



Bharatiya Vidya Bhavan's

# Sardar Patel Institute of Technology

(Empowered Autonomous Institute Affiliated to University of Mumbai)  
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

## Syllabi for Multidisciplinary Minors (M.D.M.)

### W. E. F. 2023-27 Batch

#### Abbreviations

L	Lecture Hour	O	Other Work (Self Study)
T	Tutorial Hour	E	Total Engagement in Hours
P	Laboratory Hour	C	Credit Assigned



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## M.D.M. Offered by EXTC Department for students of CSE and CE

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VII)
Industrial IoT	<b>M011:</b> Introduction to Internet of Things	<b>M012:</b> Embedded "C" and Micro Python for IoT	<b>M013:</b> Communication Protocol for IoT	<b>M014:</b> IoT Applications and Analytics
Signal Processing	<b>M021:</b> Digital Signal Processing	<b>M022:</b> Digital Image Processing	<b>M023:</b> Multimedia Signal Processing	<b>M024:</b> Digital Signal Processor System Design
Electronics Communication	<b>M031:</b> Linear Electronics Circuit	<b>M032:</b> Principles of Communication & Systems	<b>M033:</b> Data Compression and Encryption	<b>M034:</b> Wireless Communication and Networks
VLSI	<b>M041:</b> Hardware Description Language	<b>M042:</b> Basic CMOS VLSI Design	<b>M043:</b> Advanced VLSI Design	<b>M044:</b> ASIC Verification



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## **MDM-01**

### **Industrial IoT**

### **For CE/CSE**



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-01	Fundamentals of Internet of Things	3	0	0	4	8	2	0	0	3
		Examination Scheme					Component	ISE (%)	MSE (%)	ESE (%)
M011		Theory		20	20	60	100			
		Laboratory		-	--	-	-			

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b> This course provides an in-depth understanding of the Internet of Things (IoT), covering its definition, impact, convergence of Information Technology (IT) and Operational Technology (OT), challenges, architecture, data management, and compute stack. It also explores the role of sensors, transducers, smart objects, and computational units in IoT.	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M011.1	Demonstrate basic concepts, principles, and challenges in IoT
M011.2	Classify various sensing devices and actuator types used in the IoT domain
M011.3	Apply Computation and Communication Technologies for various real-life applications
M011.4	Illustrate IoT infrastructure for various IoT use cases

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M011.1	2	2	2									
M011.2	2	2	2									
M011.3	2	2	2									
M011.4	2	2	2	2								

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze @	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	<b>Title</b>	<b>Introduction to IoT</b>		5
		Definition and fundamentals of IoT, Historical background and evolution, Impact of IoT on various industries, Convergence of IT and OT in IoT	1,2	
2	<b>Title</b>	<b>IoT Challenges and Opportunities</b>		5
		Key challenges in implementing IoT solutions, Security and privacy concerns, Scalability and interoperability issues, Opportunities and potential applications of IoT.	1,2,3	
3	<b>Title</b>	<b>IoT Architectures</b>		5
		Overview of OneM2M IoT architecture, Introduction to IoT World Forum (IoTWF) architecture, Comparison of different IoT architectures Case studies of real-world implementations	1,2	
4	<b>Title</b>	<b>IoT Data Management and Compute Stack</b>		5
		Importance of data management in IoT, Overview of IoT data lifecycle Introduction to compute stack in IoT, Edge computing vs. cloud computing in IoT	1,2	
5	<b>Title</b>	<b>Layer-1 Things in IoT: Sensors and Transducers</b>		9
		Introduction to Signals and Systems. Types of sensors and transducers used in IoT, Working principles and functionalities, Examples of sensor applications in different domains, Challenges and advancements in sensor technology	1,2	
6	<b>Title</b>	<b>Things in IoT: Smart Objects</b>		4
		Definition and characteristics of smart objects, Role of smart objects in IoT ecosystem, Interoperability standards for smart objects, Case studies of smart object deployments	1,2,3	
7	<b>Title</b>	<b>Things in IoT: Computation and Communication Units</b>		9
		Introduction to Computational Units in IoT, Microcontrollers vs. microprocessors, Embedded Systems and their Applications. Need For Communication Interfaces, Serial & Parallel, I2C/ CAN Controller Area Network) – SPI (Serial Peripheral Interface) – Serial UART, MODBUS, HART, SCADA. Introduction to Programming using Microcontrollers Sensors and Actuators.	1,2	
8	<b>Self-Study</b>	Practical Applications: Design and implementation of IoT solutions, solving industry-specific use cases: Manufacturing, Healthcare, Retail, Autonomous vehicles, Supply chain management, Smart Agriculture, Smart City, Tracking and monitoring livestock. Discussion on future trends and directions in IoT.	1,2,3	4*
			<b>Total</b>	<b>42</b>



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## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Internet of Things-A Hands-On Approach	First	Arshdeep Bahga, Vijay Madiseti	University Press	2015
2	Internet of Things: Architecture and Design Principles	First	Raj Kamal	McGraw Hill Education	2017
3	Introduction to Industrial Internet of Things and Industry 4.0	First	Sudip Misra, Chandana Roy, Anadarup Mukherjee	CRC Press	2021

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence	First	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnoukos, David Boyle	Academic Press	2014
2	The Internet of Things key applications and protocols	First	Olivier Hersent, David Boswarthick, Omar Elloumi	Wiley	2012
3	Designing the Internet of Things	-	Adrian McEwen	Wiley	2013

## Online references:

1. <https://nptel.ac.in/courses/106/105/106105166/>
2. <https://nptel.ac.in/courses/108/108/108108098/>
3. <https://nptel.ac.in/courses/106/105/106105195/>
4. <https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs31/>
5. [https://onlinecourses.nptel.ac.in/noc21\\_cs17/preview](https://onlinecourses.nptel.ac.in/noc21_cs17/preview)
6. <https://nptel.ac.in/courses/108108147>
7. <https://www.mooc-list.com/tags/wearable-technology>



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-01	Embedded "C" and Micro Python for IoT	2	--	2	5	9	2	--	1	3
		Examination Scheme								
Component		ISE		MSE		ESE		Total		
Theory		20		20		60		100		
M012		Laboratory		80		--		20	100	

<b>Pre-requisite Course Codes, if any.</b>	CS101: Problem Solving using Imperative Programming EC101: Digital Systems and Microprocessors EC201: Computer Architecture and Organization
<b>Course Objective:</b> To impart students the fundamentals of Embedded "C" programming and Micro Python scripting for building IoT solutions, covering device driver creation, debugging, and optimization.	
<b>Course Outcomes (CO):</b> After successful completion of the course, student will be able to	
M012.1	Demonstrate Proficiency in Embedded "C" Programming and Micro Python
M012.2	Understand Embedded Systems Concepts and Architecture
M012.3	Develop Device Drivers and Hardware Abstraction Layers (HALs)
M012.4	Apply Embedded "C" and Micro Python for IoT Applications
M012.5	Implement Networking Protocols and Communication:

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M012.1	2	2	2	2	2							
M012.2	2	2	2	2								
M012.3	2	2	2	2	2							
M012.4	2	2	2	2	2							
M012.5	2	2	2	2	2							



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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	<b>Title</b>	<b>Embedded C Programming:</b>		06
	1.1	<b>C Fundamentals:</b> Data types, variables, operators, expressions, Conditional Compilation, Functions, function calling, parameter passing, arrays, string, pointers, Bit Operations - Packaging data, unpacking data, bit manipulations, storage classes.	1	
	1.2	<b>Memory Management in Embedded Systems:</b> Stack and heap memory, Memory allocation techniques Introduction to Integrated Development Environments (IDEs) for embedded systems, Compilers, debuggers, and simulators for embedded C	1, 2	
2	<b>Title</b>	<b>Input/Output (I/O) Operations:</b>		08
	2.1	Interfacing with peripherals: GPIO (General Purpose Input/Output), UART (Universal Asynchronous Receiver-Transmitter), SPI (Serial Peripheral Interface), I2C (Inter-Integrated Circuit), Analog-to-digital converters (ADC). Digital to Analog converters (DAC).	1,2	
	2.2	Using libraries for device drivers and hardware abstraction.	1,2	
	2.3	Interrupts and Timers: Interrupt handling mechanisms, Timer programming for real-time applications	1,2	
3	<b>Title</b>	<b>Introduction to Micro Python:</b>		06
	3.1	Overview of Micro Python and its features. Syntax, data types, variables, operators, Functions, modules, libraries Lists, tuples, dictionaries, and sets. Control flow: loops, conditionals, and exceptions in Micro Python Setting up Micro Python environment for embedded development.	4	
	3.2	Python for Data Analysis: Introduction to libraries like NumPy and pandas for data manipulation and analysis, Working with sensor data collected from IoT devices	4	
	3.3	Python for Web Development and APIs: Basics of web development using frameworks like Flask or Django (optional)	4	
4	<b>Title</b>	<b>Micro Python for IoT Applications</b>		06
	4.1	Interfacing with peripherals using Micro Python. Writing scripts for sensor data acquisition and control.	3,4	
	4.2	Networking protocols and communication in Micro Python. Implementing MQTT, HTTP, or other IoT protocols in Micro Python.	3,4	





