Multidisciplinary Minors offered by EXTC department

Curriculum Structure for MDM Courses

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		L	P	T	L	P	T	Total
ECMDMS--1	Digital Logic And Computer Organization Architecture	3	--	--	3	--	--	3
ECMDMS--2	Digital Logic Design And Analysis	3	--	--	3	--	--	3
ECMDMS--3	Electronic Components And Circuits	3	--	--	3	--	--	3
ECMDMS--4	Microcontrollers	3	--	--	3	--	--	3
ECMDMXS--5	Microcontroller And Embedded Systems	3	--	--	3	--	--	3
ECMDMS--6	Internet of Things	3	--	--	3	--	--	3
ECMDMS--7	Image Processing	4	--	--	4	--	--	4
ECMDMS--8	Smart Electronic Systems	4	--	--	4	--	--	4
ECMDLS--1	Microcontroller and Embedded System Laboratory	--	2	--	--	1	--	1
ECMDLS--2	Internet of Things Laboratory	--	2	--	--	1	--	1
	Total	**13**	**2**	**--**	**13**	**1**	**--**	**14**

Examination Scheme for MDM Courses

Course Code	Course Name	Examination Scheme					Total
		In-Semester Assessment$		End Sem Exam (ESE)	Exam Duration for Theory (in Hrs)		
		Continuous Assessment	Mid-Sem Exam		Mid-Sem	End-Sem	
ECMDMS--1	Digital Logic And Computer Organization Architecture	20	30	50	1.5	2	100
ECMDMS--2	Digital Logic Design And Analysis	20	30	50	1.5	2	100
ECMDMS--3	Electronic Components And Circuits	20	30	50	1.5	2	100
ECMDMS--4	Microcontrollers	20	30	50	1.5	2	100
ECMDMXS--5	Microcontroller And Embedded Systems	20	30	50	1.5	2	100
ECMDMS--6	Internet of Things	20	30	50	1.5	2	100
ECMDMS--7	Image Processing	20	30	50	1.5	2	100
ECMDMS--8	Smart Electronic Systems	20	30	50	1.5	2	100
ECMDLS--1	Microcontroller and Embedded System Laboratory	25	--	25	--	--	50
ECMDLS--2	Internet of Things Laboratory	25	--	25	--	--	50
	Total*	**105**	**120**	**225**	--	--	**450***

*** Any four theory courses (Three 3-credit and one 4-credit) and One Laboratory course (1-credit)**

Course Type	Course Code	Course Name	Credits
MDM	ECMDMS--01	DIGITAL LOGIC AND COMPUTER ORGANIZATION ARCHITECTURE	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ESC203- Basic Electronics Engineering

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of solutions

Course Objectives:

1. To impart the knowledge of number system arithmetic and coding schemes in recognizing their vital roles in data representation.
2. To guide in optimizing and designing combinational and sequential circuits.
3. To introduce learners to the fundamental concepts of computer, computer organization and architecture.
4. To familiarize learners with I/O operations, control unit.

Module	Details	Hrs.
	Course Introduction Digital logic and computer organization course provides essential digital electronics concepts vital for Computer Engineering, emphasizing their modern relevance and foundational role in hardware design, computer system architecture and error detection, preparing learner for careers in the field.	**01**
01.	**Number Systems and Codes** ***Learning Objectives:*** *Expected to apply number system and codes in digital logic as its crucial for understanding data representation, compression, error detection/correction and various aspect of digital system.*	**6-8**
	Contents: 1.1 Number Systems: Number Systems: Binary, Octal, Decimal, Hexadecimal, Binary Addition and Subtraction (1's and 2's complement method), Octal and Hexadecimal Arithmetic Operation. 1.2 Codes: Grey, BCD, Excess-3, ASCII.	
	Self-Learning Topics: *Error detection and Correction codes*	

	Learning Outcomes: *A learner will be able to* *LO1.1: Apply the knowledge of number system arithmetic to appreciate their role in digital system. (PI-1.1.1)* *LO1.2: Apply fundamental of coding schemes in data representation (PI-1.3.1)*	
02.	**Boolean Algebra and Logic Gates** ***Learning Objective/s:*** *Expected to design optimum logic function using Boolean algebra simplification K-map minimization.*	**6-8**
	Contents: 2.1 Boolean Algebra**:** Axiomatic definition of Boolean algebra, basic theorems and properties of Boolean algebra, Boolean functions, canonical and standard Reduction of Boolean functions using Algebraic equations. 2.2 Logic Gates: NOT, AND, OR, NAND, NOR, EX-OR, EX-NOR Gates. 2.3 K-Map	
	Self-Learning Topics: *TTL & CMOS logic families & their characteristics*	
	Learning Outcomes : *A learner will be able to* *LO2.1: Apply the knowledge of Boolean algebra and K-map to simplify the given expression. (PI-1.1.1)* *LO2.2: Apply the fundamentals of logic to discuss their advantages, limitations, and suitability for different applications. (PI-1.3.1)* *LO2.3: Identify the process to represent the expression using universal gates. (PI-2.1.2)* *LO2.4: Use appropriate method to simplify the given expression and representation. (PI-2.2.4)* *LO2.5: Design the simplified expression with minimum number of components. (PI-3.2.1)* *LO2.6: Verify the circuit correctness using truth table. (PI-3.4.3)*	
03.	**Combinational Circuits and Synchronous Sequential Logic** ***Learning Objective/s:*** *Expected to design combinational circuit and analyze sequential circuits.*	**7-9**
	Contents: 3.1 Introduction, Half and Full Adder, Half and Full Subtractor, Binary Multiplier, Combinational circuit for different code converters. 3.2 Multiplexers and De-multiplexers, Encodes, Decoders, Magnitude Comparator (One bit, two bit). 3.3 Flip Flops: SR, D, JK, JK Master Slave and T Flip Flop, Truth Tables and Excitation Tables, Flip-flop conversion. 3.4 Computer Arithmetic: Booths Multiplication Algorithm, Restoring and Non-Restoring Division Algorithm.	
	Self-Learning Topics: *BCD Adder*	

	Learning Outcomes: *A learner will be able to* *LO3.1: Apply the knowledge of Boolean Algebra to represent SOP/POS using Combinational circuits (PI-1.1.1).* *LO3.2: Apply the fundamentals of Booth's algorithm to solve binary number multiplication and division. (PI-1.3.1)* *LO3.3: Design the combinational circuits using logic gates. (PI-3.2.1)* *LO3.4: Verify and validate circuit using truth table. (PI-3.4.3)* *LO3.5: Explore and discern the distinct functionalities of various flip flops. (PI-2.2.2)* *LO3.6: Identify the conversion processes involved in representation of flip flops. (PI-2.1.2)*	
04.	**The Computer System** ***Learning Objective/s:*** *To apply engineering fundamentals of computer organization and its structural components for computing based systems and solve memory mapping problems.*	**7-9**
	Contents: 4.1 Basic Organization of Computer. 4.2 Block Level Functional Units, Von-Neumann Model. 4.3 Performance Issues- Ahmdahl's Law, Basic measures of computer performance. 4.4 Memory: Introduction and characteristics of memory, DDR DRAM, Flash memory, RAID, Optical Memory. 4.5 Cache Memory: Concept, locality of reference, Design problems based on mapping techniques, Cache coherence, and writing policies. Interleaved and Associative Memory.	
	Self-Learning Topics: *Harvard Architecture*	
	Learning Outcomes : *A learner will be able to* *LO4.1: Apply engineering fundamentals of computer organization in context of computing- based systems. (P.I.-1.3.1)* *LO4.2: Apply computer engineering fundamentals to identify the differences between computer's architecture and organization. (P.I.-1.4.1)* *LO4.3: Use appropriate mapping techniques to allocate data from main memory to cache blocks.(P.I-3.2.1)* *LO4.4: Design a cache memory based on given requirement/data. (P.I.- 3.1.4)*	
05.	**Interfacing and Communications**	**5-7**
	Learning Objective/s: *To introduce the principles and functionalities of I/O devices and their interfacing using buses.*	

	Contents: 5.1 Introduction to Input/output Devices: Overview of I/O devices, their role in computer systems, and classification. 5.2 I/O Fundamentals: I/O modules, I/O techniques: Programmed I/O, Interrupt-driven I/O. 5.3 Data Transfer Mechanisms: Direct Memory Access(DMA), Direct Cache Access, Interrupt structures: Vectorized and Prioritized, Interrupt Overhead 5.4 Buses: Synchronous and asynchronous buses, Bus Arbitration	
	Self-Learning Topics: *Emerging trends in I/O device technology and advancements in interface standards*	
	Learning Outcomes : *A learner will be able to* *LO5.1: Identify various types of I/O devices and determine their characteristics and functionalities. (P.I.-1.3.1)* *LO5.2: Apply the principles of computer engineering to comprehend I/O fundamentals and techniques. (P.I.-1.4.1)* *LO5.3: Recognize the functionality of DMA and analyze its utilization within the computer system. (P.I.-2.2.2)* *LO5.4: Appraise the synchronous and asynchronous bus for the performance and arbitration. (P.I.-2.3.1)*	
06.	**The Central Processing Unit** ***Learning Objective/s:*** *To explore the fundamental concepts of processor organization including register organization, instruction formats, addressing modes and designs of control unit.*	**6-8**
	Contents: 6.1 Instruction Sets: Machine Instruction Characteristics, Addressing Modes 6.2 Processor Structure and Function: Processor Organization, Register Organization, Instruction Cycle, Instruction pipelining (pipelining strategy, pipeline performance, pipeline hazards) 6.3 Control unit operations: Hardwired Control Unit: State Table Method, Delay Element Methods. 6.4 Microprogrammed Control Unit: Micro Instruction- Format, Sequencing and execution, Micro operations, Examples of Microprograms.	
	Self-Learning Topics: *Modern control units with CPU scheduler.*	

	Learning Outcomes : *A learner will be able to* *LO6.1: Use engineering fundamentals to summarize the concepts of processor organization. (P.I.-1.3.1)* *LO6.2: Identify the functionalities of different registers and analyze the purpose of various addressing modes. (P.I.-2.2.2)* *LO6.3: Apply the concepts of pipelining to improve performance. (P.I.-1.4.1)* *LO6.4: Analyze different methods used for designing a hardwired control unit. (P.I.-2.4.2)* *LO6.5:Identify appropriate instructions to write a micro program. (P.I.-2.1.2)*	
	Course Conclusion The Digital logic and computer organization course is essential for computer engineering students, equipping them with vital skills in topics like number systems, logic gates, and advanced circuit design, preparing them for success in the ever-changing digital technology landscape.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems.
1.3.1	Apply engineering fundamentals.
1.4.1	Apply theory and principles of computer science and engineering to solve an engineering problem.
2.1.2	Identify processes/modules/algorithms of a computer-based system and parameters to solve a problem.
2.2.2	Identify functionalities and computing resources.
2.2.4	Compare and contrast alternative solution/methods to select the best methods.
2.3.1	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance.
2.4.2	Analyze and interpret the results using contemporary tools.
3.1.4	Able to choose appropriate quality attributes as defined by ISO/IEC/IEEE standard.
3.2.1	Able to explore design alternatives.
3.4.3	Able to verify the functionalities and validate the design.

Course Outcomes: A learner will be able to-

1. Apply number systems arithmetic and coding scheme concepts to grasp their vital roles in data representation.*(LO1.1,LO1.2)*
2. Optimize the logic circuit using Boolean algebra and K-Maps. *(LO2.1,LO2.2, LO2.3, LO2.4, LO2.5, LO2.6)*
3. Design and analyse combinational and sequential circuits. *(LO3.1,LO3.2, LO3.3, LO3.4, LO3.5, LO3.6)*
4. Compare different types of memories and design cache memory based on mapping techniques. *(LO4.1,LO4.2, LO4.3, LO4.4)*

5. Analyse various I/O operations and Interfacing mechanisms. *(LO5.1,LO5.2, LO5.3, LO5.4)*
6. Apply the concepts of processor organization and control unit to write a microprogram. *(LO6.1,LO6.2, LO6.3, LO6.4, LO6.5)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECMDMS--01.1	3										
ECMDMS--01.2	3	3	3								
ECMDMS--01.3	3	3	3								
ECMDMS--01.4	3		3								
ECMDMS--01.5	3	3									
ECMDMS--01.6	3	3									
Average	3	3	3								

Text Books:

1. Modern Digital Electronics, R. P. Jain,4th Edition,2017,Tata McGraw Hill.
2. Digital Logic Applications and Design, Yarbrough John, 1st Edition,2016, Cengage Learning.
3. Computer Organization and Architecture: Designing for Performance, William Stalling, 10th Edition, Pearson Publication.
4. Computer Architecture and Organization, B. Govindarajalu, 2004, Tata McGraw-Hill Publication.

Reference Books:

1. Digital Logic and Computer Design , M. Morris Mano,5th Edition,2012, Prentice Hall India .
2. Digital Principles and Applications, Donald P. Leach, Albert Paul Malvino, 8th Edition 2008, Tata McGraw Hill.
3. Computer Organization and Architecture: Designing for Performance, William Stalling, 9th Edition, Pearson Publication.
4. Structured Computer Organization, Andrew S. Tanenbaum, Pearson Publication.

Other Resources:

1. NPTEL Course: Switching Circuits and Logic Design, By Prof. Indranil Sengupta, Department of computer science Engineering, IIT Kharagpur: https://archive.nptel.ac.in/courses/106/105/106105185/
2. NPTEL Course: Digital System Design with PLDs and FPGAs, By Prof. Kuruvilla Varghese, IISC Bangalore -Web Link: - https://nptel.ac.in/courses/117108040
3. NPTEL Course: Computer Architecture and Organization by Prof. Indranil Sengupta and Prof Kamalika Dutta Department of Computer Science and Engineering, IIT Kharagpur :- Web link- https://archive.nptel.ac.in/courses/106/105/106105163/

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

Two Class tests: 10 marks

Flip classroom worksheet: 05 marks

Regularity and active participation: 05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% - 30% weightage, and the syllabus covered from MSE to ESE carrying 70% - 80% weightage.

Course Type	Course Code	Course Name	Credits
MDM	ECMDMS--2	DIGITAL LOGIC DESIGN AND ANALYSIS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

NIL

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3:Design/development of solutions
4. PO4:Conduct investigations of complex problems
5. PO5:Enginerring tool usage

Course Objectives :

1. To make learner recall the basic philosophy underlying various number systems, including negative number representation and binary.
2. Guide learner to analyse representation of switching functions using Boolean algebra.
3. To make learner evaluate the effectiveness of different minimization techniques in logic design.
4. To assist learner to create complex logic circuits using combinational and sequential logic design principles.
5. To assist learner to design Logic and switching devices to Construction various digital circuits
6. To equip students with the knowledge and skills required to navigate and contribute to the rapidly evolving landscape of digital logic and its applications in contemporary technology.

