School of Electrical and Electronics Engineering
Department of (Electronics Engineering)
Electronics and Computer Science

Multidisciplinary Minor (MDM) Track-2: IoT for Environmental Sustainability

Sr. No.	Semester	Course Code	Course Name	Offered To (Name of the Department)
1	III	24EE01TH0305-2	Introduction to IoT system Design	All - CSE, EC, EE, BME
2	IV	24EE01TH0405-2	Programming for Environmental IoT	All -CSE, EC, EE, BME
3	V	24EE01TH0505-2	IoT Privacy and Security	All -CSE, EC, EE, BME
4	VI	24EE01TH0605-2	Use cases of Environmental IoT	All -CSE, EC, EE, BME

Multidisciplinary Minor (MDM) Track-2: IoT for Environmental Sustainability

Course Code	**24EE01TH0305-2**			
Category	**MDM-1**			
Course Title	**Introduction to IoT system Design**			
Scheme & Credits	**L**	**P**	**Credits**	**Semester**
	3	**0**	**3**	**III**

Course Outcomes

1. Understand the IoT reference Model and different element used in it.
2. Apply the understanding in identifying the element used in IoT
3. Analyze the role of different elements in IoT as a system in different use cases;
4. Propose a solution to a real-world problem using the IoT framework
5. Evaluate the engineering feasibility of the solutions'/ Use cases;

Module 1: Introduction to Internet of Everything, IoT Reference Model, Different IoT models, Elements in IoT Infrastructure
Module 2: IoT Infrastructure Elements and their roles at Different Layer in IoT Reference Model, Devices/ Function of elements in IoT Sensors, Controllers, Network, Cloud, User Applications and Data Analytics
Module 3: Perception Layer, Network Layer, Application Layer Architecture in IoT system
Module 4: Resources used at Perception Layer, Network Layer, Application Layer
Module 5: Use cases of IoT Systems builds across SAM IoT/ Arduino Nano IOT/ ESP32 / Node MCU/ PI-PICO H/W variants etc,

Text Book:

1. Internet of Things Principles and Paradigms, Rajkumar Buyya Amir Vahid Dastjerdi, Morgan Kaufman, Elsevier 2016 1st Edition

Reference Books:

1. Internet of Things Principles, Paradigms and Application of IoT, Joseph Kofi Wireko, Kaml Hiran, BPB Publications 2020 1st Edition
2. Microchip SAMIoT Application notes
3. Arduino NanoBLE/ Nano 33IoT Application notes
4. Espressif Application notes ESP32/ESP8266/Node MCU
5. Raspberry Pi- PICO application notes

Multidisciplinary Minor (MDM) Track-2: IoT for Environmental Sustainability

Course Code	**24EE01TH0405-2**			
Category	**MDM-2**			
Course Title	**Programming for Environmental IoT**			
Scheme & Credits	**L**	**P**	**Credits**	**Semester**
	3	**0**	**3**	**IV**

Course Outcomes

1. Explain the fundamental principles, classifications, and performance parameters of environmental sensors including sensitivity, specificity, accuracy, and linearity.
2. Differentiate between various types of actuators and describe their roles and complementary functions alongside sensors in environmental monitoring systems.
3. Demonstrate the ability to interface digital and analog sensors and actuators with Raspberry Pi, including push-buttons, displays, and cameras for environmental applications.
4. Develop environmental monitoring applications using ESP8266 by interfacing sensors, actuators, and peripherals, while implementing debouncing and edge detection.
5. Build and optimize IoT-based dashboards for remote environmental data visualization, while handling errors, reducing power and data usage, and ensuring reliable data transmission.

Module 1: Sensors for Environmental Monitoring

Classification of Sensors, Sensitivity, Specificity, Range, Precision, Accuracy and Resolution, Threshold and Linearity/non-Linearity

Module 2: Actuators for Environmental Monitoring

Definition and role of actuators in IoT, Types of actuators: electrical, mechanical, hydraulic, pneumatic, Actuators vs sensors: complementary functions

Module 3: Interfacing with Raspberry Pi

Understanding GPIO pins, Input/Output configuration, push-button interface, Debouncing and edge detection, Interfacing digital and analog sensors, actuators, display, camera for environmental applications

Module 4: Interfacing with ESP8266

Understanding GPIO pins, Input/Output configuration, push-button interface, Debouncing and edge detection, Interfacing digital and analog sensors, actuators, display, camera for environmental applications

Module 5: Displaying Sensor Data Remotely

Creating real-time dashboards on IoT platform, Triggering alerts or event, Error Handling and Optimization: Reconnecting on failure, Minimizing power and data usage, Data transmission intervals and timing.

Text Books:

1. Raspberry Pi for Python Programmers Cookbook, Tim Cox, Packt Publishing Limited; 2nd Revised edition, 2016.
2. Espressif Application notes ESP32/ESP8266/Node MCU

Reference Books:

1. Internet of Things Principles, Paradigms and Application of IoT, Joseph Kofi Wireko, Kaml Hiran, BPB Publications 2020 1st Edition
2. Raspberry Pi User Guide, EbenUptonand Gareth Halfacree, John Wiley& Sons, 2016.