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	<b>4.3</b>	Data Processing with Python: Data preprocessing techniques for IoT data. Handling real-time and streaming data in Python. Data Visualization in Python: Introduction to data visualization libraries like Matplotlib and Seaborn. Visualizing IoT data for analysis and insights.	3,4	
<b>5</b>	<b>Title</b>	<b>Case Studies in Embedded Systems and IoT</b>		<b>02</b>
		Exploration of real-world case studies and applications of embedded systems and IoT like <b>Smart Home Automation System, Industrial IoT (IIoT) Monitoring and Control System, Healthcare Monitoring Wearables, Smart Agriculture Solutions, Vehicle Tracking and Fleet Management, Energy Management Systems</b>	3	
			<b>Total</b>	<b>28</b>

## Laboratory Component

Sr. No.	Title of the Experiment
1	<b>Blinking LED (Hello World!!! Program):</b> Write a program to blink an LED connected to a GPIO pin of the microcontroller. Experiment with different blinking patterns (e.g., Morse code) by controlling the timing and sequence of GPIO operations.
2	<b>Push Button and LED Interaction:</b> Interface a push button and an LED to the microcontroller. Write a program to toggle the LED state when the button is pressed or released.
3	<b>Serial Communication:</b> Establish serial communication (UART) between the microcontroller and a computer. Write programs to send and receive data packets over UART, such as sending sensor readings or receiving commands.
4	<b>PWM Output:</b> Generate PWM (Pulse Width Modulation) signals using the microcontroller. Control the brightness of an LED or the speed of a motor using PWM output.
5	<b>Analog-to-Digital Conversion (ADC):</b> Interface an analog sensor (e.g., temperature sensor, light sensor) to the microcontroller. Write a program to read analog sensor values using the built-in ADC and display them.
6	<b>Interrupt Handling:</b> Configure external interrupts to detect events (e.g., button press, sensor signal). Write interrupt service routines (ISRs) to handle interrupt events and perform appropriate actions.
7	<b>Timers and Timed Operations:</b> Use timers to generate time delays and schedule periodic tasks.



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	Implement timed operations, such as blinking LEDs at specific intervals or sampling sensors at regular intervals.
8	<b>Communication Protocols:</b> Implement communication protocols such as I2C or SPI to interface with external peripherals (e.g., sensors, displays). Develop projects involving multiple devices communicating over a network using standard protocols (e.g., MQTT for IoT applications).

## Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	Embedded C Programming and the Microchip PIC	-	Richard H. Barnett, Sarah Cox, and Larry O'Cull	Delmar Cengage Learning	2003
2	Embedded System: Real time Operating Systems for the ARM Cortex <sup>TM</sup> M3		Jonathan W. Valvano	Create Space Independent Publishing Platform	2012
3	Programming with MicroPython: Embedded Programming with Microcontrollers and Python		Nicholas H. Tollervey	Shroff / Oreilly Reprints	2017
4	Internet of Things, "A Hands on Approach		Vijay Madiseti, ArshdeepBahga	UniversityPress	2015.



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-01	IOT Communication and Network Layer Protocols	2	--	2	4	6	2	--	1	3
M013		<b>Examination Scheme</b>								
		<b>Component</b>		<b>ISE(%)</b>		<b>MSE(%)</b>		<b>ESE(%)</b>		<b>Total</b>
		Theory		20		20		60		100
Laboratory		80		--		20		100		

<b>Pre-requisite Course Codes, if any.</b>	Computer Architecture and Organization Computer Communication and Networks Embedded Systems
<b>Course Objective:</b> To provide the students with a comprehensive understanding of communication protocols used in the Internet of Things (IoT) ecosystem. Students will learn about various protocols, their features, advantages, and limitations, along with hands-on experience in implementing and optimizing communication for IoT devices.	
<b>Course Outcomes (CO):</b> After successful completion of the course, student will be able to	
MDEC31.1	Understand the fundamentals of IoT communication and network layer protocols.
MDEC31.2	Compare and contrast different IoT communication and network layer protocols.
MDEC31.3	Implement and configure communication layer protocols for IoT devices.
MDEC31.4	Analyze and optimize data and network layer protocols for efficiency and security.

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M013.1	3											
M013.2	3	2										
M013.3		3				2						
M013.4	3						2					



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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	<b>Title</b>	<b>Introduction to IoT Communication</b>		<b>06</b>
	<b>1.1</b>	<b>Overview of IoT architecture</b> Importance of communication protocols in IoT Types of IoT communication (Device-to-Device, Device-to-Cloud, etc.)	1,2,4	
	<b>1.2</b>	<b>Wired Communication Protocols</b> Ethernet: Basics, protocols, and standards Power-line Communication (PLC) Industrial Ethernet protocols (MODBUS TCP/IP, EtherNet/IP)	1,2,4	
	<b>1.3</b>	<b>Wireless Communication Protocols</b> Wi-Fi: Standards, security, and IoT applications Bluetooth and Bluetooth Low Energy (BLE) Zigbee and Z-Wave protocols. LoRa WAN.	1,2,4	
<b>2</b>	<b>Title</b>	<b>IOT Data Link Layer Protocols</b>		<b>11</b>
	<b>2.1</b>	<b>Overview:</b> IOT Communications Criteria, Range, Frequency Bands, Power Consumption, Topology Constrained Devices, Constrained-Node Networks, Data Rate and Throughput, Latency and Determinism. Overhead and Payload	3,4	
	<b>2.2</b>	<b>PHY/MAC Layer:</b> 3GPP MTC, LTE-eMTC uplink and downlink layers, Architecture of IEEE 802.11, Architecture of IEEE 802.15-BLE, BLE power class classification and protocol stack	3,4	
	<b>2.3</b>	<b>Data Link Protocols:</b> Wireless HART-Architecture and protocol stack, Z-Wave- Architecture and Protocol stack, DASH7-Communication models, Zigbee Smart Energy-topology and energy features, LoRaWAN Standardization and Alliances Physical Layer MAC Layer Topology Security, Competitive Technologies LoRaWAN, NB-IoT and Other LTE Variations.	3,4	
3	<b>Title</b>	<b>IOT Network Layer Protocols</b>		<b>11</b>
	<b>3.1</b>	<b>Network Layer Routing Protocols:</b> IPv4-Header format with functions, IPv6-Header format with functions, Dynamic IP and DHCP, ICMP, RPL, CORPL, CARP.	4	



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	<b>3.2</b>	<b>Network Layer Encapsulation Protocols:</b> 6LoWPAN-IPv6 over Low power Wireless PAN, 6TiSCH, 6Lo, IPv6 over G.9959, IPv6 over BLE, RPL-Routing Protocol for Low Power and Lossy Networks, RPL Routing attributes.	4	
Self Study		Edge Computing and Fog Networking IoT Device Provisioning and Management IoT Interoperability and Standards		4
			<b>Total</b>	<b>28</b>

## Laboratory Component

Sr. No.	Title of the Experiment
1	<b>Setting up a Basic MQTT Communication Network</b> Objective: To understand the basics of MQTT protocol and set up a communication network for IoT devices. Equipment: MQTT broker (e.g., Mosquitto), IoT devices (e.g., Raspberry Pi, ESP8266/ESP32), MQTT client software (e.g., MQTT.fx, Eclipse Paho). Experiment Steps: Install and configure MQTT broker on a server or local machine. Set up IoT devices as MQTT clients and connect them to the broker. Publish and subscribe to MQTT topics to exchange messages between devices.
2	<b>Configuring Ethernet-Based Communication for IoT Devices</b> Objective: To learn about Ethernet protocols and configure wired communication for IoT devices. Equipment: Ethernet switch, Ethernet cables, IoT devices with Ethernet ports (e.g., Raspberry Pi with Ethernet adapter). Experiment Steps: Connect IoT devices to an Ethernet switch using Ethernet cables. Configure IP addresses, subnet masks, and default gateways for devices. Test communication between IoT devices using TCP/IP protocols.
3	<b>Implementing Bluetooth Low Energy (BLE) Communication</b> Objective: To implement BLE communication for IoT sensors and devices. Equipment: BLE-enabled devices (e.g., Raspberry Pi with BLE module, BLE sensors), BLE development tools (e.g., BlueZ library for Linux). Experiment Steps: Set up BLE peripherals and central devices.