Module	Details	Hrs
	Course Introduction Digital logic design and Analysis uses Boolean algebra for creating circuits with diverse implementations, enabling arithmetic and memory elements. Its applications are span computing, telecommunications, automation, sensing, and data processing, driving modern technological advancements.	**01**
01.	**Introduction to digital System** ***Learning Objective/s:*** *Learner is expected to solve and interpret the basic philosophy of number systems. Also expected to apply the concept of data representation in computer and communication systems for processing, storing and transferring. .*	**08-10**
	Contents: Number representation (Binary, Octa, Dec, Hex numbers and Conversions), synthesis of combinational and sequential logic Numbers Systems. Binary,	

	weighted codes binary coded decimal, non-weighted codes Excess – 3 code, Gray code, Alphanumeric codes – ASCII Code, EBCDIC, ISCII Code, Error detection and correction, Universal Product Code, Code conversion. Binary Arithmetic: Binary addition, Binary subtraction, Negative number representation, Subtraction using 1's complement and 2's complement, Binary multiplication and division, Arithmetic in octal number system, Arithmetic in hexadecimal number system, BCD and Excess – 3 arithmetic	
	Self-Learning Topics: *Hollerith Code, Morse Code, Teletypewriter (TTY)* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Apply Conversion between different number systems for given numerical values. (P.I.-1.1.1)* *LO 1.2: Apply binary addition and subtraction to solve simple problems. (P.I.-1.3.1)* *LO 1.3: Identify the processes involved in code conversion and arithmetic operations in different number systems. (P.I.-2.1.2)* *LO 1.4: Interpret mathematical concepts to design an error detection and correction mechanisms. (P.I.-2.4.1)* *LO 1.5: Show multiple design solutions for arithmetic circuits in different number systems. (P.I.-3.2.2)* *LO 1.6: Determine the correctness and efficiency of code conversion processes through validation. (P.I.-3.4.3)*	
02.	**Boolean algebra and Logic Gates**	**06-08**
	Learning Objective/s: *Learner is expected to derive and demonstrate the representation of switching functions using Boolean algebra. Also expected to apply the concept of Boolean algebra to simplify digital circuits used in microprocessors.*	
	Contents: Basic and Axiomatic definitions of Boolean algebra, Basic Theorems and properties of Boolean Algebra, Boolean Functions, Logic Operations, Logic Gates, Integrated Circuits.	
	Self-Learning Topics: *Canonical and Standard Forms.* ***Learning Outcomes :*** *A learner will be able to* *LO 2.1: Identify engineering principles and techniques applicable to solving problems in logic design. (P.I.-2.1.3)* *LO 2.2: Draw conclusions based on the analysis of Boolean algebraic expressions and logic circuits. (P.I.-2.4.4)* *LO 2.3: Examine various logic gates and integrated circuits to fulfill design requirements. (P.I.-3.2.1)* *LO 2.4: Define design objectives and functional requirements for logic circuits. (P.I.-3.2.2)*	
03.	**Simplification of Boolean Functions**	**07-09**
	Learning Objective/s: *Learner is expected to illustrate different minimization techniques of logic design. Also expected to interpret and evaluate different minimization techniques of logic design vital for achieving optimal performance, reducing cost.*	
	Contents:	

	K-map, Two and Three variable maps, Four variable maps, product of sum simplification, NAND and NOR implementation, Don't Care conditions, Determinant and selection of Prime Implicants.	
	Self-Learning Topics: *Simplification by Quine-McClusky Method.* ***Learning Outcomes :*** *A learner will be able to* *LO 3.1: Generate design solutions for simplifying Boolean expressions and logic circuit simplification using K-maps. (P.I.-3.2.2)* *LO 3.2: Compare design alternatives for logic circuit optimization. (P.I.-3.3.1)* *LO 3.3: Identify appropriate procedures and algorithms for simplifying Boolean expressions and implementing logic circuits. (P.I.-4.1.2)* *LO 3.4 : Interpret data representations to draw conclusions about the optimization of logic circuits. (P.I.-4.3.3)*	
04.	**Combinational Logic**	**06-08**
	Learning Objective/s: *Learner is expected to know and illustrate the concept of Combinational logic. Also expected to design and analyse complex logic circuits using combinational and sequential logic design principles to produce more complicated switching circuits.*	
	Contents: Design Procedure, Adders, Subtractors, Code Conversions, Analysis Procedure, Multilevel NAND and NOR Circuits, Exclusive-OR Circuits, Binary Parallel Adder and Subtractor, Decimal Adder, Magnitude Comparator, Decoders and Encoders, Multiplexers, Read-only-Memory (ROM).	
	Self-Learning Topics: *Programmable Logic Array (PLA), Programmable Array Logic (PAL).* ***Learning Outcomes :*** *A learner will be able to* *LO 4.1: Identify parameters and requirements for designing digital modules to solve specific problems. (P.I.-2.1.2)* *LO 4.2: Design digital circuits with appropriate applicability to meet system requirements. (P.I.-2.3.1)* *LO 4.3:: Determine design objectives and functional requirements for digital circuits and systems. (P.I.-3.2.1)* *LO 4.4: Draw multiple design solutions for digital circuits such as adders, subtractors, and code converters. (P.I.-3.2.2)* *LO 4.5: Analyse different design procedures and algorithms for designing digital circuits. (P.I.-4.1.2)* *LO 4.6: Categorize digital circuit characteristics and performance parameters in tabular and graphical forms. (P.I.-4.3.3)*	
05.	**Sequential Logic, Registers and Counters**	**07-09**
	Learning Objective/s: *Learner is expected to recall and interpret sequential logic, registers and counters. Also expected design and analyse Logic and switching devices used for construction of various digital circuits to provide memory, timing control, synchronization, state management*	
	Contents:	

	Flip-Flops, Triggering of flip-flops, Analysis of clocked sequential circuits, Design with state equations and state reduction table, Introduction to Asynchronous circuits, Circuits with latches. Registers, Shift registers, Ripple Counters, Synchronous Counters, Timing Sequences, The memory.	
	Self-Learning Topics: *General State Machine Architecture* ***Learning Outcomes :*** *A learner will be able to* *LO 5.1: Apply mathematical concepts such as Boolean algebra, state equations, and timing sequences to analyze and design sequential circuits. (P.I.-1.1.1)* *LO 5.2: Apply theoretical knowledge of flip-flops, registers, counters, and memory systems to solve engineering problems. (P.I.-1.4.1)* *LO 5.3: Determine the significance of investigating and solving problems related to flip-flops, registers, counters, and memory systems. (P.I.-4.1.1)* *LO 5.4: Select appropriate procedures and algorithms for designing sequential circuits such as flip-flops, registers, and counters. (P.I.-4.1.2)*	
06.	**Recent advancements in digital logic** ***Learning Objective/s:*** *Learner is expected to apply the knowledge and skills required to navigate and analyse rapidly evolving landscape of digital logic and its applications in contemporary technology.*	**03-05**
	Contents: Quantum Computing, Neuromorphic Computing, Reconfigurable Logic Devices, Optical Computing, Memristor-based Computing, Machine Learning in Logic Design, 3D Integrated Circuits	
	Self-Learning Topics: *Hardware Security*	
	Learning Outcomes : *A learner will be able to* *LO 6.1: Identify processes and algorithms for implementing quantum and Neuromorphic computing in logic design (P.I.-2.1.2)* *LO 6.2: Apply engineering mathematics to* ***knowledge to design and analyze reconfigurable logic devices*** *(P.I.-2.4.1)* *LO 6.3: Define operational characteristics and parameters for memristor-based computing systems (P.I.-3.2.1)* *LO 6.4: Examine alternative design solutions to meet the functional requirements of optical computing and 3D integrated circuits (P.I.-3.2.2)* *LO 6.5: Contrast the use of specific tools and techniques for Memristor-based Computing, Machine Learning in Logic Design, and 3D Integrated Circuits (P.I.-5.1.1)* *LO 6.6: Demonstrate tools and techniques tailored for Memristor-based Computing, Machine Learning in Logic Design, and 3D Integrated Circuits (P.I.-5.2.2)*	
	Course Conclusion	**01**
Total		**45**

Course Outcomes :

Learner will be able to

1. Identify various types of number systems and their conversions. *(LO 1.1, LO 1.2, LO 1.3, LO 1.4, LO 1.5, LO 1.6)*
2. Construct the Boolean expressions and apply the Boolean theorems through logical gates *(LO 2.1, LO 2.2, LO 2.3, LO 2.4 , LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
3. Apply knowledge of Boolean algebra and other minimization techniques for digital circuit design. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4 , LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
4. Demonstrate and Analyse the construction of programmable logic devices and different types of sequential circuits. *(LO 4.1, LO 4.2, LO 4.3, LO 4.4, LO 4.5, LO 4.6, LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
5. Explore emerging technologies, their principles and potential applications in streamlined digital circuit design*(LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO 6.5, LO 6.6)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECMDMS--02.1	3	3	3								
ECMDMS--02.2		3	3	3							
ECMDMS--02.3		3	3	3							
ECMDMS--02.4	3	3	3	3							
ECMDMS--02.5		3	3		3						
Average	3	3	3	3	3						

Performance Indicators:

P.I. No.	P.I. Statement
1.1.1	Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems
1.3.1	Apply engineering fundamentals.
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem.
2.1.3	Identifies mathematical algorithmic knowledge that applies to a given problem.
2.3.1	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance
2.4.1	Applies engineering mathematics to implement the solution.
2.4.4	Arrive at conclusions with respect to the objectives.
3.2.1	Ability to explore design alternatives
3.2.2	Ability to produce a variety of potential design solutions suited to meet functional requirements.
3.3.1	Ability to perform systematic evaluation of the degree to which several design concepts meet the criteria.
3.4.3	Ability to verify the functionalities and validate the design.
4.1.1	Define a problem for purposes of investigation, its scope and importance
4.1.2	Ability to choose appropriate procedure/algorithm, data set and test cases.

4.3.3 Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions

5.1.1 Identify modern engineering tools, techniques and resources for engineering activities

5.2.2 Demonstrate proficiency in using discipline specific tools

Text Books :

1. Digital Design, M. Morris Mano and Michael D. Ciletti, 6th Edition, 2018, Pearson Education
2. Digital Systems; Principles and Applications. Tocci, Widmer & Moss. 10th Edition, 2007, Pearson Prentice Hall
3. Modern Digital Electronics, R P. Jain, Kishor Sarawadekar, 5th Edition, 2022, McGraw Hill India
4. Schaum's Outline Of Digital Principles, Roger L. Tokheim, 3rd Edition, 2020, McGraw Hill

Reference Books :

1. Quantum Computing For The Brain, Melanie Swan, Renato P Dos Santos, Mikhail A Lebedev, New Edition, 2022, World Scientific
2. Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2016, PHI Learning

Other Resources :

1. NPTEL Course: Digital Systems Design, Prof. D. Roychoudhury, Department of Electronics & Electrical Communication Engineering, IIT Kharagpur, Web link- https://nptel.ac.in/courses/117105080
2. NPTEL Course: Digital System Design, Prof. Neeraj Goel, Department of Computer Science and Engineering at IIT Ropar, Web link- https://archive.nptel.ac.in/courses/108/106/108106177/
3. NPTEL Course: Embedded System Design With ARM, Indranil Sengupta, Computer Science and Engineering, IIT Kharagpur, Web link- https://onlinecourses.nptel.ac.in/noc22_cs93/preview
4. NPTEL Course: Quantum Computing, Dr. Prabha Mandayam, Department of Physics, IIT Madras, Web link- https://onlinecourses.nptel.ac.in/noc19_cy31/preview
5. NPTEL Course: Quantum Computing, Dr. Prabha Mandayam, Department of Physics, IIT Madras, Web link- https://onlinecourses.nptel.ac.in/noc19_cy31/preview

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

a) One MCQ Test as per GATE exam pattern / level: 05 Marks

b) One Class Test:05 Marks

c) One Open Notes Test: 05 Marks

d) Regularity and active participation :05 Marks

2. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
MDM	ECMDMS--3	ELECTRONIC COMPONENTS AND CIRCUITS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. ESC203- Basic Electronics Engineering

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO5: Modern Tool Usage
5. PO8: Individual and Teamwork

Course Objectives:

1. To impart knowledge on the working of analog and digital circuits to explore their applications in electronic circuits.
2. To design and analyse combinational and sequential digital circuits to implement digital systems.
3. To select appropriate engineering tool to simulate digital circuits as a group activity and present the results.

Module	Details	Hrs
	Course Introduction This course provides the students with a comprehensive understanding of electronic circuits focusing on both analog and digital components. Electronic systems play a pivotal role in enhancing the efficiency, stability, and reliability of electrical power systems through the deployment of advanced control and monitoring technologies. This includes applications like smart grid systems, FACTS (Flexible AC Transmission Systems), HVDC (High-Voltage Direct Current) transmission, Digital control systems and protective relay systems. Electronics is also crucial in the development of precision instruments and measurement systems.	**01**
01.	**Bipolar Junction Transistor and Field Effect Transistor**	**7-9**
	Learning Objective/s: *1. To apply the knowledge of electronics engineering fundamentals to model and analyze the performance of BJT and MOSFET amplifiers.*	
	Contents:	

	Bipolar Junction Transistor: Review of BJT Characteristics and DC Biasing, BJT as a switch, Common Emitter amplifier, Frequency Response, Amplifier gain calculation using h parameter model, Thermal Runaway, Applications. Field Effect Transistors: MOSFET construction, working and characteristics. MOSFET as a switch and amplifier, DC Biasing.	
	Self-Learning Topics: *Applications of MOSFET amplifiers.*	
	Learning Outcomes : *A learner will be able to* *LO1.1: Apply the knowledge of transistor fundamentals to plot the V-I characteristics of BJT and MOSFET and identify the different regions of operation. (P.I.-1.4.1)* *LO1.2: Use the core principles of engineering to understand the working of semiconductor devices. (P.I.-1.3.1)* *LO1.3: Extract the knowledge of different operating regions to analyze the working and application of BJT and MOSFET amplifiers. (P.I.-2.4.4)* *LO1.4: Use the modelling approach in BJT amplifiers to draw the h-parameter model and derive the expression of voltage gain. (P.I.-2.3.1)*	
02.	**Operational Amplifier**	**7-9**
	Learning Objective/s: *1. Use the knowledge of op-amp configurations to analyze the linear and non-linear applications.*	
	Contents: Introduction, Properties of ideal and practical Op-amp, Gain, CMRR and Slew rate, Frequency Response. Open loop and Closed loop Configurations - Concept of virtual ground. Idealized Analysis of Inverting and Non-inverting amplifier, Adder, Subtractor (Numerical on the same), Schmitt trigger, Comparators, filters, Integrators.	
	Self-Learning Topics: *Op-amp as instrumentation amplifier.* ***Learning Outcomes:*** *A learner will be able to* *LO2.1 Use the basic knowledge of differential amplifiers in identifying the block diagram and parameters of operational amplifiers. (P.I.-1.4.1)* *LO2.2 Use the basic knowledge of semiconductor devices in identifying the different configurations of differential amplifiers. (P.I.-1.3.1)* *LO2.3 Use the knowledge of op-amp fundamentals to formulate appropriate solution methods for analyzing open-loop and closed-loop configurations. (P.I.-2.2.3)* *LO2.4 Extract the knowledge of op-amp configurations to analyze various linear and non-linear applications. (P.I.-2.4.4)*	
03.	**Combinational Digital Circuits**	**7-9**
	Learning Objective/s: *1) Use the knowledge of logic gates to design and analyze combinational digital circuits for different applications.*	

