, and Cyclone V SoCs in terms of architecture and multicore capabilities.

RECONFIGURABLE PROCESSOR AND SOC APPLICATIONS	9 Hours

Reconfigurable processor based DC motor control- digital filter design- mobile phone development- High Speed Data Acquisition -Image Processing application-controller implementation for mobile robot- Crypto-processor.

Activity: Group Discussion.

Total Periods: 45 Hours

References:

1	Nurmi, Jari (Ed.) "Processor Design System-On-Chip Computing for ASICs and FPGAs" Springer, 2007.

2	Ian Grout , “Digital system design with FPGAs and CPLDs” Elsevier, 2008 Joao Cardoso, Michael Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign", Springer, 2011.
3	Ron Sass and Anderew G. Schmidt, “Embedded System design with platform FPGAs: Principles and Practices”, Elsevier, 2010.
4	Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007.
5	Pierre-Emmanuel Gaillardon, “Reconfigurable Logic: Architecture, Tools, and Applications”, 1st Edition, CRC Press , 2015.
E- resources:	
1	https://www.amd.com/en/products/adaptive-socs-and-fpgas.html
2	https://www.intel.com/content/www/us/en/products/details/fpga.html

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Explain the principles, programming tools, and architectures of reconfigurable processors and FPGAs.
2	Describe FPGA technologies, logic blocks, routing, and low-power design techniques.
3	Analyze and design FPGA architectures ,including soft-core and hard-core processor implementations.
4	Understand the architecture, features, and applications of reconfigurable SoC processors such as Zynq-7000 and Cyclone V.
5	Implement reconfigurable processor or SoC based solutions for real-world applications like motor control, digital filtering, image processing, or crypto-processors

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	1	-	-	-	-	-
2	2	2	1	2	1	-
3	3	2	-	2	1	-
4	3	2	2	2	1	-
5	2	2	1	2	1	-
Avg	2.2	2	1.3	2	1	-

“3” -High, “2” -Medium, “1” – Low, “-” – No Correlation

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26ESP714	EMBEDDED SENSOR NETWORKS	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand the fundamentals of sensor networks.
2	To study the medium access control mechanisms, S-MAC, TCP/IP, IEEE 802.15.4, ZigBee, routing techniques
3	To learn infrastructure establishment techniques.
4	To develop an understanding of sensor network databases.
5	To learn the basic Python programming skills.

Syllabus:

SENSOR NETWORKS — **9 Hours**

Overview of sensor networks - Constraints and Challenges – Advantages of sensor networks – Applications – Collaborative Processing – Key definitions in sensor networks – Tracking scenario – Problem formulation –Distributed representation and interference of states – Tracking multiple objects – Sensor models – performance comparison and metrics.

Activity: Simulate a target tracking scenario and evaluate sensor network performance using appropriate metrics.

SENSOR NETWORKING PROTOCOL — **9 Hours**

Key assumptions – Medium access control – S-MAC Protocol,-TCP/IP – IEEE 802.15.4 standard and ZigBee – General Issues – Geographic, Energy-Aware Routing – Attribute based routing –Classification and Applications of Nano sensor.

Activity: Compare geographic routing and energy-aware routing protocols based on packet delivery, delay, and energy consumption

INFRASTRUCTURE ESTABLISHMENT — **9 Hours**

Topology control – Clustering-Time synchronization – Localization – Task driven sensing- Role of sensor nodes – Information based tasking – Routing and aggregation.

Activity: Demonstrate localization and time synchronization techniques using simulation tools.

SENSOR NETWORK DATABASE — **9 Hours**

Sensor Database Challenges – Querying the physical environment – Interfaces – In-network aggregation – Data centric storage – Data indices and range queries – Distributed Hierarchical aggregation – Temporal data.

Activity: Design simple sensor database queries for environmental monitoring data using Python or SQL.

SENSOR NETWORK PLATFORMS AND TOOLS — **9 Hours**

Basics of PYTHON Programming Syntax and Style – Python Objects– Dictionaries comparison with C programming on Conditionals and Loops – Files – Input and Output – Errors and Exceptions –Functions – Modules – Classes and OOP – Execution Environment.