Multidisciplinary Minor (MDM) Track-1: Integrated Circuit Design (IC design)

Sr. No.	Semester	Course Code	Course Name	Offered To (Name of the Department)
1	III	24EE01TH0305-1	Basics of Chip Design using Verilog HDL	All - CSE, EC, EE, BME
2	IV	24EE01TH0405-1	MIPS Processor Design and Testing	All -CSE, EC, EE, BME
3	V	24EE01TH0505-1	Chip Verification using System Verilog	All -CSE, EC, EE, BME
4	VI	24EE01TH0605-1	VLSI Physical Design	All -CSE, EC, EE, BME

Multidisciplinary Minor (MDM) Track-1: Integrated Circuit Design (IC design)

Course Code	**24EE01TH0305-2**			
Category	**Multidisciplinary Minor -1**			
Course Title	**Basics of Chip Design using Verilog HDL**			
Scheme & Credits	**L**	**P**	**Credits**	**Semester**
	3	**0**	**3**	**III**

Course Outcomes:

Upon completion of this course, students will demonstrate the ability to:

1. Realize the digital systems using Verilog HDL
2. Apply the testing strategies using HDL
3. Write a synthesizable HDL code for EDA tools
4. Analyze the timing issues in digital systems
5. Implement the digital systems on FPGA platforms.

Syllabus:

Module I (6 Hrs):

Digital System Design Flow, FPGA Architecture, Introduction to FPGA Development Board, Introduction to HDL, Basic Language Elements, Syntax and Semantics of HDL

Module II (8 Hrs):

Gate level, Dataflow and Behavioral Modeling for combinational circuits like Multiplexer, De-multiplexer, Encoder-Decoder, Flip-Flop, Counter, Writing Test

Benches and Handling Text files to test the Circuits.

Module III (6 Hrs):
Design and Analysis of Standard Combinational Blocks, Algorithm to Architectural Translation for Arithmetic Circuits-Adders, Subtractor, Multiplier, Divider, Shifter, ALU and Comparator

Module IV (6 Hrs):
Design and analysis of standard sequential blocks, Finite State Machine Design.

Module V (6 Hrs):
Design of Data Path and Control unit with Case Studies.

Module VI (6 Hrs):
Logic Synthesis and Optimization Techniques for Area, Power and Delay, Timing analysis-Setup and Hold Violations, Synthesis of HDL code on FPGA platforms, Concepts of Critical Path Delay

Text Book:

1. Verilog HDL: A Guide to Digital Design and Synthesis; Samir Palnitkar, Prentice Hall PTR; 2nd Edition

2. Fundamentals of Digital Logic with Verilog; Stephen Brown and ZvonkoVranesic; McGraw Hill, 2nd Edition

Reference Books:

1. Digital Systems Design Using Verilog; Charles Roth, Lizy K. John, ByeongKil Lee; Cengage Learning 2nd Edition

2. A Verilog HDL Primer: J Bhaskar; Star Galaxy Publishing; 2nd Edition.

Multidisciplinary Minor (MDM) Track-2: Integrated Circuit Design (IC design)

Course Code	**24EE01TH0405-1**			
Category	**Multidisciplinary Minor -2**			
Course Title	**MIPS Processor Design and Testing**			
Scheme & Credits	**L**	**P**	**Credits**	**Semester**
	3	**0**	**3**	**IV**

Course Outcomes:

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

1. Understand the architecture and working of a single-cycle and multi-cycle MIPS processor, including the data path and control path design.
2. Design individual components of the MIPS processor in Verilog HDL and integrate them into a complete processor.
3. Implement and simulate the MIPS data path and control unit in Verilog HDL on FPGAs.
4. Develop testbenches in Verilog HDL to verify the functionality of individual modules and the integrated processor.
5. Perform step-by-step debugging and testing of a MIPS processor using waveform analysis and behavioral simulation.

Syllabus:

Module-I: Introduction to MIPS Processor and Design Flow

Introduction to computer system and its sub modules, Introduction to RISC and CISC paradigm, overview of the MIPS Instruction Set Architecture (ISA), registers, instruction formats, and addressing modes, single-cycle and multi-cycle execution, breakdown of the MIPS data path into instruction fetch, decode, execute, memory, and writeback stages.

Module-II: Designing the MIPS ALU and Register File
Hardware modeling for Arithmetic and logical operations performed by the MIPS ALU, implementation of a register file, testbench creation for verifying the ALU and register file operations.

Module-III: Instruction Fetch and Decode Stage Implementation
The instruction fetch stage, design of program counter (PC) and instruction memory components, instruction decode stage, generation of control signals, Integration of the instruction memory with the register file.

Module-IV: Execution, Memory, and Writeback Stages
Implementation of the execution stage, ALU operation and branching logic, memory access stage, design of control logic for load store instructions, implementation of write back stage, testing of R-type, I-type, and J-type instructions using data and control path.

Module-V: Integration and Testing of Single-Cycle MIPS Processor
Assembling the complete single-cycle MIPS processor, develop a complete Verilog testbench for the entire processor, run test programs, and debug issues that arise during simulation, analyze timing diagrams and waveforms using simulation tools.

Module-VI
Overview of Pipelining and Parallel processing concepts, multiprocessors and its characteristics, Input/Output Subsystem:-Interfaces and buses, I/O Operations, Designing I/O Systems, Overview of Domain-Specific Architectures

Text Books:

1. Computer Organization and Design Edition - The Hardware/Software Interface, David A. Patterson, John L. Hennessy, 5^{th} Edition, 2014.

Reference Books

1. Computer Architecture and Organization; J. P. Hayes; Third Edition (Fifth Reprint), McGraw Hill, 2012.
2. Computer Architecture And Parallel Processing; Kai Hawang, Faye A. Briggs, McGraw Hill, 2012