	2) To select the appropriate software tool to design combinational circuit for real life applications. (Group Activity)	
	Contents: Combinational Digital Circuits: Review of logic gates, K-map representation, Simplification of logic functions using K-map, Design of combinational circuits: Half Adder, Full Adder, Encoders, Decoders, Multiplexers, Implementation in Open source Software.	
	Self-Learning Topics: *Design of de-multiplexer circuit.*	
	Learning Outcomes : *A learner will be able to* *LO3.1 Apply the knowledge of digital electronics fundamentals to simplify logic functions. (P.I.-1.4.1)* *LO3.2 Use the basic knowledge of semiconductor devices like transistors/diodes to recall the construction of logic gates. (P.I.-1.3.1)* *LO3.3 Gain skill in identifying and using tools like K-map to simplify logic functions. (P.I.-2.1.3)* *LO3.4 Use K-map tool to simplify and analyze combinational circuits for different applications. (P.I.-2.4.4)* *LO3.5 Apply K-map to generate multiple design solutions for combinational digital circuits. (P.I.-3.2.1)* *LO3.6 Use the design solution obtained to develop a prototype of combinational circuit. (P.I.-3.2.2)* *LO3.7 Identify the software tool like MultiSim for analyzing combinational circuits. (P.I.-5.1.1)* *LO3.8 Use the software tool to simulate any combinational circuit and validate the result. (P.I.-5.1.2)* *LO3.9 Acquire skill in forming a group and working together to realize and implement one combinational circuit for real life applications. (P.I.-8.1.2)* *LO3.10 Implement the circuit and produce valid results by taking individual contribution from all team members. (P.I.-8.3.1)*	
04.	**Sequential Digital Circuits**	**7-9**
	Learning Objective/s: *1) Use the knowledge of flip-flops to design and analyze sequential digital circuits for different applications.*	
	Contents: Flip-flops- SR, JK, T, D, Counters: Synchronous and Asynchronous counters, Design, Shift Registers, Applications.	

	Self-Learning Topics: Design of ring counter. ***Learning Outcomes:*** *A learner will be able to* *LO4.1 Apply the knowledge of digital electronics fundamentals to examine the truth table and working of flip-flops (P.I.-1.4.1)* *LO4.2 Use the basic knowledge of semiconductor devices like transistors/diodes to recall the construction of flip-flops. (P.I.-1.3.1)* *LO4.3 Gain skill in identifying and using tools like K-map to simplify logic functions. (P.I.-2.1.3)* *LO4.4 Use K-map tool to simplify and analyze sequential circuits for different applications. (P.I.-2.4.4)* *LO4.5 Apply K-map to generate multiple design solutions for sequential digital circuits. (P.I.-3.2.1)* *LO4.6 Use the design solution obtained to develop a prototype of sequential circuit. (P.I.-3.2.2)*	
05.	**A/D and D/A converters** ***Learning Objective/s:*** *1) Use the knowledge of analog and digital electronics fundamentals to examine the working and types of A/D and D/A converters.*	**5-7**
	Contents: Weighted resistor converter, D/A converter ICs, Sample and hold circuit, Quantization and encoding, successive approximation A/D converter, specifications of A/D converters, A/D converter ICs, Applications.	
	Self-Learning Topics: *R-2R D/A converter*	
	Learning Outcomes : *A learner will be able to* *LO5.1 Use core principles of engineering to understand the importance of A/D and D/A converters in real life applications (P.I.-1.3.1)* *LO5.2 Use the knowledge of analog and digital electronics fundamentals to identify the specifications, working and types of A/D and D/A converters. (P.I.-1.4.1)* *LO5.3 Extract the knowledge of converters to examine the working of A/D and D/A converter ICs. (P.I.-2.1.3)* *LO5.4 Use the knowledge of these converters to analyze and select the appropriate one for various applications. (P.I.-2.4.4)*	
06.	**Specialized IC Applications**	**4-6**
	Learning Objective/s: *To analyze the working and application of voltage regulator and 555 timer ICs.*	
	Contents: Voltage Regulators: DC filters, ICs-78xx, 79xx, LM317, OPA2277, Buffer IC. IC-555: Functional block diagram, study of Astable Multivibrator, Applications.	

	Self-Learning Topics:LC Filters. ***Learning Outcomes:*** *A learner will be able to* *LO6.1 Use core principles of engineering to understand the importance of voltage regulator ICs in real life applications (P.I.-1.3.1)* *LO6.2 Use the knowledge of analog electronics fundamentals to identify the working of voltage regulator and 555 timer ICs. (P.I.-1.4.1)* *LO6.3 Extract the knowledge of these ICs to realize various applications. (P.I.-2.1.3)* *LO6.4 Apply the knowledge of regulator and timer ICs to select the appropriate one for various applications. (P.I.-2.4.4)*	
	Course Conclusion The course on Electronic Components and Circuits has provided a comprehensive overview of the working principles and applications of analog and digital circuits. Throughout this course, different topics such as BJT/MOSFET amplifiers, op-amps, A/D & D/A converters, Voltage regulators, 555 timer, combinational and sequential digital circuits have been dealt with. This understanding is a critical step towards being able to design new electronic circuits or use them appropriately as part of a larger engineering system. As the course is getting concluded, let us look forward with optimism to the future of electronic devices and the endless possibilities they hold for innovation and progress.	**01**
	Total	**45**

P.I. No.	**P.I. Statement**
1.4.1	Apply electrical engineering concepts to solve engineering problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.3.1	Combine scientific principles and electrical engineering concepts to formulate model of a system that is appropriate in terms of applicability and required accuracy.
2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis.
3.2.1	Apply formal idea generation tools to develop multiple engineering design solutions.
3.2.2	Build models/prototypes to develop a diverse set of design solutions.
5.1.1	Identify modern engineering tools such as computer-aided drafting, modelling and Analysis, techniques and resources for engineering activities.
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems.
8.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.

Course Outcomes:

1. Apply the knowledge of electronics engineering fundamentals to analyze the working and applications of analog and digital electronic circuits. *(LO1.1, LO 1.2, LO2.1, LO2.2, LO3.1, LO3.2, LO4.1, LO4.2, LO5.1, LO5.2, LO6.1, LO6.2)*
2. Identify, formulate and use the modelling approach to analyze analog and digial ciruits. *(LO1.3, LO1.4, LO3.3, LO3.4, LO4.3, LO4.4)*

3. Execute appropriate solution methodology to analyse various analog and digital circuits.*(LO2.3, LO2.4, LO5.3, LO5.4, LO6.3, LO6.4)*
4. Apply the knowledge of logic gates and flip-flops to design combinational and sequential digital circuits.*(LO4.5, LO4.6, LO3.5, LO3.6)*
5. To identify and use appropriate engineering tools like PSpice to simulate different digital circuits and present the results as a team based activity. *(LO3.7, LO3.8, LO3.9, LO3.10)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECMDMS--3.1	3	3									
ECMDMS--3.1	3	3									
ECMDMS--3.1		3									
ECMDMS--3.1	3		3								
ECMDMS--3.1					3			3			
Average	3	3	3		3			3			

Text Books :

1. Electronic Devices and Circuit Theory, Robert Boylestad and Louis Nashelsky, 10th Edition, 2013, Pearson India Ltd.
2. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, 4th Edition, 2015, Pearson India Ltd.
3. Integrated Electronics, Millman and Halkias, 2nd Edition, 2007, McGraw Hill
4. Modern Digital Electronics, R.P.Jain, 4th Edition, 2009, McGraw Hill
5. Digital principal and Applications, Malvino & Leach, 8th Edition, 2014, McGraw Hill Education.

Reference Books :

1. Electronic Devices and Circuits, David A Bell, 5th Edition, 2017, Oxford University Press
2. Electronic Devices, Thomas L.Floyd, 10th Edition, 2021, Pearson Education
3. Electronic Devices and Circuits, S. Salivahanan and N. Suresh Kumar, 4th Edition, 2017, McGraw Hill Education.
4. Introduction to Logic Design, Alan b. Marcovitz, 3rd Edition, 2009, McGraw Hill Education.

Other Resources :

1. NPTEL Course: Analog Electronic Circuits By Prof. Shanti Pavan , Department of Electrical Engineering, IIT Madras :-Web link- https://archive.nptel.ac.in/courses/108/106/108106188/
2. NPTEL Course: Digital Electronic Circuits By Prof. Goutam Saha, Department of Electrical Engineering, IIT Kharagpur. Web link- https://archive.nptel.ac.in/courses/108/105/108105132/

IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

a. Numerical Assignment/s (min. 20 problems) covering the entire syllabus: 05 Marks
b. Class test based on above numerical assignment: 05 Marks
c. Postal Creation: 05 Marks
d. Regularity and active participation in class: 05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% of the syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End semester examination will be based on syllabus coverage up to Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70 % to 80% weightage.

Course Type	Course Code	Course Name	Credits
MDM	ECMDMS--4	MICROCONTROLLERS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite:

1. ESLC103 – C Programming laboratory

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3- Design & Development of solutions
4. PO6-Environment and Sustainability
5. PO11-Life-long learning

Course Objectives:

1. To equip students with the fundamental knowledge and basic technical competence in the field of Microcontrollers.
2. To excel in building and executing assembly and C language programs for PIC microcontroller based applications.
3. To familiarize students with the internal and external peripheral interfacing of PIC microcontrollers.
4. To introduce the features and applications of advanced microcontrollers.

Module	Details	Hrs
	Course Introduction This course introduces the fundamental concepts, programming, and applications of microcontrollers, focusing on real-world scenarios. Develop expertise to interface microcontrollers with sensors and external peripheral devices, thereby facilitating engineering students with the skills required for embedded systems design and development.	**01**
01.	**Introduction to PIC Microcontroller**	**4-5**
	Learning Objective/s: 1. *To outline and demonstrate the architectural details of PIC microcontroller.*	
	Contents: Microprocessor vs microcontroller, CISC Vs RISC design, Von-Neumann vs Harvard architecture, Review and comparison of 8-bit and 16-bit general purpose microcontrollers used in practice, Block diagram of generic	

	microcontroller, Architecture of PIC microcontroller, I/O ports, Stack and stack pointer, Memory structure, Data Memory, GPRs and SFRs, STATUS register, Working Register, Bank Select Register, Program Memory, Program counter, Addressing modes.	
	Self-Learning Topics: Architecture of any 16-bit microcontroller	
	Learning Outcomes: *A learner will be able to* *LO1.1 Apply fundamental engineering concepts to identify the architectural details of microcontrollers. (P.I.-1.3.1)* *LO1.2 Use computer engineering concepts to comprehend the memory mapping/organization of PIC microcontrollers. (P.I.-1.4.1)* *LO1.3 Identify engineering and other relevant knowledge to demonstrate the organization of CPU registers in PIC microcontrollers. (PI-2.1.3).* *LO1.4 To identify the addressing modes used for accessing the data and interpret their advantages in microcontroller interfacing. (P.I.-2.1.2)*	
02.	**PIC18F Instruction Set and Programming Model**	**7-8**
	Learning Objective/s: 1. *To become acquainted with the PIC instruction set and apply programming skills to build assembly language programs for arithmetic, logic and data transfer operations.*	
	Contents: PIC18 microcontroller programming model, Bus architecture, Instruction Set, Arithmetic, logic, branching, compare and rotate instructions, Instruction formats, Assembler Directives, Assembly language programs. (Assembly programs are restricted to basic arithmetic, logical and data transfer operations only)	
	Self-Learning Topics: *Flowcharts and algorithms.*	
	Learning Outcomes: *A learner will be able to* *LO2.1 Identify the different addressing modes to access and manipulate data for implementing assembly language codes. (P.I.-2.2.2)* *LO2.2 Identify engineering and other relevant knowledge to solve the problems related to instructions, opcode handling, and operand addressing (P.I.-2.1.3)* *LO2.3 Explore design objectives for implementing assembly language programs using logical and arithmetic instructions. (P.I.-3.1.6)* *LO2.4 Organize code into modular procedures, facilitate code reuse, improve program structure, and enhance overall program maintainability. (P.I.-3.2.2)*	
03.	**Peripheral Interface-I**	**7-8**

	Learning Objective/s: 1. *To comprehend the knowledge of internal peripheral devices like interrupts and I/O ports to analyse the features and application of timer module.*	
	Contents:	
	I/O ports, Timer Module: Basic Concept of Timers and counters, Timer Registers, Control Registers, 8 bit and 16-bit operation (only for Timer 0), Interrupt Module: Basic concept of Interrupt, PIC 18 Interrupts, Interrupt versus polling, Interrupt sources, Interrupt vector, Interrupt service routine, Interrupt process, INTCON register. Introduction to embedded C, C programs for delay generation using Timers.	
	Self-Learning Topics: *Programming of Counters*	
	Learning Outcomes: *A learner will be able to* *LO3.1 Identify the timer registers and its utilization to generate delay programs. (P.I.-2.1.3)* *LO3.2 Analyse the structure and functioning of the Interrupt Vector Table (IVT) to manage interrupt vectors and prioritize interrupt handling. (P.I.-2.2.2)* *LO3.3 Determine design objectives and arrive at specifications for implementing C language programs using timers. (PI-3.1.6).* *LO3.4 Organize code into modular procedures, facilitate code reuse, improve program structure, and enhance overall program maintainability for solving real life problems. (P.I.-3.2.2)*	
4.	**Peripheral Interface-II**	**7-8**
	Learning Objective/s: 1. *To comprehend the knowledge of internal peripheral devices like CCP and ADC modules for exploring their applications in engineering domain*	
	Contents: CCP module (Capture, Compare and PWM), Watch dog Timer. ADC module: ADC Features, Block diagram of ADC module, ADC Registers, ADCON0, ADCON1 and ADCON2. Serial communication: Basics of serial communication, Data framing, USART module, SPBRG, TXREG, RCREG, TXSTA, RCSTA, PIR1. C programming to generate PWM signal, transmit and receive data serially, Applications.	
	Self-Learning Topics: *DAC module in PIC microcontroller.*	
	Learning Outcomes: *A learner will be able to* *LO4.1 Identify the ADC and CCP registers and its utilization to sense various external analog parameters and generate PWM signals. (P.I.-2.1.3)* *LO4.2 Analyze the structure and functioning of the UART module to manage serial communication. (P.I.-2.2.2)* *LO4.3 Determine design objectives and arrive at specifications for implementing C language programs using CCP and USART modules. (PI-3.1.6).*	