	<p>Develop BLE applications for data transmission between devices. Analyze BLE communication characteristics such as range, data rate, and power consumption.</p>
<b>4</b>	<p><b>Connecting IoT Devices Using Cellular Communication</b></p> <p>Objective: To establish cellular communication for IoT devices using GSM, GPRS, or LTE-M/NB-IoT standards.</p> <p>Equipment: IoT devices with cellular modules (e.g., SIM800/SIM900 modules), SIM cards, cellular network access.</p> <p>Experiment Steps:</p> <p>Configure IoT devices with cellular network settings and APNs.</p> <p>Test data transmission over cellular networks using AT commands or APIs.</p> <p>Evaluate cellular communication performance and reliability for IoT applications.</p>
<b>5</b>	<p><b>Comparing and Analyzing IoT Messaging Protocols</b></p> <p>Objective: To compare and analyze the performance of different IoT messaging protocols such as MQTT, CoAP, and AMQP.</p> <p>Equipment: IoT devices with support for multiple messaging protocols, MQTT broker, CoAP server, AMQP server.</p> <p>Experiment Steps:</p> <p>Implement message exchange using MQTT, CoAP, and AMQP protocols.</p> <p>Measure message latency, throughput, and overhead for each protocol.</p> <p>Analyze protocol characteristics and suitability for different IoT scenarios.</p>
<b>6</b>	<p><b>Optimizing IoT Communication Protocols</b></p> <p>Objective: To optimize IoT communication protocols for resource-constrained devices.</p> <p>Equipment: IoT devices with limited memory and processing capabilities.</p> <p>Experiment Steps:</p> <p>Implement protocol optimization techniques such as message compression, caching, and payload reduction.</p> <p>Measure the impact of optimizations on device performance, power consumption, and network utilization.</p>



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	Evaluate trade-offs between optimization techniques and protocol functionality.
7	<p><b>IoT Communication Protocol Implementation</b></p> <p>Objective: To design and implement a communication protocol for a specific IoT application.</p> <p>Equipment: IoT devices relevant to the chosen application, communication protocol libraries or frameworks.</p> <p>Project Steps:</p> <p>Define the communication requirements and constraints for the IoT application.</p> <p>Design a custom communication protocol or adapt existing protocols to meet the requirements.</p> <p>Implement the protocol on IoT devices and test its functionality, efficiency, and security.</p> <p>Present the project findings, including protocol design rationale, implementation details, and performance evaluation.</p>

## Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things		David Hanes, Gonzalo Salgueiro, Patrick Grossetete Robert Barton, Jerome Henry	CISCO press	June 2017
2	Internet of Things: Architectures, Protocols and Standard		Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri	WILEY Publication	2019
3	From Machine-to-Machine to the of Things: Introduction to a New Age of Intelligence	First	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle	Elsevier AP	2014



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4	The Internet of Things:Key Applications and Protocols		Hersent, Olivier, David Boswarthick, and Omar Elloumi	Wiely	2011
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## OnLine References:

1. <https://www.nabto.com/guide-iot-protocols-standards/>
2. <https://azure.microsoft.com/en-in/solutions/iot/iot-technology-protocols>
3. <https://www.datamation.com/applications/iot-protocols-and-standards/>
4. [https://onlinecourses.nptel.ac.in/noc22\\_cs53/preview](https://onlinecourses.nptel.ac.in/noc22_cs53/preview)
5. <https://archive.nptel.ac.in/courses/108/108/108108098/>





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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-01	IOT Applications and Security	3	--	2	4	7	3	--	1	4
M014		<b>Examination Scheme</b>								
		<b>Component</b>		<b>ISE (%)</b>		<b>MSE (%)</b>		<b>ESE (%)</b>		<b>Total</b>
		Theory		20		20		60		100
Laboratory		80		--		20		100		

<b>Pre-requisite Course Codes, if any.</b>	Computer Architecture and Organization Computer Communication and Networks Embedded Systems
<b>Course Objective:</b> To provide the students with a comprehensive understanding of communication protocols used in the Internet of Things (IoT) ecosystem. Students will learn about various protocols, their features, advantages, and limitations, along with hands-on experience in implementing and optimizing communication for IoT devices.	
<b>Course Outcomes (CO):</b> After successful completion of the course, student will be able to	
M014.1	Understand IoT design principles and technology fundamentals
M014.2	Implement secure communication and security mechanisms in IoT systems through various protocols
M014.3	Design and development of typical IoT Applications
M014.4	Implement data analytics with supporting services

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M014.1	3											
M014.2	3	2										
M014.3		3					2					
M014.4	3			2								



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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs
1	<b>Title</b>	<b>IoT Technology overview</b>		<b>04</b>
	1.1	<b>Overview of design principles:</b> overview of the architecture for IoT, including the overall design principles and needed capabilities, standards considerations	3	
	1.2	<b>IoT Technology Fundamentals:</b> Devices and Gateways, Local and wide area networking, Data management, Business process in IoT	3	
2	<b>Title</b>	<b>IOT Application Layer Protocols</b>		<b>10</b>
	2.1	HTTP and CoAP protocols for IoT applications, Security mechanisms for HTTP and CoAP (e.g., HTTPS, DTLS)	1,2,4	
	2.2	MQTT Protocol: Architecture, Security considerations, MQTT Deployment, MQTT based IoT Solution	1,2,4	
	2.3	CoAP Protocol: Protocol Architecture, Comparison with MQTT, Secure communication using CoAP, considerations, CoAP based IoT Solution including CoAP client-server interactions and message exchanges.	1,2,4	
3	<b>Title</b>	<b>IoT Security Fundamentals</b>		<b>10</b>
	3.1	Security threats in IoT environments, Introduction to cryptographic techniques (symmetric/asymmetric encryption, hashing, digital signatures), Authentication and access control mechanisms for IoT devices, Secure bootstrapping and provisioning of IoT devices	6	
	3.2	<b>IoT Communication Security Protocols:</b> Overview of TLS/SSL (Transport Layer Security/Secure Sockets Layer) and its relevance in IoT, Introduction to DTLS (Datagram Transport Layer Security) for secure communication over UDP, Securing MQTT communication using TLS, CoAP security considerations and usage of DTLS	5	
4	<b>Title</b>	<b>IoT Applications and Development with Data Analytics</b>		<b>12</b>
	4.1	<b>Design and Development:</b> Design Methodology, Back-end Application Designing Apache for handling HTTP Requests,	4,7	



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		MongoDB Object type Database, HTML, CSS & jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development		
	4.2	<b>Data Analytics and Supporting Services:</b> Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, Organizing in IoT/M2M, Supporting Services: Computing Using a Cloud Platform for IoT/M2M Applications/Services, Everything as a service and Cloud Service Models.	4,7	
5	<b>Title</b>	<b>Case studies/Industrial Applications</b>		6
		IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth	7,8	
Self-Study		Data analytics tools such as Python with libraries like Pandas, NumPy, and Scikit-learn for data analysis and visualization. Learn about applying machine learning algorithms to IoT data for predictive analytics and anomaly detection.		
			<b>Total</b>	<b>42</b>

## Laboratory Component

Sr. No.	Title of the Experiment
1	<p><b>Implementing IoT Data Encryption</b></p> <p><b>Equipment/Software Needed:</b></p> <ul style="list-style-type: none"> <li>● IoT Devices</li> <li>● OpenSSL library</li> <li>● Python IDE</li> </ul> <p><b>Experiment Steps:</b></p> <ol style="list-style-type: none"> <li>1. Generate public and private keys using OpenSSL.</li> </ol>



	<ol style="list-style-type: none"><li>2. Implement encryption and decryption functions in Python using the generated keys.</li><li>3. Modify previous IoT application to encrypt sensor data before transmission.</li><li>4. Ensure that data is decrypted at the receiving end.</li></ol>
2	<p><b>Securing IoT Device Boot Process</b></p> <p><b>Equipment/Software Needed:</b></p> <ul style="list-style-type: none"><li>● Raspberry Pi or similar IoT device</li><li>● Secure Boot software (e.g., U-Boot)</li><li>● Computer with Linux OS</li></ul> <p><b>Experiment Steps:</b></p> <ol style="list-style-type: none"><li>1. Install U-Boot bootloader on the IoT device.</li><li>2. Configure U-Boot to verify the integrity of the boot image.</li><li>3. Implement secure boot process using cryptographic signatures.</li><li>4. Test the secure boot process by attempting to boot with a modified image.</li></ol>
3	<p><b>IoT Network Security Analysis</b></p> <p><b>Equipment/Software Needed:</b></p> <ul style="list-style-type: none"><li>● Wireshark or similar network analysis tool</li><li>● IoT devices connected to a local network</li><li>● Router or network switch</li></ul> <p><b>Experiment Steps:</b></p> <ol style="list-style-type: none"><li>1. Capture network traffic using Wireshark.</li><li>2. Analyze the captured packets to identify potential security threats.</li><li>3. Implement network segmentation to isolate IoT devices from other network segments.</li><li>4. Configure firewall rules to restrict unauthorized access to IoT devices.</li></ol>



<b>4</b>	<b>Implementing Secure Firmware Updates</b>  <b>Equipment/Software Needed:</b> <ul style="list-style-type: none"><li>● IoT devices with firmware update capability</li><li>● Digital signatures generation tool</li><li>● Firmware update server</li></ul> <b>Experiment Steps:</b> <ol style="list-style-type: none"><li>1. Generate digital signatures for firmware updates using cryptographic algorithms.</li><li>2. Implement firmware update mechanism in IoT devices to verify the authenticity of firmware images.</li><li>3. Set up a firmware update server to distribute signed firmware updates.</li><li>4. Test the firmware update process and verify the integrity of the updated firmware.</li></ol>
<b>5</b>	<b>Implementing Access Control for IoT Devices</b>  <b>Equipment/Software Needed:</b> <ul style="list-style-type: none"><li>● IoT devices with user authentication capabilities</li><li>● Authentication server (e.g., LDAP server)</li><li>● Python IDE</li></ul> <b>Experiment Steps:</b> <ol style="list-style-type: none"><li>1. Configure an authentication server (LDAP) to manage user credentials.</li><li>2. Implement user authentication mechanism in IoT devices using Python.</li><li>3. Create access control policies to restrict access based on user roles and permissions.</li><li>4. Test the access control mechanism by attempting to access IoT devices with different user credentials.</li></ol>
<b>6</b>	<b>IoT Device Hardening</b>  <b>Equipment/Software Needed:</b> <ul style="list-style-type: none"><li>● IoT devices (e.g., Raspberry Pi, BeagleBone)</li></ul>