Activity: Develop Python programs demonstrating variables, loops, functions, dictionaries, file handling, and exception handling.

Total Periods: 45 Hours

References:

1	Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks An information processing approach", Mogan Kanufmann Publishers, 2004.
2	Richard Zurawski, "Embedded System Hand Book", CRC Press, 2009.

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3	Iran Stojmenovic, “Hand book of sensor networks”, John Wiley & Sons, 2005.
4	Michel Banatre, Pedre Jose Marron, Anibal Ollero and Adam Wilisz, “Cooperating Embedded System and Wireless sensor Network”, John Willy, 2008.
5	Embedded System Handbook, “Networked Embedded Systems”, 2nd Edition, CRC press, 2009.
E- resources:	
1	https://developer.arm.com

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Identify the various components of sensor network and formulate the various performance metrics.
2	Illustrate the various types of sensor networking protocol.
3	Interpret the various infrastructure establishment in sensor networks
4	Describe the various networking database environment.
5	Study the software concepts in python programmimg.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	-	-	-	-	-	-
2	3	2	2	2	1	-
3	3	2	2	2	1	-
4	3	2	2	2	1	-
5	2	2	1	1	1	-
Avg	2.75	2	1.75	1.75	1	-

“3” -High, “2” -Medium, “1” – Low, “-” – No Correlation

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26ESP715	COMPUTER VISION	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To introduce the fundamentals of Human and Computer Vision.
2	To introduce the major ideas, concepts, methods and techniques in Computer Vision.
3	To impart Computer Vision knowledge by way of learning related algorithms.
4	To make them familiar with both the Theoretical and Practical aspects of Computing with Images.
5	To provide the student with programming experience for implementing Computer Vision and algorithms.

Syllabus:

INTRODUCTION TO COMPUTER VISION — **9 Hours**

Digital Image Processing – Various Fields that use Image Processing – Fundamentals Steps in Digital Image Processing – Components of an Image Processing System. Applications of Computer Vision – Recent Research in Computer Vision. Introduction to Computer Vision and Basic Concepts of Image Formation: Introduction and Goals – Image Formation and Radiometry – Geometric Transformation – Geometric Camera Models – Image Reconstruction from a Series of Projections.
Activity: Students draw and label the basic steps of an image processing and computer vision pipeline for a given application.

IMAGE PROCESSING CONCEPTS AND IMAGE FEATURES — **9 Hours**

Image Processing Concepts: Fundamentals – Image Transforms – Image Filtering – Colour Image Processing – Mathematical Morphology – Image Segmentation. Image Descriptors and Features: Texture Descriptors – Colour Features – Edge Detection – Object Boundary and Shape Representation – Interest or Cornet Point Detectors – Histogram Oriented Gradients – Scale Invariant Feature Transform.
Activity: Given sample images, students identify edges, textures, corners, and shapes using conceptual explanations.

IMAGE PROCESSING WITH OPENCV — **9 Hours**

Introduction to OpenCV and Python: Setting up OpenCV – Image Basics in OpenCV – Handling Files and Images – Constructing Basic Shapes in Open CV. Image Processing in OpenCV: Image Processing Techniques – Constructing and Building Histograms – Thresholding Techniques.
Activity: Instructor shares a simple OpenCV Python code; students predict outputand explain each processing step.

OBJECT DETECTION — **9 Hours**

Models and types – Importance of Object Detection. The Working: Inputs and outputs – Basic Structure – Model Architecture Overview – Object Detection on the Edge. Use Cases and Applications: Video Surveillance – Self-driving Cars. Embedded Boards: Connecting Cameras to Embedded Boards – Simple algorithms for processing Images and Videos.
Activity: Students prepare a flowchart explaining the working of an object detection system (input → model → output).