	LO4.4Organize code into modular procedures, facilitate code reuse, improve program structure, and enhance overall program maintainability. (P.I.-3.2.2) *LO4.5 Examine the role of microcontrollers in advancing applications for sustainable transportation and other related domains. (PI 6.2.2)*	
05.	**External Interface**	**07-08**
	Learning Objective/s: 1. *To comprehend the knowledge of PIC microcontroller peripheral devices to understand the interfacing with external peripheral devices.*	
	Contents: LCD Interfacing, Keyboard interfacing, Sensing external parameters V/I with ADC, Stepper motor Interfacing, DC motor interfacing, Traffic Signal Controller. C programming to rotate DC and Stepper motor clockwise and anticlockwise, Applications .	
	Self-Learning Topics: *Sine wave generation using PIC microcontroller*	
	Learning Outcomes: *A learner will be able to* *LO5.1 Identify the I/O ports and its registers to interface external peripheral devices. (P.I.-2.1.3)* *LO5.2Examine various interfacing techniques with different external peripheral devices suitable for industrial practices on environmental contexts. (PI-2.2.2, PI 6.1.2).* *LO5.3 Determine design objectives and arrive at specifications for implementing C language programs. (PI-3.1.6).* *LO5.4 Organize code into modular procedures, facilitate code reuse, improve program structure, and enhance overall program maintainability. (P.I.-3.2.2)* *LO5.5 Examine the role of microcontrollers in advancing applications for sustainable transportation and other related domains. (PI6.2.2)*	
06.	**Introduction to Advanced Microcontrollers**	**05-06**
	Learning Objective/s: 1. *To identify the changing trends in microcontrollers with their applications in engineering domain..*	
	Contents: Introduction to ARM and DSP microcontrollers, Features and architecture of STM32 ARM microcontroller, Fixed point vs Floating point DSP processors, TMS320 family of DSPs, Memory architecture, Applications.	
	Self-Learning Topics: *PWM generation using DSP TMS320F280049C processor.*	

	Learning Outcomes: *A learner will be able to* *LO6.1 Apply fundamental engineering concepts to identify the functional blocks and data flow paths of ARM and DSP microcontrollers. (P.I.-1.3.1)* *LO6.2 Apply computer and digital engineering concepts to comprehend the operation and performance characteristics of ARM and DSP microcontrollers (P.I.-1.4.1)* *LO6.3 Analyse sourced technical information to gather latest developments in the field of microcontrollers. (PI 11.3.2)* *LO6.4 Prepare a report or deliver a presentation analysing at least one application that utilizes either an ARM or DSP microcontroller. (PI 11.3.1)*	
	Course Conclusion The microcontroller course greatly improves students' expertise in embedded systems design, programming, and optimization, empowering them for success and growth in hardware engineering, embedded systems development, and the semiconductor industry.	**01**
Total		**45**

Performance Indicators:	
P.I. No.	**P.I. Statement**
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply electrical engineering concepts to solve engineering problems.
2.1.2	Identify the engineering systems, variables, and parameters to solve the problems.
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to given problem.
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3.1	Able to apply computer engineering principles to formulate modules of a system with required applicability and performance.
3.1.6	Determine design objectives, functional requirements and arrive at specifications.
3.2.2	Able to produce a variety of potential design solutions suited to meet functional requirements.
6.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline.
6.1.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability.
11.3.2	Analyse sourced technical and popular information for feasibility, viability, sustainability, etc.
11.3.1	Source and comprehend technical literature and other credible sources of information.

Course Outcomes:

Learner will be able to

1. Apply engineering principles to examine the architectural features of PIC and advanced microcontrollers. (*LO1.1, LO1.2, LO1.3, LO1.4, LO6.1, LO6.2)*

2. Utilize the PIC instruction set and addressing modes to develop, execute, and debug assembly language programs. *(LO2.1, LO2.2, LO2.3, LO2.4)*
3. Identify CPU registers of internal peripheral devices and develop C programs for their effective execution and interfacing for various applications. *(LO3.1, LO3.2, LO3.3, LO3.4, LO4.1, LO4.2, LO4.3, LO4.4)*
4. Utilize the various I/O registers to develop C programs for interfacing PIC microcontrollers with external peripheral devices. (*LO5.1, LO5.2, LO5.3, LO5.4)*
5. Identify the importance of microcontrollers in various application domains while showcasing independent learning. *(LO4.5, LO5.5, LO6.3, LO6.4)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECMDMS--4.1	3	3									
ECMDMS—4.2		3	3								
ECMDMS--4.3		3	3								
ECMDMS--4.4		3	3								
ECMDMS--4.5						3					3
Average	3	3	3			3					3

Text Books :

1. Ramesh Gaonkar, “Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family)”, Penram International publications (Ind) Pvt. Ltd.
2. Ali Mazidi, Rolind D Mckinlay and Danny Causey , “PIC Microcontroller and Embedded Systems”, Pearson Education ltd., 2015.
3. Han Way Huang, “PIC Microcontroller: An Introduction to Software and Hardware Interfacing”, Cengage Learning, 2005.
4. Phil Lapsley, Jeff Bier, Amit Shoham, Edward A. Lee, “DSP Processor Fundamentals: Architecture and features”, Wiley-IEEE Press, 1997.
5. Muhammed Ali Mazidi, Shujen Chen, Eshragh Ghaemi “STM32 ARM programming for Embedded systems”, Microdigitaled, 2018.
6. Alexander G Dean, ”Embedded system fundamentals with ARM Cortex M based microcontrollers A practical approach”, ARM education media, 2017.

Reference Books :

1. Robert B. Reese, “Microcontroller from Assembly Language to C using PIC18FXX2”, Davinci Engineering press.
2. Peatman,”Design with PIC microcontrollers, 1e”, Pearson Education ltd., 2002.

Other Resources :

1. NPTEL Course: **Microprocessors And Microcontrollers** By Prof. Santanu Chattopadhyay, Dept. of Electrical Engineering, IIT Kharagpur:- Web link- https://nptel.ac.in/courses/108/105/108105102/
2. NPTEL Course: **Introduction to Embedded System Design** By Prof. Dhananjay V. Gadre, Prof. Badri N Subudhi, Dept. of Electrical Engg, Netaji Subhas University of Technology and IIT Jammu:- Web link- https://archive.nptel.ac.in/courses/108102169/

IN-SEMESTER ASSESSMENT (50 MARKS)

Suggested breakup of distribution

1. Continuous Assessment (20 Marks)
   - Numerical Assignments + Class test based on numerical assignment (05+05 marks)
   - Open Book test: 05 marks
   - Regularity and Active Participation: 05 marks
2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80 weightage.

Course Type	Course Code	Course Name	Credits
MDM	ECMDMS--5	MICROCONTROLLER AND EMBEDDED SYSTEM	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. ITPCC302: Computer Organization and Architecture

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Development of Solutions
4. PO5: Engineering Tool Usage

Course Objectives:

1. To familiarize learner with the concepts and architecture of embedded systems
2. To acquaint leaners with the basics of microcontroller 8051.
3. To familiarize learner with the concepts of microcontroller 8051 interface.
4. To introduce leaners with the concepts of ARM architecture.
5. To familiarize learner with the concepts of real-time operating system
6. To introduce leaners with the concepts of different design platforms used for an embedded systems application

Module	Detailed Contents	Hrs
00.	**Course Introduction** Microcontrollers & embedded systems deal with the basic principles of microcontrollers, with emphasis on the Intel x51 and ARM microcontrollers and their associated peripheral chips. The fundamental concepts of this subject are essential for Internet of Things.	**01**
01.	**Introduction to Embedded Systems** ***Learning Objective/s:*** *Introduce the concepts of embedded systems and architecture of embedded systems.* **Contents:**	**05-06**
	Overview of Embedded System Architecture, Application areas, Categories of embedded systems, specialties of embedded systems. Brief introduction to embedded microcontroller cores CISC, RISC, ARM, DSP and SoC	

	Self-Learning Topics: *Comparison of RISC and CISC.* ***Learning Outcomes :*** *A learner will be able to* *LO 1.1: Apply embedded systems concepts to identify different categories of embedded system with its significance. (P.I.-1.3.1)* *LO 1.2: Use core principles of embedded systems to understand the importance of embedded systems in applications. (P.I.-1.4.1)* *LO 1.3: Differentiate Embedded microcontroller cores like CISC, RISC. (P.I.-2.1.3)* *LO 1.4: Identify major performance criteria for the design of embedded systems. (P.I.-2.2.3)*	
02.	**The Microcontroller Architecture and Programming of 8051** ***Learning Objective/s:*** *Know and understand the concepts of 8051 Architecture and its Programming*	**07-09**
	Contents: Introduction to 8051 Microcontroller, Architecture, Pin configuration, Memory organization, Input /Output Ports, Counter and Timers, Serial communication, Interrupts. Instruction set, Addressing modes, Development tools, Assembler Directives, Programming based on Arithmetic & Logical Operations, I/O parallel and serial ports, Timers & Counters, and ISR.	
	Self-Learning Topics: *Write assembly language code for 8051 for any real time case study.* ***Learning Outcomes :*** *A learner will be able to* *LO 2.1: Formulate the programmer's model for 8051 by applying basic concepts. (P.I.-1.3.1)* *LO 2.2: Use registers of 8051 to write programs(P.I.-1.4.1)* *LO 2.3: Use development tools to program parallel & serial ports of 8051. (P.I.-2.1.2)* *LO 2.4: Apply fundamental 8051 concepts to use timers and counters in 8051. (P.I.-2.2.3)* *LO 2.5: Determine requirements of problem and decide instructions and registers to be used in 8051 programs. (P.I.-3.2.1)* *LO 2.6: Identify the development tools to write and run 8051 programs to check accuracy of solution (PI-3.2.2)*	
03.	**Interfacing with 8051 Microcontroller** ***Learning Objective/s:*** *Illustrate interfacing of peripherals with 8051 microcontroller and write programs.*	**07-09**
	Contents: Interfacing ADC, DAC, Stepper motor, LCD , 8255 PPI .	
	Self-Learning Topics: *8051 interfacing with KBD matrix.* ***Learning Outcomes :*** *A learner will be able to*	

	LO 3.1: Identify pins to be used of 8051 to program with ADC, DAC and then analyze it to determine the time response. (P.I.-1.3.1) *LO 3.2: Use registers of 8051 to write programs to operate stepper motor(P.I.-1.4.1)* *LO 3.3: Solve the given problem by interfacing 8255PPI with 8051 (P.I.-2.1.3)* *LO 3.4: Construct and interpret the result on LCD by interfacing it with 8051 for a system for its stability. (P.I.-2.2.3)*	
04.	**ARM 7 Architecture** ***Learning Objective/s:*** *Understand and apply the concepts of ARM architecture.*	**07-09**
	Contents: Architectural inheritance, Detailed study of Programmer's model, ARM Development tools, Instruction set: Data processing, Data Transfer, Control flow. Addressing modes. Writing simple assembly language programs. Pipelining, Brief introduction to exceptions and interrupts handling.	
	Self-Learning Topics: *ARM code for real time problem* ***Learning Outcomes :*** *A learner will be able to* *LO 4.1: Apply the concepts of ARM architecture and development tools to use in an embedded system(P.I.-1.3.1)* *LO 4.2: Use registers of ARM to write assembly language programs (P.I.-1.4.1)* *LO 4.3: Identify the addressing modes and pipelining to be used for embedded applications. (P.I.-2.1.3)* *LO 4.4: Analyze the exceptions and interrupt handling in ARM embedded system. (P.I.-2.2.3)*	
05.	**Opensource RTOS** ***Learning Objective/s:*** *Know and understand the concepts of open source real-time operating system.*	**07-09**
	Contents: Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, basic architecture of an RTOS, scheduling systems, inter-process communication, performance Matrix in scheduling models, interrupt management in RTOS environment, memory management, file systems, I/O systems, advantage and disadvantage of RTOS. POSIX standards, RTOS issues – selecting a Real Time Operating System, RTOS comparative study.	
	Self-Learning Topics: *Differences between general purpose OS & RTOS*	

	Learning Outcomes : *A learner will be able to* *LO 5.1: Use interprocess communication for knowing basic architecture of RTOS(P.I.-1.3.1)* *LO 5.2: Apply scheduling systems in RTOS to know performance matrix inb scheduling models(P.I.-1.4.1)* *LO 5.3: Identify how interrupts and memory be managed in RTOS for stability. (P.I.-2.2.2)* *LO 5.4: Determine the POSIX standards and RTOS issues to select a suitable RTOS for embedded system. (P.I.-2.2.3)*	
06.	**Introduction to Embedded Systems Target Boards** ***Learning Objective/s:*** *Know and understand concepts of different design platforms used for an embedded systems application.*	**04-05**
	Contents: Introduction to Arduino, Raspberry Pi, etc. Opensource prototyping platforms. Basic Arduino programming; Extended Arduino libraries; Arduino-based Internet communication; Raspberry pi; Sensors and Interfacing: Temperature, Pressure, Humidity.	
	Self-Learning Topics: ***Study the ARM Cortex or Galileo target board*** ***Learning Outcomes :*** *A learner will be able to* *LO 6.1: Formulate the prototyping platform to use a suitable embedded system board for an application. (P.I.-1.3.1)* *LO 6.2: Use Arduino libraries for a specific application on Arduino. (P.I.-1.4.1)* *LO 6.3: Identify the sensors to be used with a suitable embedded system board for an application. (P.I.-2.2.2)* *LO 6.4: Determine the how to use Arduino based Internet communication for an application(P.I.-2.2.3)* *LO 6.5: Adapt modern tool Arduino IDE sketch to program Arduino for an embedded system. (P..I-5.1.2)* *LO 6.6: Verify the results of embedded system using Arduino IDE sketch(P.I.- 5.3.2)*	
	Course Conclusion	**01**
	Total	**45**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply engineering fundamentals
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem
2.2.2	Identifies functionalities and computing resources.

2.2.3 Identify existing solution/methods to solve the problem, including forming justified approximations and assumptions
3.2.1 Ability to explore design alternatives.
3.2.2 Ability to produce a variety of potential design solutions suited to meet functional requirements.
5.1.2 Create/adapt/modify/extend tools and techniques to solve engineering problems
5.3.2 Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.