	<ul style="list-style-type: none"><li>● Secure shell (SSH) client</li><li>● Linux OS</li></ul> <p><b>Experiment Steps:</b></p> <ol style="list-style-type: none"><li>1. Disable unnecessary services and ports on the IoT device.</li><li>2. Configure firewall rules to block incoming and outgoing traffic.</li><li>3. Enable secure shell (SSH) access and disable password-based authentication.</li><li>4. Install security updates and patches to mitigate known vulnerabilities.</li></ol>
7	<p><b>Implementing Secure Communication with TLS/SSL</b></p> <p><b>Equipment/Software Needed:</b></p> <ul style="list-style-type: none"><li>● IoT devices with network connectivity</li><li>● Web server with TLS/SSL support (e.g., Apache, Nginx)</li><li>● OpenSSL library</li></ul> <p><b>Experiment Steps:</b></p> <ol style="list-style-type: none"><li>1. Generate SSL/TLS certificates for the web server and IoT devices.</li><li>2. Configure the web server to enable HTTPS communication with SSL/TLS certificates.</li><li>3. Implement SSL/TLS client in IoT devices to establish secure connections with the server.</li><li>4. Test the secure communication by exchanging data between IoT devices and the server.</li></ol>
8	<p><b>IoT Device Monitoring and Intrusion Detection</b></p> <p><b>Equipment/Software Needed:</b></p> <ul style="list-style-type: none"><li>● IoT devices with logging capabilities</li><li>● Intrusion detection system (e.g., Snort)</li><li>● Monitoring software (e.g., Nagios)</li></ul> <p><b>Experiment Steps:</b></p> <ol style="list-style-type: none"><li>1. Configure logging on IoT devices to record system activities and network traffic.</li></ol>



	<ol style="list-style-type: none"><li>2. Set up an intrusion detection system (IDS) to monitor network traffic for suspicious activities.</li><li>3. Configure alerting mechanisms to notify administrators of potential security breaches.</li><li>4. Deploy monitoring software to track the health and performance of IoT devices.</li></ol>
9	<p><b>Collecting and Analyzing IoT Sensor Data</b></p> <p><b>Equipment/Software Needed:</b></p> <ul style="list-style-type: none"><li>● IoT devices with sensors (e.g., temperature, humidity)</li><li>● Raspberry Pi or similar IoT platform</li><li>● Python IDE</li><li>● Pandas and Matplotlib libraries for data analysis and visualization</li></ul> <p><b>Experiment Steps:</b></p> <ol style="list-style-type: none"><li>1. Connect sensors to the IoT device and collect real-time data.</li><li>2. Write Python scripts to read sensor data and store it in a CSV file or a database.</li><li>3. Use Pandas library to perform basic data analysis such as mean, median, and standard deviation.</li><li>4. Visualize sensor data using Matplotlib library to identify trends and patterns.</li></ol>
10	<p><b>Anomaly Detection in IoT Sensor Data</b></p> <p><b>Equipment/Software Needed:</b></p> <ul style="list-style-type: none"><li>● IoT devices with sensors</li><li>● Historical sensor data with known anomalies</li><li>● Python IDE</li><li>● Statistical libraries such as NumPy and SciPy</li></ul> <p><b>Experiment Steps:</b></p> <ol style="list-style-type: none"><li>1. Collect historical sensor data containing both normal and anomalous behavior.</li><li>2. Calculate statistical measures such as mean, standard deviation, and z-score for the sensor data.</li><li>3. Identify thresholds for anomaly detection based on statistical measures.</li></ol>



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	<ol style="list-style-type: none"><li>4. Implement anomaly detection algorithms using Python and NumPy/SciPy libraries.</li><li>5. Evaluate the performance of the anomaly detection system using precision, recall, and F1-score metrics.</li></ol>
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## Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things		David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry	CISCO press	June 2017
2	Internet of Things: Architectures, Protocols and Standard		Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri	WILEY Publication	2019
3	from Machine-to-Machine to the of Things: Introduction to a New Age of Intelligence	First	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle	Elsevier AP	2014
4	The Internet of Things: Key Applications and Protocols		Hersent, Olivier, David Boswarthick, and Omar Elloumi	Wiley	2011
5	Implementing SSL / TLS Using Cryptography and PKI		Joshua Davies	Wiley	2010
6	Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations	First	Fei Hu	CRC Press	2016





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7	Internet of Things – A hands-on approach		Arshdeep Bahga, Vijay	Universities Press	2017
8	Rethinking the Internet of Things: A Scalable Approach to Connecting Everything	First	Francis daCosta	Apress Publications	2016

Online resources:-[https://onlinecourses.nptel.ac.in/noc22\\_cs52/preview](https://onlinecourses.nptel.ac.in/noc22_cs52/preview)

Introduction to Industry 4.0 and Industrial Internet of Things

OnLine References:

1. <https://www.nabto.com/guide-iiot-protocols-standards/>
2. <https://azure.microsoft.com/en-in/solutions/iiot/iiot-technology-protocols>
3. <https://www.datamation.com/applications/iiot-protocols-and-standards/>
4. [https://onlinecourses.nptel.ac.in/noc22\\_cs53/preview](https://onlinecourses.nptel.ac.in/noc22_cs53/preview)
5. <https://archive.nptel.ac.in/courses/108/108/108108098/>



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## **MDM-02**

# **Signal Processing**

## **For CE/CSE**



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-02	Digital Signal Processing	2	0	2	5	8	2	0	1	3
		Examination Scheme								
M021		Component		ISE (%)	MSE (%)	ESE (%)	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b> The primary objective of this course is to provide a thorough understanding and working knowledge of Discrete Time Signal operation and implementation of DSP Algorithms.	
<b>Course Outcomes (CO):</b> <i>At the end of the course students will be able to</i>	
M021.1	Sample and describe Discrete time signals
M021.2	Classify and Perform signal operations
M021.3	Apply DFT properties
M021.4	Illustrate FFT algorithm
M021.5	Design FIR filter
M021.6	Implement DSP Algorithms

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M021.1	3	3							2			
M021.2	3	3		2	2				2			
M021.3	3	3							2			
M021.4	3	3							2			
M021.5	3	3	2	2	2				2			
M021.6	3	3	2	2	3				2			

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Discrete-Time Signal</b>	1, 2, 3	8
	1.1	Introduction: Signals and Systems, Continuous Time signal, Discrete - Time signal and representation, Digital signal, The Sampling theorem, Classification of Discrete - Time Signals		
	1.2	Operations on Discrete - Time Signals: Linear Convolution, Circular Convolution, Matrix Representation of Circular Convolution, Linear Convolution using Circular Convolution, Auto and Cross Correlation		
	1.3	Discrete - Time systems: Representation of system using impulse response, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) system, Response of the FIR system using convolution		
2	<b>Title</b>	<b>Discrete Fourier Transform</b>	1, 2	6
	2.1	Introduction to DTFT, Relation between DFT and DTFT, DFT of DT signal, Inverse DFT. Computations in DFT		
	2.2	Properties of DFT		
3	<b>Title</b>	<b>Fast Fourier Transform</b>	1,2	6
	3.1	Need of FFT, Radix-2 DIT-FFT algorithm, Flow graph for N=4 and N=8 using Radix-2 DIT-FFT		
	3.2	Inverse FFT algorithm, Computations in FFT		
4	<b>Title</b>	<b>Digital FIR Filter Design</b>	1,2, 3	04
	4.1	Linear Phase Concept		
	4.2	Linear Phase Low Pass/High Pass/Band Pass FIR filter design using Windowing Method		
5	<b>Title</b>	<b>DSP Algorithms</b>	1,2	04
	5.1	Fast Linear and Circular Convolution using FFT		
	5.2	Linear FIR filtering		
	5.3	Signal Matching using Carl's Correlation Algorithm		
6	<b>Self Study</b>	Composite FFT, FFT Flowgraph for N=6 and N=9 Linear Phase Realization of FIR Filter	1,2	06
<b>Total</b>				<b>28</b>



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**Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)**

Sr. No	Title of the Experiment
1	Sampling and Reconstruction
2	Digital Signal Operations
3	Discrete Convolution
4	Discrete Correlation
5	Discrete Fourier Transform
6	Fast Fourier Transform
7	FIR Filter Design
8	Linear Convolution using FFT
9	Circular Convolution using FFT
10	Linear Filtering using Overlap Add Method
11	Linear Filtering using Overlap Save Method
12	Audio Signal Matching using Carl's Correlation Algorithm

## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processing	Fourth Edition	John Proakis and Dimitris Monolakis	Pearson Publication	2007
2	Digital Signal Processing	Second Edition	S.Salivahanan, A Vallavaraj	Tata McGraw Hill	2010
3	Analog and Digital Signal Processing	Second Edition	Ashok Ambardar	Brooks/Cole Publishing	1999

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processing	Forth Edition	P. Ramesh Babu	Scitech Publication Pvt Ltd	2011