APPLICATIONS AND CASE STUDIES — **9 Hours**

Applications: Machine Learning algorithms and their Applications in Medical Image Segmentation – Motion Estimation and Object Tracking – Face and Facial Expression

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Recognition – Image Fusion. Case Studies: Face Detection – Object Tracking – Eye Tracking – Handwriting Recognition with HoG. **Activity:** Students discuss one application (face detection, medical imaging, tracking) and explain the technique used.
Total Periods: 45 Hours

References:	
1	Rafael C Gonzalez and Richard E Woods, "Digital Image Processing", 4th Edition (Global Edition), Pearson Education Limited, 2018.
2	Manas Kamal Bhuyan, "Computer Vision and Image Processing - Fundamentals and Applications", CRC Press, 2020.
3	Alberto FernándezVillán, "Mastering OpenCV 4 with Python", Packt Publishing, 2019.
4	Adrian Rosebrock ,"Practical Python and Open CV: Case Studies", 3rd Edition, PyImage Search, 2016.
E- resources:	
1	https://www.tensorflow.org
2	https://pytorch.org

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

CO No.	Course Outcomes
1	Explain the fundamentals of image formation, digital image processing, and computer vision systems.
2	Analyze image features, descriptors, segmentation, and transformation techniques
3	Apply OpenCV tools to perform basic image processing and analysis tasks.
4	Describe object detection models, architectures, and their deployment in embedded and edge systems.
5	Interpret and apply computer vision techniques to real-world applications and case studies.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	-	-	-	-	-	-
2	2	2	2	2	1	-
3	2	2	1	2	1	-
4	2	1	1	2	2	-
5	2	2	-	2	1	-
Avg	2	1.75	1.3	2	1.25	-

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ESP716	EMBEDDED NETWORKING AND AUTOMATION OF ELECTRICAL SYSTEM	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To discuss the fundamentals building blocks of a digital instrument.
2	Introduce wired, WSN for configuring metering network
3	Discuss requirements for grid automation using meters
4	To discuss networking configuration to develop PAN.
5	To discuss the functions of digital instrument Power quality monitoring

Syllabus:

BUILDING SYSTEM AUTOMATION — **9 Hours**

Sensor Types & Characteristics: Sensing Voltage, Current, flux, Torque, Position, Proximity, Accelerometer - Data acquisition system- Signal conditioning circuit design- Uc Based & PC based data acquisition – uC for automation and protection of electrical appliances –processor based digital controllers for switching Actuators: Stepper motors, Relays –System automation with multi channel Instrumentation and interface.

Activity: Interface voltage, current, temperature, proximity, or accelerometer sensors with a microcontroller (Arduino/ESP32) and observe the sensor outputs.

EMBEDDED NETWORKING OF INSTRUMENT CLUSTER — **9 Hours**

Embedded Networking: Introduction – Cluster of Instruments in System- Comparison of bus protocols – RS 232C- embedded ethernet - MOD bus and CAN bus, LIN BUS- Introduction to WSN- Commercially available sensor nodes-Zigbee protocol -Network Topology Energy efficient MAC protocols –SMAC –Data Centric routing Applications of sensor networks- Database perspective on sensor networks- IoT Applications.

Activity: Simulate ZigBee, CAN, or LIN communication using available development kits or simulation software and compare their performance.

AUTOMATION OF SUBSTATION — **9 Hours**

Substation automation- Distribution SCADA system principles -role of PMU,RTU, IEDs, BUS for smart

Substation automation- Introduction to Role of IEC 61850,IEEEC37.118 std- Interoperability and IEC 61850-challenges of Substations in Smart Grid - challenges of Energy Storage and Distribution Systems monitoring - Communication Challenges in monitoring electric utility asset .

Activity: Study the architecture of a digital substation and prepare a block diagram showing PMU, RTU, IEDs, and SCADA communication

METERING OF SMART GRID — **9 Hours**

Characteristics of Smart Grid- Generation by Renewable Energy Sources based on solar grid- Challenges in Smart Grid and Microgrids- electrical measurements with AMI -Smart meters for EV plug in electric vehicles power management -Home Area Netmetering and Demand side Energy Management applications.

Activity: Develop a simple IoT-based smart energy monitoring system using ESP32/Arduino and cloud platforms.