Course Outcomes:
Learner will be able to

1. Apply the fundamentals of embedded system to identify a suitable chip for the given application.(*LO 1.1, LO1.2, LO 1.3, LO 1.4)*
2. Illustrate architecture of 8051 and write embedded program for 8051. (*LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 2.5, LO 2.6)*
3. Apply concepts of 8051 to interface it with the peripherals. *(LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
4. Use ARM architecture concepts to real world applications. *(LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
5. Apply the concepts of Real Time Operating system on embedded systems *(LO 5.1, LO 5.2, LO 5.3, LO 5.4)*
6. Use the concepts of Embedded target board for applications. (*LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO 6.5, LO 6.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECMDMS --5.1	3	3									
ECMDMS --5.2	3	3	3								
ECMDMS --5.3	3	3									
ECMDMS --5.4	3	3									
ECMDMS --5.5	3	3									
ECMDMS --5.6	3	3			3						
Average	**3**	**3**	**3**		**3**						

Text Books:

1. The 8051 microcontroller & Embedded systems, M. A. Mazidi, J. G. Mazidi, R. D. McKinlay, Third Edition, 2020, Pearson
2. The 8051 microcontroller & Embedded systems, Kenneth J. Ayala, Dhananjay V. Gadre, Second Edition, 2018,Cengage Learning
3. Embedded / real – time systems: concepts, design & programming, Black Book, Dr. K. V. K. K. Prasad, Fourth edition 2013,Dreamtech press,
4. Introduction to embedded systems, Shibu K. V, Second Edition, 2018, McGraw Hill
5. ARM System on chip Architecture, Steve Furber, Second Edition, 2015, Pearson

Reference Books:

1. Embedded systems an integrated approach, Laya B. Das, Third edition, 2013, Pearson publication.
2. ARM system developer's guide, Andrew N. Sloss, Dominic Symes, Chris Wright,First Edition, 2004, Morgan Kaufmann Publishers
3. Embedded system design A Unified hardware/software Introduction, Frank Vahid, Tony Givargis, Second Edition2006,Wiley publication
4. ARM Technical Reference manual

Other Resources:

1. NPTEL Course on Microprocessors and Microcontrollers by Prof. Santanu Chatopadhyay, Department of Electronics and Electrical Communication Engineering, IIT Kharagpur
   Web link- https://archive.nptel.ac.in/courses/108/105/108105102/

2. NPTEL Course on Embedded System Design with ARM by Prof. Indranil Sengupta, Department of Computer Science and Engineering, IIT Kharagpur
   Web link- https://onlinecourses.nptel.ac.in/noc22_cs93/preview

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

a) One MCQ Test as per GATE exam pattern / level: 05 Marks

b) One Class Test:05 Marks

c) One Think Pair Share (TPS) activity: 05 Marks

d) Regularity and active participation :05 Marks

2. Mid Semester Examination (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
MDM	ECMDMS--6	INTERNET OF THINGS	03

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. ESC102- Basic Electrical Engineering
2. ESC203- Basic Electronics Engineering

Program Outcomes addressed:

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/Development of Solutions
4. PO5: Engineering Tool Usage

Course Objectives:

1. To provide overview of internet-of-things
2. To impart knowledge on IoT platform design methodology
3. To introduce Networking & Communication Protocols for IoT applications
4. To provide knowledge on online IoT Hardware Platforms
5. To introduce Mobile App platform for IoT
6. To impart knowledge on home and city automation IoT Applications

Module	Details	Hrs
	Course Introduction Internet of Things is a foundation course which deals with fundamental concepts of IoT and its applications. The fundamental concepts of this subject are essential for designing Automation systems using IoT connectivity and communication technologies.	**01**
01.	**Introduction to Internet of Things**	**7-9**
	Learning Objective/s: *To apply fundamental and electrical engineering concepts for comprehending Internet of Things, building blocks of IoT, IoT enabling technologies, characteristics of IoT levels, IoT and M2M*	
	Contents: Introduction to IoT : Definition & Characteristics of IoT, Physical Design of IoT-Things in IoT, IoT protocol, Logical Design of IoT– IoT functional blocks, IoT Communication Models, IoT communication APIs, IoT Enabling Technologies	

	– Wireless Sensor Networks, Cloud computing, Big Data Analytics, Communication Protocols, Embedded Systems, IoT levels and Deployment Techniques, IoT and M2M	
	***Self-Learning Topics**: Sensing, actuation*	
	Learning Outcomes: *A learner will be able to* *LO1.1: Apply fundamental engineering concepts to identify and understand IoT characteristics (P.I.-1.3.1)* *LO1.2: Apply domain specific engineering concepts to understand Physical and logical design of IoT. (P.I.-1.4.1)* *LO1.3: Identify and comprehend IoT Enabling Technologies and IoT levels (P.I.-2.1.2)* *LO1.4: Differentiate between IoT and M2M using mathematical, engineering and other relevant knowledge (P.I.-2.1.3)*	
02.	**IoT Platforms Design Methodology**	**7-9**
	Learning Objective/s: *To identify and synthesize design methodology required in IoT application development*	
	Contents: IoT Platforms Design Methodology: Introduction, IoT design Methodology, Case Study on IoT system for Weather Monitoring	
	Learning Outcomes: *A learner will be able to* *LO2.1: Identify information and resources related to IoT platforms design methodologies (P.I.-2.2.2)* *LO2.2: Identify design methodology to specific IoT application using assembled information (P.I.-2.2.3)* *LO2.3: Synthesize design requirements from review of various IoT platforms design methodologies (P.I.-3.1.3)* *LO2.4: Determine design methodology based on IoT level, Functional view, operational view specification for specified application development (P.I.-3.1.6)*	
03.	**IoT Connectivity and Communication Technologies**	**7-9**
	Learning Objective/s: *To identify and interpret IoT Connectivity, Communication protocols for selecting most appropriate connectivity protocol in IoT implementation.*	
	Contents: IoT Connectivity and Communication Technologies: IoT Connectivity technologies –IEEE 802.15.4, Zigbee, Zwave, RFID, LoRa, Wi-fi, Bluetooth, IoT Communication Technologies –Introduction, MQTT, CoAP, REST, HTTP RESTful, WebSocket	

	Learning Outcomes: *A learner will be able to* *LO3.1: Identify IoT Connectivity and Communication Technologies for IoT applications (P.I.-2.1.2)* *LO3.2: Identify the salient features and application scope of common connectivity protocols in IoT (P.I.-2.1.3)* *LO3.3: Extract requirements from relevant connectivity protocols for IoT applications (P.I.-3.1.4)* *LO3.4: Determine appropriate connectivity protocols for IoT applications (P.I.-3.1.6)*	
04.	**IoT Hardware Development Platforms**	**7-9**
	Learning Objective/s: *To synthesize existing online IoT hardware development platforms and select specific platform for implementation of Home Automation IoT system*	
	Contents: IoT Hardware Development Platforms: Overview IoT hardware platforms, Design and implementation of Home Automation IoT System using online hardware platforms – Smart Lighting, Home intrusion detection.	
	Learning Outcomes: *A learner will be able to* *LO4.1: Apply fundamental engineering concepts to execute specific Home Automation IoT system (P.I.-1.3.1)* *LO4.2: Apply domain specific engineering concepts to execute specific Home Automation IoT system (P.I.-1.4.1)* *LO4.3: Synthesize engineering requirements to solve design problem of Home Automation IoT system (P.I.-3.1.3)* *LO4.4: Extract relevant protocols for executing the defined IoT system home automation problem (P.I.-3.1.4)* *LO4.5 Adapt online IoT hardware platforms to execute Home Automation IoT system (P.I.-5.1.2)* *LO4.6: Verify the credibility of results obtained from online IoT hardware platforms for Home Automation IoT system (P.I.-5.3.2)*	
05.	**Introduction to Mobile App platform**	**4-6**
	Learning Objective/s: *To apply electrical /computer engineering concepts for understanding Mobile App platform required for Mobile to server integration using Mobile app protocol stack of IoT*	
	Contents: Introduction to Mobile App platform: Protocol stack of Mobile app for IoT, Mobile to server integration	

	Learning Outcomes: *A learner will be able to* *LO5.1: Apply fundamental engineering concepts to understand Mobile to server integration system (P.I.-1.3.1)* *LO5.2: Apply domain specific engineering concepts to comprehend Mobile to server integration using Mobile app platform (P.I.-1.4.1)* *LO5.3: Identify existing Protocol stack of Mobile app for IoT (P.I.-2.2.3)* *LO5.4: Extract desired understanding and conclusions required for executing mobile to server integration (P.I.-2.4.4)*	
06.	**IoT Applications**	**5-7**
	Learning Objective/s: *To Identify and synthesize engineering system designs of different IoT applications*	
	Contents: IoT Applications: Case Studies illustrating IoT Design – Cities (Smart Parking, Garbage collection), Environment (Pollution detection, Forest Fire Detection), Power (Smart Grid)	
	Learning Outcomes: *A learner will be able to* *LO6.1: Identify and understand IoT designs in context to different case studies illustrating IoT design (P.I.-2.1.2)* *LO6.2: Extract desired understanding and conclusions in terms of IoT application designs (P.I.-2.4.4)* *LO6.3: Synthesize engineering requirements from a review of IoT designs (P.I.-3.1.3)* *LO6.4: Explore and synthesize engineering requirements considered in IoT applications including garbage collection, pollution detection, forest fire detection (P.I.-3.1.5)*	
	Course Conclusion This course has provided a comprehensive exploration of IoT technologies and their diverse applications. Through a blend of theoretical learning and practical implementation, students have gained insights into the interconnected world of IoT devices, sensors, networks, and data analytics.	**01**
	Total	**45**

Performance Indicators:

P.I. No.	P.I. Statement
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
1.4.1	Apply domain specific engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems.

2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.

2.2.2 Identify, assemble and evaluate information and resources.

2.2.3 Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions.

2.4.4 Extract desired understanding and conclusions consistent with objectives and limitations of the analysis.

3.1.3 Synthesize engineering requirements from a review of the state-of-the-art.

3.1.4 Extract engineering requirements from relevant engineering Codes and Standards.

3.1.5 Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural, whole-life cost, net zero carbon, culture, environment and societal issues.

3.1.6 Determine design objectives, functional requirements and arrive at specifications

5.1.2 Create/adapt/modify/extend tools and techniques to solve engineering problems.

5.3.2 Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.

Course Outcomes :

1. Apply fundamentals of IoT to understand characteristics of IoT system. *(LO1.1,LO1.2,LO1.3, LO1.4)*
2. Identify and determine IoT platform design methodology for given IoT application. *(LO2.1, LO2.2, LO2.3, LO2.4)*
3. Identify and select relevant communication protocol suitable for IoT implementation. *(LO3.1, LO3.2, LO3.3, LO3.4)*
4. Adapt online IoT hardware platforms to execute specific Home Automation IoT system and verify the credibility of results. (*LO4.1, LO4.2, LO4.3, LO4.4, LO4.5, LO4.6*)
5. Extract desired understanding and conclusions required for executing mobile to server integration using Mobile app protocol stack for IoT. (*LO5.1, LO5.2, LO5.3, LO5.4*)
6. Synthesize IoT designs through an understanding of case studies illustrating IoT implementation in home and city automation. *(LO6.1, LO6.2, LO6.3, LO6.4)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECMDMS--6.1	3	3									
ECMDMS--6.2		3	3								
ECMDMS--6.3		3	3								
ECMDMS--6.4	3		3		3						
ECMDMS--6.5	3	3									
ECMDMS--6.6		3	3								
Average	3	3	3		3						

Text Books :

1. "Internet of Things (A Hands-on-Approach)", Vijay Madisetti and Arshdeep Bahga, 1st Edition, 2014, VPT
2. "Introduction to IoT", S. Misra, A. Mukherjee, and A. Roy, 2020, Cambridge University Press.
3. "Introduction to Industrial Internet of Things and Industry 4.0", S. Misra, C. Roy and A. Mukherjee, 2020, CRC Press
4. "Internet of Things: Architecture and Design Principles", Raj Kamal, First Edition, McGraw Hill Education.

Reference Books :

1. "Designing the Internet of Things", Adrian McEwen, Hakim Cassimally, 2014, John Wiley
2. "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Francis daCosta, 1st Edition, 2013, Apress Publications.
3. "Getting Started with the Internet of Things", CunoPfister, 2011, OReilly Media.
4. "Internet of Things", Samuel Greenguard, 2015, MIT Press
5. "Internet of Things. IoT Infrastructures", Mandler, B., Barja, J., Mitre Campista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Springer International Publishing
6. "The Internet of Things: Key Applications and Protocols", Olivier Hersent, David Boswarthick, Omar Elloumi Wiley-Blackwell.
7. "Internet of things (IoT): Technologies, Applications, Challenges, and Solutions" Edited by B.K. Tripathy J. Anuradha, 2018, CRC Press,

Other Resources :

1. NPTEL Course: Introduction to Internet of Things By Prof. Sudip Misra, IIT Kharagpur:-Web link- https://nptel.ac.in/courses/106105166

IN-SEMESTER ASSESSMENT (50 MARKS)

1. **Continuous Assessment (20 Marks)**
   Suggested breakup of distribution
   Assignment on live problems/case studies:10 marks
   Technical Report Writing: 05 marks
   Attendance & Active Participation: 5 marks
2. **Mid Semester Exam (30 Marks)**
   Mid semester examination will be based on 40% to 50% syllabus

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
MDM	ECMDMS--7	IMAGE PROCESSING	04

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Exam (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

NIL

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO4: Conduct Investigations of complex problems
4. PO8: Individual and Collaborative Team work
5. PO9: Communication

Course Objectives:

1. To introduce learners to the concepts of image processing and basic analytical methods to be used in image processing.
2. To familiarize learners with different image enhancement techniques that can be applied to a given image for improving the quality of digital image required for an application.
3. To make the learners aware of discrete image transforms and comprehend the impacts and effects of image compression techniques.
4. To acquaint the learners with the proper procedure for segmenting images and demonstrate how image object can be described using image representation techniques.
5. To make the learners comprehend how to shape and reshape a given object in an image using morphological techniques over binary and grey scale images.