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2.	Digital Signal Processing	First Edition	M. H. Hayes	The McGraw Hill	2007
3	Digital Signal Processing	Second Edition	Nagoor Kani	Tata McGraw Hill	2012

## Web References:

### NPTEL Courses

1. **Digital Signal Processing and Applications by Prof. V. M. Gadre, IIT Bombay**  
[https://onlinecourses.nptel.ac.in/noc21\\_ee20/preview](https://onlinecourses.nptel.ac.in/noc21_ee20/preview)
2. **Digital Signal Processing by Prof. S.C.Dutta Roy IIT Delhi**  
<https://nptel.ac.in/courses/117102060>

### MIT OpenCourseWare

1. **Digital Signal Processing by Prof. Alan V. Oppenheim**  
<https://ocw.mit.edu/courses/res-6-008-digital-signal-processing-spring-2011/>



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-02	Digital Image Processing	2	1	2	5	10	2	1	1	4
		Examination Scheme								
M022	Digital Image Processing	Component		ISE (%)	MSE (%)	ESE (%)	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b> The primary objective of Image Processing Course is to understand and apply image processing tools to process the Digital image	
<b>Course Outcomes (CO):</b> <i>At the end of the course students will be able to</i>	
M022.1	apply image enhancement technique on image
M022.2	apply image segmentation technique on image
M022.3	perform binary image processing Operation
M022.4	develop fast image transform flowgraph
M022.5	solve image compression and decompression
M022.6	develop image processing application

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M022.1	3	3	2	3	3				2			
M022.2	3	3	2	3	3				2			
M022.3	3	3	2	3	3				2			
M022.4	3	3	2	3	3				2			
M022.5	3	3	2	3	3				2			
M022.6	3	3	2	3	3				2			

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Fundamentals of Digital Image</b>	1,2	2
	1.1	Sampling and Quantization, Digital Image Representation		
	1.2	Introduction of Coordinate representation and Pixel		
	1.3	Neighbors of pixel adjacency connectivity		
2	<b>Title</b>	<b>Image Enhancement</b>	1,2	6
	2.1	Gray Level Transformations, Zero Memory Point Operations		
	2.2	Histogram Processing		
	2.3	Neighborhood Processing		
	2.4	Spatial Filtering: Smoothing and Sharpening Filters		
3	<b>Title</b>	<b>Image Segmentation and Representation</b>	1,2,4	6
	3.1	Detection of Discontinuities, Point Detection, Line Detection and Edge Detection		
	3.2	Edge Linking using Local processing and Global Processing Hough Transform, Graph Theoretic Method		
	3.3	Region based Segmentation, Image growing by pixel aggregation, Split and Merge Technique		
4	<b>Title</b>	<b>Binary Image Processing</b>	1,2	6
	4.1	Representation and Description, Chain Code, Shape Number, Moments.		
	4.2	Binary Morphological Operators: Dilation, Erosion, Opening and Closing, Boundary Extraction, Region Filling, Hit or Miss Transform, Corner Detection, Thinning and Thickening algorithm		
5	<b>Title</b>	<b>Image Transform</b>	1,3	4
	5.1	Introduction to Unitary Transform		
	5.2	Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)		
	5.3	Discrete Hadamard Transform (DHT), Fast Hadamard Transform (FHT)		
	5.4	Discrete Cosine Transform (DCT)		
6	<b>Title</b>	<b>Image Compression</b>	1,2,3,4	6
	6.1	Introduction, Redundancy, Fidelity Criteria		
	6.2	Lossless Compression Techniques: Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM		
	6.3	Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG		





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7	<b>Self Study</b>	Connected Component Labeling, Gray Scale Morphology and Color Image Enhancement		
			<b>Total</b>	<b>28</b>

**Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)**

Sr. No	Title of the Experiment
1	Image Enhancement using zero memory point processing
2	Image Enhancement using Histogram Processing
3	Image Enhancement using Spatial Filtering
4	Image Segmentation based on discontinuity property
5	Image Segmentation based on similarity property
6	Morphological Image Processing
7	Thinning and Thickening Algorithm
8	Image representation using Chain code, Shape Number and Moments
9	Fast Image Transform
10	Image Compression using Lossless Compression techniques
11	Image Compression using Lossy Compression techniques
12	Application of Image Processing

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Image Processing	Third Edition	Rafel C. Gonzalez and Richard E. Woods	Pearson Education Asia	2009
2	Digital Image Processing	First Edition	S.Jayaraman, E.Esakkirajan and T. Veerkumar	TataMcGraw Hill Education Private Ltd	2009



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3	Digital Image Processing	First Edition	S. Sridhar	Oxford	2011
4	Digital Image Processing	First Edition	B. Chanda D. Dutta Majumdar	PHI	2003

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Fundamentals and Digital Image Processing	Third Edition	Anil K. Jain	Prentice Hall of India Private Ltd	2012
2.	Digital Image Processing and computer Vision	First Edition	Milan Sonka, Vaclav Hlavac and Roger Boyle	Cengage Learning	2008
3	Multidimensional Signal, Image and Video Processing and Coding	Second Edition	John W Woods	Elsevier	2012
4	Digital Image Processing	Third Edition	William Pratt	John Wiley & Sons	2003

## Web References:

### NPTEL Courses

1. Digital Image Processing by Prof. Prabir Kumar Biswas, IIT Kharagpur  
[https://onlinecourses.nptel.ac.in/noc22\\_ee116/preview](https://onlinecourses.nptel.ac.in/noc22_ee116/preview)

### Online Video Course :

1. Digital Image Processing by Prof. Rich Radke ,Rensselaer Polytechnic Institute  
<https://sites.ecse.rpi.edu/~rjradke/improccourse.html>



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-02	Multimedia Signal Processing	2	0	2	5	10	2	0	1	3
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)		Total	
M023		Theory		20		20		60		100
		Laboratory		80		--		20		100

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b> The major emphases of the course are Extension and application of one-dimensional signal processing concepts into multiple dimensions (2 dimensions for images and 3 dimensions for video)	
<b>Course Outcomes (CO):</b> <i>At the end of the course students will be able to</i>	
M023.1	Describe and apply the principles and techniques of signal processing in multimedia systems.
M023.2	Analyze speech and audio signals using multichannel filtering techniques and cepstral analysis
M023.3	Analyze video signals with motion estimation techniques; describe video compression standards (MPEG and H263/264).
M023.4	Explain basic concepts of multimedia applications such as human computer interaction, multimedia retrieval and multimedia security.

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M023.1	3	3	2	2					3			
M023.2	3	3	3	3					3			
M023.3	3	3	3	3					3			
M023.4	3	3	2	2					3			

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Fundamentals of Multimedia Signal Processing</b>	1	04
	1.1	Theoretical background of one- and multidimensional signal processing, statistical analysis and modeling		
	1.2	Coding and information theory about the principles and design of image, video and audio compression systems.		
	1.3	Algorithms for multimedia signal coding technology		
	1.4	Principles behind multimedia coding standards		
2	<b>Title</b>	<b>Audio and Speech Processing</b>	2	06
	2.1	Principle Characteristics of Audio, Speech Analysis and Synthesis Systems, Sound Spectrogram, Mel frequency Cepstral Coefficients, Filter bank and Zero Crossing Analysis, Analysis –by-Synthesis, Pitch Extraction.		
	2.2	Linear Predictive Coding Analysis, Speech Recognition, speaker recognition		
	2.3	Audio Compression: Overview, MPEG Audio Coder		
3	<b>Title</b>	<b>Video Processing</b>	3	06
	3.1	Video Compression Standards: Overview, H.261, H.263, H.264, MPEG-1: Specification, continuity and synchronization, MPEG-2: Overview, scalability.		
	3.2	Motion analysis and estimation		
4	<b>Title</b>	<b>Biomedical Signal Processing</b>	4	04
	4.1	Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters		
	4.2	Coherent treatment of various biomedical signal processing methods and applications		
	4.3	Biomedical signal processing, Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals		
5	<b>Title</b>	<b>Multi-rate Signal processing</b>	5	04
	5.1	Fundamentals decimation, interpolation, resampling by rational fractions, Multi rate identities		
	5.2	Poly phase representations, maximally decimated filter banks		
	5.3	Aliasing, amplitude, and phase distortion perfect reconstruction conditions		
6	<b>Self Study</b>	Adaptive Filters, Stochastic Processes	5	04
			<b>Total</b>	<b>28</b>



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## Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To analyze audio signals and to obtain various parameters of it.
2	To extract Mel Frequency Cepstral Coefficients (MFCCs) from an audio signal
3	To extract Linear Predictive Coding (LPC) coefficients from an audio signal
4	To detect speech from given sample of signals
5	To recognize Speaker based on MFCC and LPC coefficients
6	To estimate motion for a video sequence using a full search algorithm.
7	To perform stereo matching to generate output signal by merging input stereo/video signals
8	The study of video compression algorithms
9	To analyze the ECG signal
10	To remove the noise from ECG signal using band-pass filtering
11	To study and implement decimation operation
12	To study and implement interpolation operation
13	Implementation of published conference paper

## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Multimedia Signal Coding and Transmission (Signals and Communication Technology)	First Edition	Jens-Rainer Ohm	Springer	2015
2	Multimedia Signal Processing: Theory and Applications in Speech, Music and Communications	First Edition	Saeed V. Vaseghi	Springer	2007
3	Practical Image and Video Processing using MATLAB	First Edition	Marques	John Wiley and Sons Ltd	2011
4	Biomedical Digital Signal Processing	First Edition	W. J. Tompkins	Prentice Hall	1998



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5	Multirate Digital Signal Processing: Multirate Systems - Filter Banks - Wavelets	First Edition	N. J. Fliege	John Wiley and Sons Ltd	1999
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### Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Multimedia Technologies	First Edition	Ashok Banerji, Anand Mohan Ghosh	Tata McGraw Hill	2010
2.	Audio Signal Processing and Coding	First Edition	Andreas Spanias, Ted Painter, Venkatraman Atti	John Willey	2007
3.	H.264 and MPEG-4 Video Compression: Video Coding for Next Generation Multimedia	First Edition	Iain Richardson, Iain E. G. Richardson	John Willey	2004



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-02	Digital Signal Processors System Design	2	1	2	5	10	2	1	1	4
		Examination Scheme								
M024		Component		ISE (%)	MSE (%)	ESE (%)	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b>	
<b>Course Outcomes (CO): At the end of the course students will be able to</b>	
M024.1	Evaluate different types of errors in DSP implementation.
M024.2	Analyze the architectures of TMS320XX devices
M024.3	Differentiate between General Purpose Processor and DSP processor Interface various devices to DSP Processors.
M024.4	Develop interfacing techniques to memory and I/O devices
M024.5	Develop DSP application using DSP hardware

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M024.1	3	3			3				3			
M024.2	3	3			3				3			
M024.3	3	3			3				3			
M024.4	3	3	2		3				3			
M024.5	3	3	3		3				3			

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember ✓	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Introduction to Digital Systems</b>	1,2	4
		Representation of Numbers in the digital system (Floating point, Fixed-point representation), Types of arithmetic in a digital system, Quantization effect & Errors therein, Concept of Limit Cycle Oscillations & Scaling		
2	<b>Title</b>	<b>Introduction to Digital Signal Processors</b>	1,2	6
		Architectures of P-DSP, Features of Processors– Types of architecture, Concepts of DMA, MAC, Pipelining, etc., Introduction to DSP architecture. Peripherals available in DSP IC chips,		
3	<b>Title</b>	<b>Code Composer Studio</b>		4
		Introduction to CCS as IDE for TI processors, Basics of CCS, Multiprocessing with CCS, Testing Program, debugging Breakpoints, points, using file I/O, Memory map, Watch window, Integrated editor, project environment.		
4	<b>Title</b>	<b>Software Development and Programming</b>	1,2	6
		Overview, description, object module, program loading and running, Assembler, Assembler directives, Macros, Linker, using C language Writing program for some simple objectives like initializing peripheral, timer interrupt and ISR for timer interrupt, PWM generation etc. for C2000 microcontrollers.		
5	<b>Title</b>	<b>TI 320XX Digital Signal Processor</b>	1,2	6
		TMS320XX Introduction, Functional Overview, Memory map, brief description of available peripherals, register maps, device emulation registers, interrupts, system control, On-chip Peripherals, Timers, PWM generation, ADC, Serial Communication, GPIO, Flash Memory		
6	<b>Self Study</b>	High-Performance Computing using P-DSP: Preliminaries of HPC, MPI, OpenMP, multicore DSP as HPC infrastructure.		4
			<b>Total</b>	<b>28</b>





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**Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)**

Sr. No	Title of the Experiment *
1	Fast Linear Convolution
2	Fast Circular Convolution
3	Linear Filtering using Overlap Add Method
4	Linear Filtering using Overlap Save Method
5	Audio Signal Matching using Carl's Correlation Algorithm
6	Digital Image Enhancement
7	Image representation using Chain code, Shape Number and Moments
8	Image Compression using Lossless Compression techniques
9	Image Compression using Lossy Compression techniques
10	Analyze Real Time ECG signal
11	Fast Image Transform
12	Discrete Wavelet Transform
13	Real Time Signal Processing

\* All experiments are based on implementation using DSP Hardware

## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Signal Processors	Second Edition	B. Venkataramani M. Bhaskar	Tata McGraw Hill	2012
2	DSP Implementation using DSP microprocessor with Examples from TMS32C54XX	First Edition	Avtar Singh, S.Srinivasan	Thomson Publication	2004



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## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	DSP Processor Fundamentals, Architectures & Features	First Edition	Phil Lapsley, Jeff Bier, Amit Shoham, Edward A. Lee	Wiley Publication	1997
2.	Digital Signal Processors Architectures, Implementation and Application	First Edition	Sen M. Kuo Woon Serg Gan	Pearson	2009
3.	Architectures for Digital Signal Processing	Second Edition	Peter Pirsch	Wiley Publication	1998

## Web References :

### NPTEL Courses

1. Real-Time Digital Signal Processing by Prof. Rathma G. N. IISc Bangalore  
[https://onlinecourses.nptel.ac.in/noc22\\_ee99/preview](https://onlinecourses.nptel.ac.in/noc22_ee99/preview)
2. Mapping of Signal Processing Algorithms to Architectures By Prof.Nitin Chandrachoodan, IIT Madras  
[https://onlinecourses.nptel.ac.in/noc19\\_ee70/preview](https://onlinecourses.nptel.ac.in/noc19_ee70/preview)

## Online Video :

1. TI Development Tools  
<https://www.youtube.com/watch?v=11lsNYW7zkw>
2. Code Composer Studio user Guide  
[https://software-dl.ti.com/ccs/esd/documents/users\\_guide/ccs\\_getting-started.html](https://software-dl.ti.com/ccs/esd/documents/users_guide/ccs_getting-started.html)



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## **MDM-03**

# **Electronics Communication**

## **For CE/CSE**



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-03	Linear Electronics Circuit	2	0	2	4	8	2	0	1	3
		<b>Examination Scheme</b>								
		<b>Component</b>		<b>ISE (%)</b>		<b>MSE (%)</b>		<b>ESE (%)</b>		<b>Total</b>
M031		<b>Theory</b>		<b>20</b>		<b>20</b>		<b>60</b>		<b>100</b>
		<b>Laboratory</b>		<b>80</b>		<b>--</b>		<b>20</b>		<b>100</b>

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b>	
<b>Course Outcomes (CO): At the end of the course students will be able to</b>	
M031.1	Explain Op-Amp circuit and parameters including CMRR, PSRR, Input & Output Impedances and Slew Rate etc.
M031.2	Design linear applications including Amplifier, filters and Oscillator using operational amplifier IC.
M031.3	Design non-linear applications including comparator, Schmitt trigger and rectifier using operational amplifier IC.
M031.4	Design applications of Timer ICs using Astable and Monostable mode.
M031.5	Discuss various data conversion techniques like ADC and DAC.

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M031.1	3											
M031.2		3										
M031.3		3										
M031.4			3									
M031.5	3											

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember✓	Understand✓	Apply✓	Analyze✓	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Operational Amplifier Overview</b>	1, 2, 3, 4	04
	1.1	Op-Amp symbol and Terminals, Ideal Op-Amp and Practical Op-Amp characteristics, Op-Amp Parameters, open loop and closed loop configurations, Virtual ground concept.		
	1.2	Inverting and non-inverting modes, Feedback in Op-Amp Circuits (Positive and Negative).		
2	<b>Title</b>	<b>Applications of Operational Amplifier</b>	1, 2, 3, 4	08
	2.1	<b>Amplifiers:</b> Current amplifier, difference amplifier, instrumentation amplifier and programmable gain amplifier.		
	2.2	<b>Active Filters:</b> Low pass, high pass, band pass and band reject filters.		
	2.3	<b>Sine Wave Oscillators:</b> Barkhuizen criterion, RC phase shift oscillator		
3	<b>Title</b>	<b>Non-Linear Applications of Operational Amplifier</b>	1, 2, 3, 4	06
	3.1	<b>Comparators:</b> Inverting comparator, non-inverting comparator, zero crossing detector, window detector and level detector.		
	3.2	<b>Schmitt Triggers:</b> Inverting Schmitt trigger, non-inverting Schmitt trigger, and adjustable threshold levels.		
	3.3	<b>Precision Rectifiers:</b> Half-wave, full-wave and applications.		
	3.4	Peak detectors, sample and hold circuits.		
4	<b>Title</b>	<b>Timer IC (IC 555)</b>	1, 4	04
	4.1	Functional block diagram, working, design and applications: <b>Astable mode</b>		
	4.2	Functional block diagram, working, design and applications: <b>Monostable mode</b>		
5	<b>Title</b>	<b>Voltage Regulators: Functional block diagram, working and design of three terminal</b>	1, 4	02
	5.1	Fixed Voltage Regulators (78XX, 79XX series).		
	5.2	Adjustable (LM 317, LM 337) voltage regulators.		
6	<b>Title</b>	<b>ADC and DAC Conversion</b>	1, 4	04
	6.1	<b>D to A Conversion Techniques:</b> R - 2R ladder, Multiplying DAC with Applications.		
	6.2	<b>A to D Conversion Techniques:</b> Dual slope ADC, Ramp ADC, Successive approximation ADC.		
	<b>Self Study</b>	<b>Feedback topologies and Oscillators:</b> Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc.	5	04*
<b>Total</b>				<b>28</b>



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Exp. No.	list of Experiments
1	To measure different parameters of Op-Amp.
2	Design Low pass Filter using Op-amp for given specification.
3	Design high pass Filter using Op-amp for given specification.
4	Design RC phase shift oscillator using Op-amp for given specification.
5	Design Inverting comparator, non-inverting comparator and window detector using Op-amp for given specification.
6	Design Half wave and full wave Precision Rectifiers using Op-amp.
7	Design inverting and non-inverting Schmitt trigger using Op-amp for given specification.
8	Design Voltage Regulators to generate Fixed and Adjustable Voltage for given specification.
9	Design Astable Multivibrator using Timer IC (IC 555) given specification.
10	Design Monostable Multivibrator using Timer IC (IC 555) given specification.
11	Convert Analog signal to Digital signal using ADC IC.
12	Convert Digital signal to Analog signal using DAC IC.
13	Application based experiment. (experiment may cover op-amp, timer IC, Regulator and DAC/ADC).