SMART METERS FOR PQ MONITORING — **9 Hours**

Power Quality issues of Grid connected Renewable Energy Sources -Smart meters for Power Quality monitoring and Control - Power Quality issues -Surges – Flicker - Interharmonics - Transients – Power Quality Benchmarking – Power Quality Meters- Meter data management In Smart Grid-, communication enabled Power Quality metering

Activity: Study communication-enabled smart power quality meters and prepare a comparative report on their features.
Total Periods: 45 Hours

References:	
1	Control and automation of electrical power distribution systems, James Northcote-Green, Robert Wilson, CRC, Taylor and Francis, 2006
2	Krzysztof Iniewski,"Smart Grid ,Infrastructure& Networking",TMcGH,2012
3	Robert Faludi,"Building Wireless Sensor Networks,O'Reilly,2011
4	Mohammad Ilyas And Imad Mahgoub, 'Handbook of sensor Networks: Compact wireless and wired sensing systems', CRC Press,2005
5	Shih-Lin Wu,Yu-Chee Tseng,{"Wireless Ad Hoc Networking, PAN, LAN, SAN, Aurebach Pub,2012
E- resources:	
1	https://www.netacad.com
2	https://www.siemens.com

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Demonstrate criteria of choice of sensors, components to build meters.
2	Illustrate the demand for BUS communication protocols are introduced
3	Analyse the need and standards in Substation automation
4	Deployment of PAN for metering networked commercial applications
5	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded networked communications

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	1	1	2	1	-
2	2	1	1	2	1	-
3	2	2	1	1	1	-
4	2	1	1	2	1	-
5	2	1	1	1	1	-
Avg	2	1.2	1	1.6	1	-

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ESP717	RENEWABLE ENERGY AND GRID INTEGRATION	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To provide knowledge about the stand alone and grid connected renewable energy systems..
2	To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
3	To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
4	To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems
5	To develop maximum power point tracking algorithms

Syllabus:

INTRODUCTION	**9 Hours**
Introduction to renewable energy systems, environmental aspects of electric energy conversion, impacts of renewable energy penetration to grid. Grid Codes in India and other countries. Basic power electronic converters for renewable energy integration to grid-Qualitative analysis - Boost and buck-boost converters, three phase AC voltage controllers- AC-DC-AC converters, PWM Inverters, Grid Interactive Inverters-matrix converters. **Activity:** Study Indian Grid Codes for renewable energy integration and prepare a comparative report with international grid standards.	
PHOTO VOLTAIC ENERGY CONVERSION SYSTEMS	**9 Hours**
Introduction, Photo Voltaic (PV) effect, Solar Cell, Types, Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect,Stand-alone PV system, Grid connected PV system, Design of PV system-load calculation, array sizing, selection of converter/inverter, battery sizing. **Activity:** Demonstrate the effect of partial shading on PV output using simulation tools.	
WIND ENERGY CONVERSION SYSTEMS	**9 Hours**
Introduction, Power contained in wind, Efficiency limit in wind, types of wind turbines, Wind control strategies, Power curve and Operating area, Types of wind generators system based on Electrical Machines-Induction Generator and Permanent Magnet Synchronous Generator(PMSG), Grid Connected-Single and Double output system, Self-excited operation of Induction Generator and Variable Speed PMSG. **Activity:** Analyze the power curve and operating regions of a wind turbine and prepare a performance report.	
MPPT TECHNIQUES IN SOLAR AND WIND SYSTEMS	**9 Hours**
Case studies of PV-Maximum Power Point Tracking (MPPT) and Wind Energy system **Activity:** Evaluate the improvement in power extraction achieved through MPPT under varying environmental conditions.	
HYBRID STORAGE SYSTEMS AND GRID MANAGEMENT	**9 Hours**
Energy Storage systems, need for Hybrid Systems, Features of Hybrid Systems, Range and types of Hybrid systems (Wind-Diesel, PV-Diesel and Wind-PV), **Activity:** Analyze the performance of battery energy storage systems in renewable energy integration through simulation.	
Total Periods: 45 Hours	

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References:	
1	S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2	Haitham Abu-Rub, Mariusz Malinowski and Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications", IEEE Press and John Wiley & Sons Ltd Press, 2014.
3	Rashid .M. H "power electronics Hand book", Academic press, 2001.
4	Rai. G.D, "Non-conventional energy sources", Khanna publishes, 1993
5	Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995
E- resources:	
1	https://www.mathworks.com
2	https://www.nrel.gov