Module	Details	Hrs
00.	**Course Introduction** This is a MDM course which deals with fundamentals of image processing, various operations that can be performed on images and their applications.	**01**
01.	**Introduction to Image Processing** ***Learning Objective:*** *To make the learner summarize and apply the fundamentals of digital images.*	**07-09**
	Contents:	

	Image Fundamentals: Image Definition, Steps and Components of Image Processing, Image Sensing and Acquisition, Image Sampling and Quantization. **Relationship Between Pixels:** Adjacency, Connectivity and Distance.	
	Self-Learning Topics: *Different Image File Formats and Types of noise in image.*	
	Learning Outcomes : *A learner will be able to* *LO 1.1: Apply operations such as brightness adjustment, contrast enhancement, and color manipulation (P.I.-1.3.1)* *LO 1.2: Apply the basic steps and components involved in digital image processing for a given application. (P.I.-1.4.1)*	
02.	**Image Enhancement**	**10-12**
	Learning Objective/s: *To make the learner comprehend and use different techniques for enhancing digital images, ensuring clarity and quality improvement.*	
	Contents: **Point Processing Techniques:** Image Negative, Bit Plane Slicing, Gray Level Slicing, Contrast Stretching, Clipping, Thresholding, Dynamic Range Compression. **Mask Processing Techniques:** Filtering in Spatial Domain, Average Filter, Weighted Average Filter, Order Statistic Filter: Min, Max, Median Filter. **Histogram Processing:** Histogram Equalization and Specification.	
	Self-Learning Topics: *Application of Image Enhancement in Spatial Domain.*	
	Learning Outcomes : *A learner will be able to* *LO 2.1: Apply different Point Processing Techniques on a given image (P.I.-1.3.1)* *LO 2.2: Apply different Image enhancement techniques to a given image. (P.I.-1.4.1)* *LO 2.3: Differentiate between Contrast Stretching and Thresholding to select the best method for a given problem. (P.I.-2.2.4)* *LO 2.4: Apply different Image enhancement techniques. (P.I.- 2.4.1)* *LO 2.5: Identify appropriate image enhancement techniques to solve a given problem. (P.I.-4.1.2)* *LO 2.6:* Represent data graphically using histogram processing to facilitate analysis of data (P.I.- 4.3.3)	
03.	**Image Transforms**	**09-11**
	Learning Objective: *To provide learner with a comprehensive understanding of discrete transforms, their mathematical foundations, computational implementations, and practical applications in signal and image processing.*	
	Contents:	

	Discrete Fourier Transform: Transform Pair, Transform Matrix, Properties, Filtering in Frequency Domain. **Other Discrete Transforms:** Discrete Cosine Transform, Discrete Hadamard Transform, Discrete Walsh, Transform, Discrete Haar Transform. ***Self-Learning Topics:*** ***Application of Transforms in Steganography and CBIR.***	
	Learning Outcomes : *A learner will be able to* *LO 3.1: Compute the discrete Fourier and other Fourier transforms of a given image (P.I.-1.3.1)* *LO 3.2: Apply a given Image Transformation technique to a given image. (P.I.-1.4.1)* *LO 3.3: Apply different frequency domain filters to a given image. (P.I.- 2.4.1)* *LO 3.4: Identify appropriate image Transformation techniques to solve a given problem. (P.I.-2.1.2)*	
04.	**Image Compression**	**09-11**
	Learning Objective: *To make the learner familiarize with compression techniques to reduce file sizes while preserving image quality, and apply transformation methods for efficient image analysis and storage.*	
	Contents: Entropy, Redundancy and Types, Compression Ratio, Compression Methods. **Lossless Compression:** Run-Length Encoding, Huffman Coding, Arithmetic Coding, LZW Coding, Lossless Predictive coding. **Lossy Compression:** Fidelity Criterion, Improved Gray scale Quantization, Symbol-Based Coding, Bit-Plane Coding, Vector Quantization.	
	Self-Learning Topics: *DPCM, Block Transform Coding, JPEG compression.*	
	Learning Outcomes : *A learner will be able to* *LO 4.1: Compute the Huffman code of a given image (P.I.-1.3.1)* *LO 4.2: Apply the concept of Lossless and Lossy compression. (P.I.-1.4.1)* *LO 4.3: Identify appropriate image compression technique to solve a given problem. (P.I.-2.1.2)* *LO 4.4: Apply different Image compression techniques to compress a given image (P.I.- 2.4.1)*	
05.	**Image Segmentation and Representation**	**09-11**
	Learning Objective/s: *To make the learner master segmentation techniques to partition images into meaningful regions and extract features like texture and shape for analysis and classification purposes.*	

	Contents: **Image Segmentation:** Point, Line and Edge Detections Methods, Hough Transform, Graph Theoretic Method, Region Based Segmentation. **Image Representation:** Chain Codes, Shape Number, Polygon Approximation, Statistical Moments.	
	Self-Learning Topics: *Fourier Descriptors, Otsu Thresholding, Application in Number Plate Recognition.*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Compute the Chain Code and Shape Number of a given image (P.I.-1.3.1)* *LO 5.2: Apply the concept of Image Segmentation and representation. (P.I.-1.4.1)* *LO 5.3: Apply different Edge Detections Methods to detect the boundary of a given object. (P.I.- 2.4.1)* *LO 5.4: Select the appropriate image segmentation technique for a given image by comparing different methods. (P.I.- 2.2.4)* *LO 5.5: Select the appropriate image segmentation technique for a given problem statement and present the solution effectively in a team. (P.I.-2.1.2, 8.2.1, 9.2.2)* *LO 5.6: Select the appropriate image representation technique for a given problem statement and present the solution effectively in a team. (P.I.-2.2.4, 8.3.1, 9.3.1)*	
06.	**Morphological Image Processing**	**08-10**
	Learning Objective/s: *To make the learner gain a thorough understanding of morphological image processing, object recognition and classification and apply it to various applications of image processing.*	
	Contents: **Basic Morphological Methods:** Erosion, Dilation, Opening, Closing, Hit-or-Miss Transformation. **Advanced Morphological Methods:** Skeletonization, Thinning, Thickening, Pruning, Boundary Extraction. **Object Recognition and Classification:** Feature-based recognition, template matching, machine learning approaches. **Applications of Image Processing**: Medical imaging, satellite imaging, computer vision applications.	
	Self-Learning Topics: *Convolutional neural networks (CNNs) for image classification and segmentation.*	
	Learning Outcomes :	
	A learner will be able to *LO 6.1: Compute open and close morphological forms of a given image (P.I.-1.3.1)* *LO 6.2: Apply different morphological techniques to extract the features of a given image. (P.I.-1.4.1)* *LO 6.3: Apply different Morphological Methods. (P.I.- 2.4.1)*	

	LO 6.4: Select the appropriate Object Recognition and Classification technique for a given application. (P.I.- 2.2.4)	
	Course Conclusion	**01**
	Total	**60**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.3.1	Apply engineering fundamentals.
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem.
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem
2.2.4	Compare and contrast alternative solution/methods to select the best methods
2.4.1	Applies engineering mathematics to implement the solution.
4.1.2	Ability to choose appropriate procedure/algorithm, data set and test cases.
4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
9.2.2	Deliver effective oral presentations to technical and non-technical audiences
9.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations

Course Outcomes:
Learner will be able to

1. Apply the fundamentals of Image Processing. *(LO 1.1, LO 1.2)*
2. Select and apply image enhancement and image transformation techniques suitable for a given image. *(LO 2.1, LO 2.2, LO 2.3, LO 2.4, LO 2.5, LO 2.6, LO 3.1, LO 3.2, LO 3.3, LO 3.4)*
3. Apply different image processing methods to compress the image. *(LO 4.1, LO 4.2, LO 4.3, LO 4.4)*
4. Select and apply appropriate image segmentation and morphological methods to extract the features of image. *(LO 5.1, LO 5.2, LO 5.3, LO 5.4, LO 5.5, LO 5.6, LO 6.1, LO 6.2, LO 6.3, LO 6.4)*
5. Select and apply an appropriate image representation and image segmentation technique and present the solution effectively in a team. *(LO 5.5, LO 5.6)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECMDMS--7.1	3										
ECMDMS--7.2	3	3		3							
ECMDMS--7.3	3	3									
ECMDMS--7.4	3	3						3	3		
ECMDMS--7.5		3						3	3		
Average	**3**	**3**		**3**				**3**	**3**		

Text Books :

1. Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, 4th Edition, 2017, Pearson.
2. Digital Image Processing, William K. Pratt, 4th Edition, 2007, John Wiley & Sons.
3. Digital Image Processing, S. Jayaraman, S. Esakkirajan and T. Veerakumar, 2019, MC GRAW HILL INDIA.

Reference Books :

1. Digital Image Processing using MATLAB , Rafael C. Gonzalez and Richard E. Woods, 2003, Pearson Education.
2. Fundamentals of Digital Image Processing, Anil K. Jain, 1st Edition, 2015, Pearson India.
3. Digital Signal processing Principles, Algorithms and Applications, J. G. Proakis and D. G. Manolakis, 4th Edition, 2006, Pearson Publications.
4. Digital Image Processing and Computer Vision, Milan Sonka, 2nd Edition, 2007, Thomson publication.
.

Other Resources :

1. NPTEL Course: Digital Image Processing By Prof. Prabir Kumar Biswas, Department of Electronics and Electrical Communication Engineering, IIT Kharagpur.
Web link- https://onlinecourses.nptel.ac.in/noc21_ee78/
2. NPTEL Course: Image Processing using Python By Prof. Mrs. Bharati Patel; Dr. Dipti Verma, Department of Computer Science and Engineering, Swami Vivekananda Technical University, Bhilai. Web link- https://onlinecourses.swayam2.ac.in/nou23_cs15/
3. NPTEL Course: Computer Vision and Image Processing - Fundamentals and Applications By By Prof. M. K. Bhuyan,Department of Computer Science and Engineering, IIT Guwahati.
Web link- https://onlinecourses.nptel.ac.in/noc23_ee39/

A. IN-SEMESTER ASSESSMENT (50 MARKS)

1. Continuous Assessment (20 Marks)

Suggested breakup of distribution

a) One MCQ test as per GATE exam pattern / level : 05 Marks

b) Class Test : 05 Marks

c) Think-pair-share worksheets: 05 Marks

d) Regularity and active participation in class :05 Marks

2. Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

B. END SEMESTER EXAM (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20% to 30% weightage, and the syllabus covered from MSE to ESE carrying 70% to 80% weightage.

Course Type	Course Code	Course Name	Credits
MDM	ECMDMS--8	SMART ELECTRONIC SYSTEMS	04

Examination Scheme					
Distribution of Marks			Exam Duration (Hrs.)		Total Marks
In-semester Assessment		End Semester Examination (ESE)			
Continuous Assessment	Mid-Semester Exam (MSE)		MSE	ESE	
20	30	50	1.5	2	100

Pre-requisite :

1. ESL103: Programming Laboratory-II(C)
2. ESL205: Programming Laboratory-II(Java)
3. ECMDM3013: Electronics Components and Circuits

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO5: Modern tool usage
4. PO8: Individual and Team Work
5. PO9: Communication

Course Objectives :

1. To comprehend the basic concepts of AI & ML and apply them in electrical/electronic systems.
2. To comprehend strength and weakness of problem solving and search algorithms.
3. To know about basic concepts of knowledge, and reasoning in AIML applications.
4. To optimize the different methods of regression and classification.
5. To interpret working of different machine learning models and dimensionality reduction on data set.

Module	Details	Hrs.
	Course Introduction Artificial Intelligence (AI) and Machine Learning (ML) are transformative technologies reshaping industries and everyday life. AI refers to the simulation of human intelligence processes by machines, especially computer systems, encompassing a range of capabilities from learning and reasoning to problem-solving and language understanding. Machine Learning, a subset of AI, involves the use of algorithms and statistical models to enable computers to improve their performance on a task through experience. By analyzing vast amounts of data, ML models can identify patterns, make decisions, and predict outcomes with increasing accuracy. Together, AI and ML are driving innovations across various fields such as healthcare, finance, transportation, and entertainment, promising a future of smarter, more efficient systems.	**01**
01.	**Introduction** ***Learning Objective:*** *To comprehend basic AI&ML and mathematical concepts to engineering problems.*	**8**
	Contents: **Introduction to AI:**	

	Basic Definitions and terminology, Foundation and History of AI, Overview of AI problems, Evolution of AI, Applications of AI, Classification/Types of AI. Artificial Intelligence Vs Machine learning. Intelligent Agent, Types of AI Agent, Concept of Rationality, nature of environment, structure of agents. Turing Test in AI. ***Self-Learning Topics:*** *Applications of AI in Electrical Engineering domain.* ***Learning Outcomes:*** *A learner will be able to* *LO 1.1: Apply mathematical techniques such as calculus, linear algebra, and statistics to develop AIML systems and its elements. (PI-1.1.1)* *LO 1.2: Apply fundamental AI&ML concepts to engineering problems. (PI-1.3.1)*	
02.	**Problem Solving** ***Learning Objective:*** *To identify different AI search algorithms to solve engineering problems.* **Contents:** Search Algorithms in Artificial Intelligence: Terminologies, Properties of search Algorithms, Types of search algorithms: uninformed search and informed search, State Space Search **Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Best-first Search; Problem Reduction. Constraint Satisfaction problem:** Interference in CSPs; Back tracking search for CSPs; Local Search for CSPs; structure of CSP Problem. **Beyond Classical Search: Local search algorithms and optimization problem, local search in continuous spaces, searching with nondeterministic action and partial observation, online search agent and unknown environments.** ***Self-Learning Topics:*** *Real life applications of the different search algorithms discussed here.* ***Learning Outcomes:*** *A learner will be able to* *LO 2.1: Apply mathematical techniques such as calculus, linear algebra, and statistics to different search algorithms. (PI-1.1.1)* *LO 2.2: Apply fundamental concepts of different search algorithms and techniques to solve engineering problems. (PI-1.3.1)* *LO 2.3: Identify and apply appropriate search algorithm/technique to solve problems. (PI-2.1.2)* *LO 2.4: Compare performance of different search algorithms/techniques and select the moist suitable one for a particular AI application. (PI-2.2.4)*	**9**
03.	**Knowledge and Reasoning** ***Learning Objective:*** *Identify knowledge based agents and reasoning in AI application.* **Contents:** **Knowledge-Based Agent in Artificial intelligence:** Architecture, Approaches to designing a knowledge-based agent, knowledge representation: Techniques of knowledge representation, Propositional logic, Rules of Inference, First-Order Logic, Forward Chaining and backward chaining in AI,	**8**

	Reasoning in Artificial intelligence: Types of Reasoning and Probabilistic reasoning, Uncertainty. **Case Study Assignment:** AI in Electrical Engineering - Research & Discussion with report submission.	
	Self-Learning Topics: *To illustrate how theoretical concepts are applied in Real World AI applications.*	
	Learning Outcomes: *A learner will be able to* *LO 3.1: Apply advanced mathematical techniques to knowledge based AI agent and reasoning. (PI-1.1.2)* *LO 3.2: Apply fundamental concepts of knowledge based AI and reasoning to solve engineering problems. (PI-1.3.1)* *LO 3.3: Identify different techniques of knowledge representation and types of reasoning to solve problems. (PI-2.1.2)* *LO 3.4: Identify the mathematical knowledge required for knowledge representation and reasoning in AI application. (PI-2.1.3)* *LO 3.5: Identify different AIML software tools to adapt in Electrical/Electronic domain real world applications with the help of case study/research literature and submit report for the same as a team. (PI-5.1.1, 5.1.2, 8.2.1, 8.3.1, 9.1.1, 9.1.2)*	
04.	**Name of the Module** ***Learning Objectives:*** *Identify suitable ML technique/tool to solve engineering problems.*	**12**
	Contents: History of ML Examples of Machine Learning Applications, Learning Types, ML Life cycle, AI & ML, dataset for ML, Data Pre-processing, Training versus Testing, Positive and Negative Class, Cross-validation.	
	Self-Learning Topics: *To learn about the mathematics applied in ML technology and few real world examples.*	
	Learning Outcomes: *A learner will be able to* *LO 4.1: Apply advanced mathematical techniques to implement ML model. (PI-1.1.2)* *LO 4.2: Apply fundamental ML concepts to engineering problems. (PI-1.3.1)* *LO 4.3: Apply engineering mathematics and computations to solve ML models. (PI-2.4.1)* *LO 4.4: Identify and apply appropriate ML technique with suitable approximations and assumptions for engineering application. (PI-2.2.3)*	
05.	**Learning and Classification** ***Learning Objective/s:*** *Identify and apply learning methods and dimensionality reduction techniques. Also to understand binary and multiclass classification.*	**11**
	Contents: **Types of Learning:** Supervised, Unsupervised and Semi-Supervised Learning. Supervised: Learning a Class from Examples, Types of supervised Machine Learning Algorithms, Unsupervised: Types of Unsupervised Learning Algorithm, Dimensionality Reduction: Introduction to Dimensionality Reduction, Subset Selection, and Introduction to Principal Component Analysis. Classification: Binary and Multiclass Classification: Assessing Classification Performance,	