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Design with Operational Amplifiers and analog integrated circuits	3rd Edition	Sergio Franco	McGraw Hill International edition	2017
2	Linear Integrated Circuits	4th Edition	D. Roy Choudhury and S. B. Jain	New Age International Publishers,	2017
3	Op-Amps and Linear Integrated Circuits	4th Edition	Ramakant A. Gayakwad,	Pearson Prentice Hall	2015

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Operational Amplifiers and Linear Integrated circuits	6th Edition	Robert Coughlin, Frederick F. Driscoll	PHI Learning	2001
2	Electronic Devices and Circuits	5th Edition	David A. Bell	Oxford University Press	2008

1. [NPTEL :: Electrical Engineering - NOC: Basic Electronics](#) (Prof. M.B.Patil)



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-03	Principles of Communication & Systems	2	0	2+2	5	10	2	0	1+1	4
		<b>Examination Scheme</b>								
<b>Component</b>		<b>ISE (%)</b>		<b>MSE (%)</b>		<b>ESE (%)</b>		<b>Total</b>		
M032		<b>Theory</b>	20		20		60		100	
		<b>Laboratory-I</b>	80		--		20		100	
	<b>Laboratory-II</b>	80		--		20		100		

<b>Pre-requisite Course Codes, if any.</b>		MDM-I: Analog Electronics and Circuits
<b>Course Objective:</b> The objective is to equip the students with basic knowledge for analyzing analog and digital communication systems ranging from data networks and internet to mobile data communication systems such as cellular and WiFi systems. Specifically, the students will learn how to manage communication system resources including bandwidth and power by selecting a proper signaling and/or analog/pulse/digital modulation scheme		
<b>Course Outcomes (CO):</b> <i>At the end of the course students will be able to</i>		
M032.1	Explain, compare, and distinguish between the components of analog, pulse, and digital communication systems.	
M032.2	Analyze the behavior of modulated signals in time domain, frequency domain, and signal space.	
M032.3	Create different source coding and error correction codes.	
M032.4	Examine the performance of different analog and digital modulation schemes.	
M032.5	Examine and calculate system performance metrics like bit rate and bandwidth for different digital modulation techniques, as well as for source and error correction codes.	

## CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M032.1	3				-				-	-		1
M032.2	2	2			3				3	3		
M032.3	2	2			3				3	3		1
M032.4	3	3			3				3	3		1
M032.5	2	2			3				3	3		



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## BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember✓	Understand✓	Apply✓	Analyze✓	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1 2	<b>Title</b>	<b>Analog and Pulse modulation</b>	1,2	07
	1.1	Introduction to Signals, Fourier analysis, Classification of Frequency spectrum, Need for modulation, Block diagram of an analog and digital communication system.		
	1.2	DSB-FC: Principle of working, Waveforms and power relations and power spectrum, Single and multitone, Types of AM FM: Mathematical analysis, Armstrong method of FM generation, Block diagram of Superheterodyne receiver		
	1.3	Sampling theorem, Types of Sampling, Pulse Amplitude modulation, Pulse Width Modulation, Pulse code modulation (PCM)		
	1.4	Delta modulation, Time Division multiplexing		
2	<b>Title</b>	<b>Source coding and Channel Coding</b>	1,2	07
	2.1	Uncertainty, Information, Entropy, Source coding theorem, Huffman encoding, Shannon Fano coding		
	2.2	Channel capacity Theorem, Linear block codes, Cyclic codes-Shift register method and Polynomial division method, Convolutional codes- Shift Register approach, State diagram, Trellis, Viterbi decoding		
3		<b>Digital Modulation Techniques</b>	1,2	10
	3.1	Line coding and Power spectral density (PSD) of line codes		
	3.2	BPSK,8-QAM,16-QAM, BFSK, MSK- Principle of working, PSD and Signal space analysis. LAN specific		
	3.3	Inter symbol Interference, Eye diagram,		
	3.4	Digital Modulation tradeoffs: Probability of Error evaluations of various modulations		
5	<b>Title</b>	<b>Spread Spectrum and OFDM</b>	1,2	04
	5.1	Direct sequence spread spectrum		
	5.2	Frequency hopping spread spectrum		
	5.3	OFDM		
6	<b>Self Study</b>	Applications and health, safety, and environment aspects of Analog and Digital communication techniques		06
<b>Total</b>				<b>28</b>





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## PCS-I Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Implementation of double sideband full carrier for various modulation index and demodulation
2	Implement the frequency modulation circuit to obtain FM waveforms and calculate modulation index
3	Implementation of natural sampling and reconstruction of waveforms
4	Implementation of pulse amplitude modulation.
5	LBC encoder and decoder
6	Implementation of Binary Phase Shift Keying
7	Implementation of Binary Frequency shift keying
8	Signal space analysis of QAM
9	PSD and ISI analysis of BPSK
10	BER analysis of BPSK without and with Convolutional codes

## PCS -II Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	<b>Getting Started with ARM Microcontrollers</b> <ul style="list-style-type: none"><li>• <b>Objective:</b> Learn the basics of ARM microcontrollers and set up the development environment.</li><li>• <b>Experiments:</b><ul style="list-style-type: none"><li>• Install ARM development tools (e.g., Keil, GCC, STM32CubeIDE, or others).</li><li>• Write and execute a simple "Hello, World!" program with onboard LED blinking.</li></ul></li></ul>



2	<p><b>GPIO and Basic Peripherals</b></p> <ul style="list-style-type: none"><li>• <b>Objective:</b> Understand General Purpose Input/Output (GPIO) and basic peripherals.</li><li>• <b>Experiments:</b><ul style="list-style-type: none"><li>• Control an LED using a GPIO pin.</li><li>• Read input from a push-button or switch.</li><li>• Implement Pulse Width Modulation (PWM) to control an LED's brightness.</li></ul></li></ul>
3	<p><b>Analog-to-Digital Conversion (ADC)</b></p> <ul style="list-style-type: none"><li>• <b>Objective:</b> Learn to read analog signals with ADC.</li><li>• <b>Experiments:</b><ul style="list-style-type: none"><li>• Read a value from a potentiometer.</li><li>• Connect a temperature sensor (e.g., LM35, TMP36) and read temperature data.</li></ul></li></ul>
4	<p><b>UART/Serial Communication</b></p> <ul style="list-style-type: none"><li>• <b>Objective:</b> Establish communication between the microcontroller and other devices via UART.</li><li>• <b>Experiments:</b><ul style="list-style-type: none"><li>• Set up a UART connection and send/receive data to/from a computer.</li><li>• Connect a serial-based sensor (e.g., GPS module) and extract information.</li></ul></li></ul>
5	<p><b>Interfacing with Digital Sensors</b></p> <ul style="list-style-type: none"><li>• <b>Objective:</b> Learn to connect and read data from digital sensors.</li><li>• <b>Experiments:</b><ul style="list-style-type: none"><li>• Connect a digital temperature/humidity sensor (e.g., DHT11/DHT22).</li></ul></li></ul>



	<ul style="list-style-type: none"><li>• Connect a motion sensor (e.g., PIR sensor).</li><li>• Connect a distance sensor (e.g., ultrasonic HC-SR04).</li></ul>
6	<b>Interfacing with Analog Sensors</b> <ul style="list-style-type: none"><li>• <b>Objective:</b> Connect and read data from analog sensors.</li><li>• <b>Experiments:</b><ul style="list-style-type: none"><li>• Connect an analog temperature sensor (e.g., LM35, TMP36).</li><li>• Use a photoresistor (LDR) to measure light intensity.</li><li>• Connect an analog accelerometer to measure acceleration.</li></ul></li></ul>
7	<b>Communication Protocols: I2C and SPI</b> <ul style="list-style-type: none"><li>• <b>Objective:</b> Learn to use I2C and SPI for sensor communication.</li><li>• <b>Experiments:</b><ul style="list-style-type: none"><li>• Connect and read data from an accelerometer (e.g., MPU6050) using I2C.</li><li>• Connect and control an OLED display via SPI.</li></ul></li></ul>
8	<b>Wi-Fi Communication</b> <ul style="list-style-type: none"><li>• <b>Objective:</b> Establish Wi-Fi connectivity for IoT applications.</li><li>• <b>Experiments:</b><ul style="list-style-type: none"><li>• Connect an ESP8266 or ESP32 module to the ARM microcontroller for basic Wi-Fi communication.</li><li>• Implement a simple HTTP server on the microcontroller to serve data.</li><li>• Send data to a cloud platform (e.g., ThingSpeak, AWS IoT, Google Cloud IoT).</li></ul></li></ul>
9	<b>Bluetooth/BLE Communication</b> <ul style="list-style-type: none"><li>• <b>Objective:</b> Explore Bluetooth connectivity for short-range communication.</li><li>• <b>Experiments:</b></li></ul>