Course Outcomes: Upon successful completion of the course, students will be able to	
CO No.	**Course Outcomes**
1	Relate the power generation of different renewable energy sources to grid impact and grid codes
2	Explain the design principles of solar energy management systems
3	Understand the power conversion system of wind generators
4	Analyze the different Maximum Power Point tracking Techniques
5	Build grid connected and stand alone renewable energy management system

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	3	2	2	2	2	-
2	3	2	2	2	2	-
3	3	2	2	2	2	-
4	3	3	2	1	1	-
5	3	2	1	1	1	-
Avg	3	2.2	1.8	1.6	1.6	-

"3" -High, "2" -Medium, "1" – Low, "-" – No Correlation

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26ESP718	SMART SYSTEM DESIGN	T	L	T	P	J	C
			3	0	0	0	3

Course Objectives:

1	To understand about the smart system technologies and its role in real time applications.
2	To expose students to different open-source platforms and attributes.
3	To teach the architecture and requirements of Home Automation.
4	To provide an insight into smart appliances and energy management concepts.
5	To familiarize the design and development of embedded system based system design.

Syllabus:

INTRODUCTION	9 Hours

Overview of a smart system - Design Requirements - Hardware and software selection & co-design - Smart sensors and Actuators – Communication protocols used in smart systems – Data Analytics: Need & Types – Open-source Analytics Platform for embedded systems (IFTTT &Thingspeak) –Smart Microcontrollers - Embedded system for Smart card design and development – Recent trends.

Activity: Interface smart sensors (temperature, light, motion, etc.) with Arduino/ESP32 and upload sensor data to Thing Speak or IFTTT.

HOME AUTOMATION	9 Hours

Home Automation – Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security - System Architecture - Essential Components - Linux and Raspberry Pi – Design and Real-Time implementation

Activity: Implement real-time monitoring of home parameters (temperature, humidity, motion) and visualize the data on a cloud platform

SMART APPLIANCES AND ENERGY MANAGEMENT	9 Hours

Energy Management: Demand-side Load Management: Energy scheduling – Significance of smart appliances in energy management - Embedded and Integrated Platforms for Energy Management - Smart Meters: Significance, Architecture & Energy Measurement Technique - Smart Networks for Embedded Appliances – Security Considerations.

Activity: Study the architecture of a smart meter and prepare a report on energy management and smart appliance communication.

SMART WEARABLE DEVICES	9 Hours

Application of Smart Wearables in Healthcare & Activity Monitoring - Functional requirements–Selection of body sensors, Hardware platform, OS and Software platform – Selection of suitable communication protocol. Case Study: Design of a wearable, collecting heart-beat, temperature and monitoring health status using a smartphone application.

Activity: Design the architecture of a wearable healthcare monitoring system and identify suitable sensors, communication protocols, and software.

EMBEDDED SYSTEMS AND ROBOTICS	9 Hours

Robots and Controllers components - Aerial Robotics - Mobile Robot Design - Three-Servo Ant Robot - Autonomous Hex Copter System.

Activity: Program a mobile robot using Arduino/Raspberry Pi to perform obstacle avoidance or line-following.

Total Periods: 45 Hours

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References:	
1	Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013.
2	Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw- Hill, 2008
3	NilanjanDey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016.
4	Karim Yaghmour, Embedded Android, O'Reilly, 2013.
5	Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress, 2013
E- resources:	
1	https://docs.espressif.com
2	https://www.mathworks.com

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

CO No.	Course Outcomes
1	Understand the concepts of smart system design and its present developments.
2	Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications.
3	Acquire knowledge on different platforms and Infrastructure for Smart system design
4	Infer about smart appliances and energy management concepts
5	Apply and improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.

CO	PO1	PO2	PO3	PSO1	PSO2	PSO3
1	2	1	1	2	2	-
2	3	2	2	2	2	-
3	3	2	2	2	2	-
4	3	2	2	2	2	-
5	3	2	1	1	1	-
Avg	2.8	1.8	1.6	1.6	1.6	-

“3” -High, “2” -Medium, “1” – Low, “-” – No Correlation

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