	Handling more than two classes, Multiclass Classification-One Vs One, One vs Rest.	
	Self-Learning Topics: *To summarize practical benefits and challenges of applying these learning methods and dimensionality reduction techniques in engineering applications.*	
	Learning Outcomes : *A learner will be able to* *LO 5.1: Apply mathematical techniques such as calculus, linear algebra, and statistics to solve Machine Learning problems using classification models. (PI-1.1.1)* *LO 5.2: Apply fundamental concepts of classification in machine learning techniques to solve engineering problems. (PI-1.3.1)* *LO 5.3: Identify suitable type of learning with justified approximations and assumptions in ML application. (PI-2.2.3)* *LO 5.4: Identify redundant features and perform dimensionality reduction on a data set to have lower number of variables. (PI-2.1.2)* *LO 5.5: Identify assumptions (mathematical and physical) necessary to implement classification models at the level of accuracy required. (PI-2.3.2)*	
06.	**Regression and Applications of AIML in Electronic Systems** ***Learning Objective/s:*** *To interpret regression techniques, their evaluation, and applications of AIML in Electronic Systems.*	**10**
	Contents: Regression: Assessing performance of Regression – Error measures, Overfitting and Underfitting, Catalysts for Overfitting, VC Dimensions. **Applications of AIML in Electronic Systems:** AI/ML in Circuit Design, Fault Diagnosis and Predictive Maintenance, Signal Processing, Power Management and Energy Efficiency, Embedded Systems and IoT, Intelligent Testing and Quality Assurance, Robotics and Automation, Smart Sensors and Actuators, Cybersecurity in Electronic Systems, Consumer Electronics, Renewable Energy Systems **Note: Case study assignments will be based on above areas of application of AIML in Electronic Systems.**	
	Self-Learning Topics: *Study Practical challenges and solutions in real-world classification and regression tasks, enhancing the applicability of theoretical knowledge. Applications of AIML in Electronic Systems.*	
	Learning Outcomes: *A learner will be able to* *LO 6.1: Apply mathematical techniques such as calculus, linear algebra, and statistics to implement regression models. (PI-1.1.1)* *LO 6.2: Apply fundamental concepts of regression techniques in ML to solve electrical/electronic engineering problems. (PI-1.3.1, 1.4.1)* *LO 6.3: Assess model performance accurately and understand the implications of various error measures. (PI-2.4.3)* *LO 6.4: Identify assumptions (mathematical and physical) necessary to implement regression models at the level of accuracy required. (PI-2.3.2)*	

	LO 6.5: Identify different AIML software tools to adapt in Electrical/Electronic domain real world applications with the help of case study/research literature and submit report for the same as a team. (PI-5.1.1, 5.1.2, 8.2.1, 8.3.1, 9.1.1, 9.1.2)	
	Course Conclusion Learning Artificial Intelligence and Machine Learning (AIML) provides a comprehensive understanding and skill set that can be applied across various industries and domains. Here are the expected outcomes of learning AIML: 1. **Comprehensive Knowledge:** Understanding of fundamental and advanced AI and ML concepts and techniques. 2. **Practical Skills:** Proficiency in implementing, training, evaluating, and deploying AI and ML models. 3. **Analytical Ability:** Enhanced data analysis, problem-solving, and model optimization skills. 4. **Industry Application:** Understanding of AI and ML applications across various industries and ethical considerations. 5. **Professional Growth:** Improved career opportunities, certifications, and leadership skills in AI and ML.	**01**
	Total	**60**

Performance Indicators:

P.I. No.	**P.I. Statement**
1.1.1	Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems.
1.1.2	Apply advanced mathematical techniques to model and solve engineering problems
1.3.1	Apply fundamental engineering concepts to solve engineering problems.
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4.1	Apply engineering mathematics and computations to solve mathematical models.
2.4.3	Identify sources of error in the solution process, and limitations of the solution.
5.1.1	Identify modern engineering tools such as computer-aided drafting, modelling and analysis; techniques and resources for engineering activities.
5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems.
8.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.1	Read, understand and interpret technical and non-technical information.
9.1.2	Produce clear, well-constructed, and well-supported written engineering documents.

Course Outcomes: A learner will be able to -

1. Apply various AI/ML algorithms and tools, including search algorithms, knowledge representation, reasoning methods, and machine learning models, to solve real-world engineering problems. *(LO 1.2, LO 2.2, LO 3.2, LO 4.2, LO 5.3, LO 6.2)*

2. Use advanced mathematical methods such as calculus, linear algebra, and statistics to implement AI and ML systems effectively. *(LO 1.1, LO 2.1, LO 3.1, LO 3.3, LO 3.4, LO 4.1, LO 4.3, LO 6.1)*
3. Identify and adapt AI/ML software tools to meet the specific requirements of engineering problems, considering practical constraints and approximations. *(LO 2.3, LO 3.5, LO 6.4, LO 6.5)*
4. Compare the performance of different AI and ML algorithms, including classification, regression, and search techniques, and select the most suitable one for specific applications. *(LO 2.4, LO 4.4, LO 5.1, LO 5.2, LO 5.5)*
5. Perform dimensionality reduction and optimize AI/ML models to improve computational efficiency and prediction accuracy in engineering applications. *(LO 5.4, LO 6.3)*
6. Implement intelligent systems in the electrical and electronic engineering domain by integrating AI/ML principles, addressing challenges such as fault diagnosis, predictive maintenance, energy management, and automation in a team. *(LO 6.1, LO 6.2, LO 6.3, LO 6.4, LO 6.5)*

CO-PO Mapping Table with Correlation Level

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECMDMS--8.1	3	2									
ECMDMS--8.2	3	3									
ECMDMS--8.3		3			3			3	3		
ECMDMS--8.4	3	3									
ECMDMS--8.5		3									
ECMDMS--8.6	3	3			3			3	3		
Average	3	2.8			3			3	3		

Text Books :

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, “Artificial Intelligence – Building Intelligent Systems”, PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), “Artificial Intelligence: A Modern Approach,” Third edition, Pearson, 2003.
5. Nils J. Nilsson, “Artificial Intelligence: A New Synthesis”, 1st Edition, Morgan-Kaufmann, 1998.
6. R. O. Duda, E. Hart, and D.G. Stork, “Pattern Classification”, Second Edition, John Wiley & Sons, Singapore, 2012.
7. Francois Chollet, “Deep Learning with Python”, Manning Publications, Shelter Island, New York, 2018.

Reference Books :

1. Elaine Rich, Kevin Knight, & Shivashankar B Nair, “Artificial Intelligence”, McGraw Hill, 3rd ed.,2017.
2. Patterson, “Introduction to Artificial Intelligence & Expert Systems”, Pearson, 1st ed. 2015.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH
5. Ethem Alpaydin, “Introduction to Machine Learning”, 3rd Edition, MIT Press, 2014.
6. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.

7. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.

8. Navin Kumar Manaswi, “Deep Learning with Applications using Python”, A press, New York, 2018.

Other Resources :

1. NPTEL Course: Artificial Intelligence and Machin Learning, Prof. Krishanu Biswas, IIT Kanpur https://onlinecourses.nptel.ac.in/noc24_ce107/preview.

IN-SEMESTER ASSESSMENT (75 MARKS)

Continuous Assessment - Theory-(20 Marks)

Case Study Assignments: 10 Marks
Flipped Classroom: 5 Marks
Regularity and Active Participation: 5 Marks

Mid Semester Exam (30 Marks)

Mid semester examination will be based on 40% to 50% syllabus.

END SEMESTER EXAMINATION (50 MARKS)

End Semester Examination will be based on syllabus coverage up to the Mid Semester Examination (MSE) carrying 20%-30% weightage, and the syllabus covered from MSE to ESE carrying 70%-80% weightage.

Course Type	Course Code	Course Name	Credits
MDL	ECMDLS--1	Microcontrollers & Embedded System Laboratory	01

Examination Scheme		
Continuous Assessment	**Practical /Oral**	**Total**
25	25	50

Pre-requisite:

1. ESL103 -Programming Laboratory-I(C)

Program Outcomes addressed:

1. PO2: Problem analysis
2. PO5: Engineering Tool Usage
3. PO8: Individual and Collaborative Team work
4. PO9: Communication
5. PO11: Life-long Learning

Course Objectives:

1. Familiarize the students with Assembly Language Programming of PIC microcontrollers.
2. Impart the skills for interfacing the microcontroller using Embedded C programming.

Module	Details	Hrs
	Course Introduction This course aims to provide hands-on experience with PIC microcontroller development boards and the various software tools used for programming and testing embedded systems.	
01.	***Learning Objective:*** **1.** ***To equip the knowledge and skill in selecting appropriate software tools, understanding the core concepts of opcodes and operands, and performing error debugging to effectively develop assembly language programs.***	**12**
	Content: Develop assembly language codes using MPLABIDE software for handling data transfer/arithmetic/logic/branching/compare/rotate operations.	
	Theme for conducting multiple experiments: 1. Build and execute simple Assembly language programs using MPLABIDE to demonstrate arithmetic/logic, data transfer, branching, rotate and compare instructions in PIC microcontroller.	
	Learning Outcomes: *A learner will be able to* *LO1.1: Identify relevant mathematical knowledge to write/execute assembly language programs using MPLABIDEv6.20. Additionally, use modern software tools to solve engineering problems, perform technical documentation and present the results as a team. (PI:2.1.2, PI:2.1.3, PI:9.1.2, PI:9.1.3, PI:5.1.1, PI:5.1.2, PI:8.2.1, PI:8.3.1)*	

02.	***Learning Objective/s:*** ***1. To enhance proficiency in embedded C programming and error debugging for interfacing PIC microcontrollers with their internal peripheral devices.***	**6**
	Content: Embedded C language programming, Configuring I/O ports, internal peripheral devices for different applications, Delay/counter program by using timer module of PIC18F, PWM generation by using CCP modules, USART module of PIC18F, voltage and current sensing by ADC module.	
	Theme for conducting experiment: 1. Build and execute embedded C programs for square wave generation /counter operation/ PWM generation/serial transmission/Voltage and current sensing. ***Learning Outcome:*** *A learner will be able to* *LO2.1 Use modern software tools/techniques to build embedded C language code for solving engineering problems and present the results individually or as a team. (PI:5.1.1, PI:5.1.2, PI:8.2.1, PI:8.3.1)* 2. Interface and configure the internal peripherals of the PIC18F microcontroller to enhance system functionality and performance. ***Learning Outcome:*** *A learner will be able to* *LO2.2 Identify the mathematical and other relevant knowledge to interface and configure the internal peripheral devices and present the results in the form of report. (PI:2.1.2, PI:2.1.3, PI:9.1.2, PI:9.1.3)*	
03.	***Learning Objective/s:*** ***1. To develop skills in embedded C programming and error debugging for interfacing PIC microcontrollers with external peripheral devices.***	**06**
	Content: Embedded C language programming for interfacing PIC with external peripheral devices like LED/LCD/DC Motor/Stepper Motor/7-segment LED display/Traffic Signal Controller. Registers associated for interfacing, selection of I/O ports, modular programming. Demonstration of interfacing a stepper motor with a PIC microcontroller using a PIC programmer.	
	Theme for conducting experiment: 1. Build and execute embedded C programs for interfacing LED/LCD/Stepper motor/DC motor/Traffic signal controller/7-segment display with PIC18F. ***Learning Outcome:*** *A learner will be able to* *LO3.1 Acquire the necessary knowledge and skills to use modern software tools/techniques for building embedded C language code for interfacing PIC with external peripheral devices, write technical documentation and present the results*	

	individually or as a team. (PI:2.1.2, PI:2.1.3, PI:5.1.1, PI:9.1.2, PI:9.1.3, PI:8.2.1, PI:8.3.1) 2. Interface and configure the external peripheral devices of the PIC18F microcontroller for real-life applications. ***Learning Outcome:*** *A learner will be able to* *LO3.2 Demonstrate the ability to engage in lifelong learning by applying PIC microcontrollers to real-life scenarios and adapting to emerging technologies in automation, IoT, and control applications using modern tools. (PI:11.2.2, PI:11.3.1, PI:5.1.2)*	
	Minimum 3 experiments from each module and one microcontroller based task for real-life applications.	

Performance Indicators:	
P.I. No.	**P.I. Statement**
2.1.2	Identify engineering systems, variables, and parameters to solve the problems
2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given Problem.
5.1.1	Identify modern engineering tools such as computer aided drafting, modelling and analysis; techniques and resources for engineering activities.
5.1.2	Adapt the tools and techniques to solve engineering problems.
8.2.1	Demonstrate effective individual and team operations in communication, problem solving, conflict resolution and leadership skills.
8.3.1	Present results as a team, with smooth integration of contributions from all individual efforts.
9.1.2	Produce clear, well-constructed, and well-supported written engineering documents.
9.1.3	Create flow in a document or presentation a logical progression of ideas so that the main point is clear
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.
11.3.1	Source and comprehend technical literature and other credible sources of information.

Course Outcomes:

Learner will be able to

1. Apply suitable software tools to develop and execute Assembly language programs for PIC microcontrollers and present the results as a team. *(LO1.1)*
2. Apply software tools to execute embedded C language programs for solving engineering problems and present the results in the form of report. *(LO2.1, LO3.1)*
3. Utilize relevant registers to interface the internal & external peripheral devices of the PIC18F microcontroller using software tools. (*LO2.2)*
4. Implement microcontroller based tasks for real-life applications using suitable software tools. *(LO3.2)*

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECMDLS--1.1					3			3			
ECMDLS--1.2					3				3		
ECMDLS--1.3		3			3						
ECMDLS—1.4					3						3
Average		3			3			3	3		3

Text Books:

1. Ramesh Gaonkar, "Fundamentals of Microcontrollers and Applications in Embedded Systems (with the PIC18 Microcontroller Family)", Penram International publications (Ind) Pvt. Ltd.
2. Ali Mazidi, Rolind D Mckinlay and Danny Causey , "PIC Microcontroller and Embedded Systems", Pearson Education ltd., 2015.
3. Han Way Huang, "PIC Microcontroller: An Introduction to Software and Hardware Interfacing", Cengage Learning, 2005.
4. Phil Lapsley, Jeff Bier, Amit Soham, Edward A. Lee, "DSP Processor Fundamentals: Architecture and features", Wiley-IEEE Press, 1997.

Reference Books:

1. Robert B. Reese, "Microcontroller from Assembly Language to C using PIC18FXX2", Davinci Engineering press.
2. Peatman,"Design with PIC microcontrollers, 1e", Pearson Education ltd., 2002.

Other Resources:

- NPTEL Course: **Microprocessors And Microcontrollers** By Prof. Santanu Chattopadhyay, Dept. of Electrical Engineering, IIT Kharagpur:- Web link- https://nptel.ac.in/courses/108/105/108105102/
- NPTEL Course: **Introduction to Embedded System Design** By Prof. Dhananjay V. Gadre, Prof. Badri N Subudhi, Dept. of Electrical Engg, Netaji Subhas University of Technology and IIT Jammu:- Web link- https://archive.nptel.ac.in/courses/108102169/

CONTINUOUS ASSESSMENT (25 Marks)

Suggested breakup of distribution

- Practical Exercises- 10 Marks
- Mock Practical I (Based on the experiments performed) - 5 Marks
- Microcontroller-based task for real-life applications - 5 Marks
- Regularity and active participation - 05 Marks

END SEMESTER ASSESSMENT (Oral Examination) (25 Marks)

- Students will be appearing for Oral examination in front of both Internal and External examiners.
- Two examiners, one Internal and one External will do the evaluation.

Course Type	Course Code	Course Name	Credits
MDL	ECMDLS--2	INTERNET OF THINGS LABORATORY	01

Examination Scheme		
Internal Assessment	**Practical & Oral**	**Total**
25	25	50

Prerequisite:

1. ESC103: Programming Laboratory -I (C)
2. ESCLC205: Java Programming Laboratory
3. ITSBL301: Python Laboratory
4. ECMDM4025 :Microcontroller & Embedded System

Program Outcomes addressed :

1. PO1: Engineering knowledge
2. PO2: Problem analysis
3. PO3: Design/development of solutions
4. PO4: Conduct investigations of complex problems:
5. PO5: Engineering tool usage
6. PO6: The Engineer and the World
7. PO7: Ethics
8. PO8: Individual and Collaborative team work
9. PO9: Communication
10. PO10: Project management and finance
11. PO11: Life-long learning

Course Objectives:

1. Familiarize students to the fundamental concept of IoT and guide them in setting up basic IoT environment.
2. Demonstrate and facilitate hands-on implementation of fundamental IoT tasks.
3. Assist students in Designing the problem solution as per the requirement analysis using sensors , while configuring and managing programming sensors and emulators.
4. Provide hands-on experience in creating and interfacing hardware with Mobile /Web Apps for remote data access .
5. Assist in analyzing data collected from different sensors , testing the mini project successfully and improvising the team building, communication and management skills of the students

Module	Detailed Contents	Hrs
00.	**Course Introduction** The objective of Internet of Things Laboratory course is to get practical knowledge of basics of sensors and to implement and verify various concept of IoT The course aims to develop a connected, secure, and smart Internet of Things (IoT) based platform, empowered with machine learning and data analytics, to address economic, social, and environmental, and business needs with development of various IoT applications.	--

01.	**Basic IoT setup with Arduino and ESP8266** *Learning Objective:* ***To make learner u**nderstand the fundamental concepts and significance of IoT, explore its interdisciplinary natuur, examine various application involving with implementing basic IoT setup.*	**02**
	Contents: Sensors, Actuators, Microcontrollers(Arduino uno, Rasberry Pi), embedded processors**.** **Task 1:** Connection of Arduino board with ESP8266 wifi module, interfacing Arduino with ESP8266 using AT commands like UART, CWMODE, CWLAP, CWJAP, CIPMUX, CIPSERVER, CIFSR. **Task 2:** Connecting Arduino to access-point with LAN/internet with static IP. Checking TCP connection with Arduino over LAN/internet.	
	Self-Learning Topic: *Node Structure: Different sensors, Sensing, Processing, Communication.* ***Learning Outcomes :*** *A learner will be able to* *LO 1.1: Design and implement an IoT system by interfacing an Arduino board with sensors and ESP8266, ensuring proper connectivity, integration, and functionality for real-world applications. (P.I-1.3.1, 1.4.1,2.1.2,2.4.2,3.3.1, 3.4.2,4.1.3, 5.1.1)* *LO 1.2: Develop and evaluate a basic IoT application using Arduino, integrating hardware components and analyzing system performance through software tools and data interpretation. (P.I-1.3.1, 1.4.1, 2.4.4, 4.3.1, 5.2.2)*	
02.	**Demonstrate the working of simple IoT task with Arduino** ***Learning Objective:*** *To make learner to identify hardware components and sensor configuration, as well as understand software requirements for basic implementation of an IoT Task using Arduino.*	**04**
	Contents: Investigation of Hardware requirements, Software requirements, Arduino Programming Language, required sensors, Arduino Uno Wired & Wireless connectivity, LCD commands, Serial Communication commands. **Task 3:** Write a IoT based Program on Arduino(Case study of LED control) Write a basic program (i.e. html code) in a PC for creating command buttons on a browser window. Write and upload the Arduino code for ON/OFF control of LED. Run the program of Arduino and give the browser based command to control the LED.	
	Self-Learning Topic: *Learn about other* ***Learning Outcomes :*** *A learner will be able to* *LO 2.1: Gain practical experience in configuring microprocessor, implement required processes supporting the installation process to solve a given problem (P.I.- 3.4.2, 4.1.3,5.1.1).*	
03.	**Formulation of Problem statement , Gathering requirement analysis and Design of circuitry** ***Learning Objective/s:***	**02**

	To make learner understand Design your own circuit board using multiple sensors etc.	
	Task 4: The students may visit different websites, IEEE and other standard papers, to identify their IOT topic with abstract considering the concept, importance, challenges and carry out appropriate literature survey and requirement analyses. **Task 5:** Design the circuit board using multiple sensors and other hardware and physically connect components using breadboard as per requirement analysis .	
	Self-Learning Topic: *Each components technical details* ***Learning Outcomes:*** *The learner will be able to* *LO 3.1: Apply engineering fundamentals to conduct a literature survey, analyze IoT problem statements, and gather requirements for designing an effective IoT solution. (P.I.- 3.1.1,3.2.1,4.1.1,4.3.1,11.3.1)* *LO 3.2: Utilize IoT principles to design and develop a circuit board using multiple sensors and hardware components, ensuring proper integration and functionality. (P.I.- 3.2.1, 3.3.2, 3.4.2,4.1.3,5.1.1,5.2.2)*	
04.	**System Interfacing and Emulation** ***Learning Objective:*** *To make learner understand install, configure and manage your sensors in such a way so that they can communicate with each other.*	**06**
	Task 6: To study and Implement Contiki OS : History of Contiki OS, Applications, Features, ,Communication Components in Contiki OS **Task7:** To study and Implement interfacing the Contiki OS with the Cooja simulator and to program the IoT for broadcasting data from sensor	
	Self-Learning Topics: *Learn about blynk application, AWS IoT Application, Google cloud IoT Core Application* ***Learning Outcomes:*** *The learner will be able to* *LO 4.1: Work with the Contiki operating system to configure and program input devices on sensors, utilizing modern tools and techniques for system interfacing. (P.I.- 3.4.2 ,4.1.3,5.1.1, 5.2.2)* *LO 4.2: Implement and interface Contiki OS with the Cooja simulator to enable sensor data broadcasting, demonstrating competence in employing modern development tools for IoT applications. (P.I.- 3.3.1, 3.4.2, 4.1.3,4.3.1,5.1.1,5.2.2)*	
05.	**User interfacing and Data analysis of IoT data on Cloud** ***Learning Objective:*** *To make learner create and interface the hardware using Mobile/Web to remotely access the data on Internet, analysis of data and report findings.*	**08**
	Task 8: Create an interface using Mobile/Web to publish or remotely access the data on the Internet. **Task 9:** Analyze the collected IoT data from different sensors on platform like Blynk/thinkspeak/AWS/Azure.	

	Self-Learning Topics: Study of data analysis software ***Learning Outcomes:*** *The learner will be able to* *LO 5.1: Build and integrate a user interface on a mobile or web application to remotely access and publish IoT data on the Internet, ensuring seamless connectivity and usability. (P.I.- 3.3.1,3.4.2, 5.1.1, 5.2.2)* *LO 5.2: Analyze IoT data collected from various sensors using platforms like Blynk, Thinkspeak, AWS, or Azure, leveraging modern tools for data processing, visualization, and performance evaluation. (P.I.- 2.4.2, 2.4.4, 5.3.1, 5.1.1, 5.2.1)*	
06.	**Implementation of Mini project** ***Learning Objective:*** *To make learner implement a complete IoT application with analysis of data.* **Task 10:** To test and implement the IoT application successfully in real world.	**08**
	Self-Learning Topics: *Any case study: Design network for any scenario as per users requirement.* *Learning Outcomes:* *The learner will be able to* *LO 6.1: Successfully test and deploy an IoT application, ensuring its real-world functionality by addressing security, privacy, and accessibility concerns while adhering to ethical and societal standards. Additionally, demonstrate effective teamwork, project management, and problem-solving skills, including resource allocation and evaluation of economic and financial feasibility. (P.I.- 3.3.1, 3.2.2, 6.1.1, 6.3.1, 7.1.1, 7.2.2, 8.1.1, 8.2.1, 9.1.2, 9.2.1, 10.2.1, 10.3.1, 11.2.1,11.3.1)*	
	Total	**30**

Performance Indicators:

P. I. Number	**P. I. Statement**
1.3.1	Apply engineering fundamentals.
1.4.1	Apply theory and principles of computer science engineering to solve an engineering problem.
2.1.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem.
2.4.2	Analyse and interpret the results using contemporary tools.
2.4.4	Arrive at conclusions with respect to the objectives.
3.1.1	Able to define a precise problem statement with objectives and scope
3.2.1	Ability to explore design alternatives.
3.3.1	Ability to perform systematic evaluation of the degree to which several design concepts meet the criteria.

3.3.2	Consult with domain experts and stakeholders to select candidate engineering design solution for further development
3.4.2	Ability to implement and integrate the modules.
4.1.1	Define a problem for purposes of investigation, its scope and importanc
4.1.3	Ability to choose appropriate hardware/software tools to conduct the experiment.
4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.
5.2.2	Demonstrate proficiency in using discipline specific tools
6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level .
6.3.1	Identify risks/impacts in the life-cycle of an engineering product or activity.
7.1.1	Identify situations of unethical professional conduct and propose ethical alternatives.
7.2.2	Examine and apply moral & ethical principles to known case studies .
8.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team.
8.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills.
9.1.2	Present results as a team, with smooth integration of contributions from all individual efforts.
9.2.1	Listen to and comprehend information, instructions, and viewpoints of others
10.2.1	Analyze and select the most appropriate proposal based on economic and financial considerations.
10.3.1	Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.
11.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current.
11.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.

Course Outcomes:

Learner will be able to:

1. Apply fundamental IoT concepts by interfacing an Arduino board with hardware components and establishing network connectivity using ESP8266. *(LO1.1, LO1.2)*
2. Develop and implement basic IoT tasks using Arduino, including hardware configuration and programming for simple IoT applications. *(LO2.1)*

3. Conduct requirement analysis, literature survey, and design circuitry for IoT-based problem-solving by integrating multiple sensors and hardware. *(LO3.1)*

4. Demonstrate system interfacing and simulation using Contiki OS and Cooja, enabling sensor data broadcasting and communication. *(LO4.1, LO4.2)*

5. Develop a user interface for IoT data visualization and analysis on cloud platforms and Successfully implement, test, and deploy an IoT mini-project, addressing real-world challenges while ensuring ethical considerations, teamwork, and project management*(LO5.1, LO5.2, LO6.1)*

CO PO Mapping:-

CO ID	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ECMDLS--2.1	3	3									
ECMDLS--2.2	3	3									
ECMDLS--2.3	3	3	3								
ECMDLS--2.4	3			3	3						
ECMDLS--2..5		3	3		3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3

Text Books:

1. Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann ,"Interconnecting Smart Objects with IP: The Next Internet" O'Reilly ISBN: 9780123751652, 1st Edition - June 1, 2010.
2. Adrian McEwen (Author), Hakim Cassimally" .Designing the Internet of Things" ,Wiley publication, ISBN: 978-1-118-43062-20,November 2013.
3. Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers," Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems" River Publishers , **ISBN:** 9788792982735-June 2013
4. Vijay Madisetti , Arshdeep Bahga," Internet of Things (A Hands-on-Approach) , Universities Press, , **ISBN:** 9788173719547-June 2015.

Reference Books:

1. Zach Shelby, Carsten Bormann ,"6LoWPAN: The Wireless Embedded Internet" Wiley, ISBN: 9781119965343-August 2011.
2. Daniel Minoli John Wiley & Sons ,"Building the internet of things with ipv6 and mipv6, The Evolving World of M2M Communications" , Wiley, ISBN: 978-1-118-64705-9-June 2013.
3. S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, " Fundamentals of Sensor Network Programming: Applications and Technology" Wiley publication, ISBN: 978-0-470-87614-5,December 2010.

Other Resources:

1. IoT Analytics –Things https://thingspeak.com
2. Emulator Tutorial: Web Link- https://www.contiki-ng.org/

3. Web Link- . http://www.ideationinstru.com/training.htm

NPTEL Course:

1. Internet of Things by Prof. Sudip Misra , IIT Kharagpur

   Web Link- https://onlinecourses.nptel.ac.in/noc22_cs53/preview

2. Internet of Things by Prof. Prabhakar T V , IIT Kharagpur, IISc Bangalore

   Web Link- https://onlinecourses.nptel.ac.in/noc21_ee85/preview

A. IN SEMESTER ASSESMENT (25 Marks)

Lab Experiments orals: 10 Marks

Mini Project Evaluation :10 marks

(Problem statement evaluation, presentation of project, demo of project, team work, active involvement during practical): 10 marks

Attendance: 5 marks

B. END SEMESTER ASSESSMENT (Practical and Oral Exam) (25 Marks)

Presentation and Demo of Miniproject: 10 Marks

Results and discussion, Inferences drawn: 05 Marks

Oral Test:10 Marks

Practical & Oral Exam: Practical and oral exam of 25 marks will be held based on the above syllabus.

Two examiners, one Internal and one External will do the evaluation.