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	<ul style="list-style-type: none"><li>• Connect to a Bluetooth module (e.g., HC-05/HC-06) and send/receive data to/from a smartphone.</li><li>• Implement BLE communication with a smartphone or another BLE-capable device.</li></ul>
10	<b>Integration with IoT Platforms</b> <ul style="list-style-type: none"><li>• <b>Objective:</b> Connect the microcontroller to an IoT platform for data monitoring and control.</li><li>• <b>Experiments:</b><ul style="list-style-type: none"><li>• Send sensor data to an IoT platform and visualize it.</li><li>• Set up IoT triggers to control microcontroller outputs (e.g., control an LED from a remote platform).</li></ul></li></ul>

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Principles of Communication Systems	2nd	Taub H. and Schilling D.L	Tata McGraw Hill	2001
2	Communications Systems	4th	Haykin S	John Wiley and Sons	2001

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital and Analog Communication	4th	B.P.Lathi	Oxford	2017
2.	Communication Systems Engineering	4th	Proakis J. G. and Salehi M.	Pearson Education	2002.
3.	Digital Communication	3rd	Haykin S	John Wiley and Sons	2001



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-03	Data Compression and Encryption	2	0	2	6	10	2	0	1	3
		<b>Examination Scheme</b>								
M033		Component		ISE (%)	MSE (%)	ESE (%)	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b>	
<ol style="list-style-type: none"> <li>1. To identify situations where lossless and lossy compression are required, distinguish between applications that benefit from each type of compression.</li> <li>2. To evaluate the limitations and drawbacks of existing data compression algorithms and standards.</li> <li>3. To comprehend the fundamental principles behind the design of encryption algorithms, including mathematical concepts such as permutations, substitutions, and modular arithmetic.</li> <li>4. To acquire a thorough grasp of the cryptographic mechanisms employed by each encryption technique and their relevance in modern cybersecurity practices.</li> </ol>	
<b>Course Outcomes (CO): At the end of the course students will be able to</b>	
M033.1	Identify the necessity for lossless and lossy compression and implement image, audio and video compression techniques.
M033.2	Analyze the advancements and limitations of data compression techniques over the past decade and assess the current state-of-the-art progress in the field of data compression.
M033.3	Demonstrate comprehension of the design process of encryption algorithms and the underlying mathematical principles involved.
M033.4	Analyze various encryption techniques, including DES, AES, SHA, RSA, and Diffie-Hellman, and their respective cryptographic mechanisms.

## CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M033.1	3			2	2				2			
M033.2		3		2	2	1			2			
M033.3			3	2	2				2			
M033.4		3			2	1			2			



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## BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember✓	Understand✓	Apply✓	Analyze✓	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Data Compression</b>	1,2	8
	1.1	Need for compression from information theory point of view. <b>Lossless Compression:</b> Arithmetic Coding, Dictionary based coding with applications, Image compression- CALIC and JPEG-LS.		
	1.2	<b>Lossy Compression:</b> Rate Distortion criteria, Quantization, Differential Encoding- Predictive coding, Differential pulse code modulation (DPCM), ADPCM, Delta modulation.		
	1.3	JPEG, Sub band coding, Wavelet based Image Compression JPEG2000.		
2	<b>Title</b>	<b>Audio and Video Compression</b>	1,2	6
	2.1	Introduction to Audio Coding, MPEG Audio Coding: Base and Advanced,		
	2.2	Video Coding: Video encoder decoder block diagram, Motion Estimation and Compensation, Few Fast Motion Estimation Schemes, Video compression Standards: MPEG-1, 2, 4, and H.264.		
3	<b>Title</b>	<b>Data Encryption</b>	1,2	5
	3.1	Basics of Encryption, Classical Ciphers and their working, Substitution cipher, transposition cipher, stream and block cipher, and arithmetic modes for block ciphers,		
	3.2	Security Goals and Notions.		
4	<b>Title</b>	<b>Number Theory and Cryptography</b>	1,2	9
	4.1	Essential Number Theory and Discrete Math, Primes, factorization, Fermat's little theorem, Euler's theorem, and extended Euclidean algorithm,		
	4.2	Information Security, Computational Security, DES, P-Box S-Box design. Cryptographic Hashes: SHA		
	4.3	Asymmetric Ciphers: RSA, Diffie-Hellman.		
5	<b>Self Study</b>	<b>Applications:</b> Key Management, Malware detection and Intrusion detection systems, Authentication, ethical hacking, etc.		
			<b>Total</b>	<b>28</b>



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## Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To create a program to compress text files using Arithmetic coding.
2	Developing a program to compress and decompress image files using Arithmetic coding.
3	Writing a program to encode images into the JPEG format and decode them back to their original form.
4	To perform $\mu$ law encoding to compress audio signals.
5	To develop DPCM encoder and decoder for audio signals
6	To implement one dimensional DCT to audio signals for compression.
7	To perform two dimensional DCT to images for compression.
8	To execute Caesar Cipher algorithm to encrypt and decrypt text messages.
9	Write a program to generate public and private keys using the RSA algorithm for secure communication.
10	To carry out Diffie-Hellman Key exchange between two parties

## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Introduction to Data Compression	4th	Khalid Sayood	Morgan Kaufmann Series	2012
2	Data Compression: Complete Reference	3rd	David Soloman	Springer-Verlag London	2004
3.	Cryptography and Network Security: Principles and Practice	8th	William Stallings	Pearson	2023



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## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	The Data Compression Book	2nd	Mark Nelson	BPB publication	2010
2.	Cryptography and Network Security	2nd	Behrouz Forouzan	McGraw-Hill	2011
3.	Cryptography & Network Security	3rd	Atul Kahate	Tata McGraw Hill	2017

## Online Resources:

- 1) [https://onlinecourses.swayam2.ac.in/nou24\\_cs19/preview](https://onlinecourses.swayam2.ac.in/nou24_cs19/preview)
- 2) [https://onlinecourses.nptel.ac.in/noc24\\_cs57/preview](https://onlinecourses.nptel.ac.in/noc24_cs57/preview)
- 3) <https://nptel.ac.in/courses/117104129>





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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)						Credits Assigned				
		L	T	P	Pr.	O	E	L	T	P	Pr.	Total
MDM-03	Wireless Communication and Networks	2	0	2	2	5	11	2	0	1	1	4
		<b>Examination Scheme</b>										
M034		<b>Component</b>		<b>ISE (%)</b>		<b>MSE (%)</b>		<b>ESE (%)</b>		<b>Total</b>		
		<b>Theory</b>		<b>20</b>		<b>20</b>		<b>60</b>		<b>100</b>		
		<b>Laboratory</b>		<b>80</b>		<b>--</b>		<b>20</b>		<b>100</b>		
		<b>Project</b>		<b>80</b>		<b>--</b>		<b>20</b>		<b>100</b>		

\*Pr. → Project

Pre-requisite Course Codes, if any.	
<b>Course Objective:</b> Aim to equip students with the knowledge, skills, and practical experience necessary to design, deploy, and manage wireless sensor networks effectively in various real-world scenarios.	
<b>Course Outcomes (CO):</b> <i>At the end of the course students will be able to</i>	
M034.1	Analyze and design wireless systems effectively, understanding RF communication basics, multiple access techniques, and channel coding methods.
M034.2	Comprehend mobile network operation principles and protocols, including cellular network architecture, multiple access techniques, and key technologies such as GSM, LTE, and 5G.
M034.3	Deploy and manage wireless networks securely and efficiently, utilizing protocols such as IEEE 802.11 for WLANs, Bluetooth, WiMAX, and internetworking protocols.
M034.4	Optimize wireless communication system performance by understanding antenna fundamentals, propagation path loss models, and signal reception impacts.
M034.5	Explore wireless sensor networks (WSNs) and Mobile Ad Hoc Networks (MANETs), learning sensor node architecture, network protocols, routing algorithms, and real-world deployment case studies.
M034.6	Gain insights into emerging wireless communication technologies like 5G and 6G, understanding their key features, potential applications, and security challenges, preparing them for contributing to the advancement of wireless communication systems.

## CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M034.1	3	2			2							
M034.2	3	2			2							
M034.3	3	2			2							
M034.4	3	2			2							
M034.5	3	2			2							
M034.6	3	2			2							



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## BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember✓	Understand✓	Apply✓	Analyze✓	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Wireless Communication and Networks</b>		4
	1.1	Introduction to wireless communication Basics of radio frequency (RF) communication		
	1.2	Frequency Division Multiple access, Time Division Multiple access, Spread Spectrum Multiple access, Space Division Multiple access, and OFDM.		
	1.3	Channel coding and error correction techniques		
	1.4	Signal propagation and path loss models		
2	<b>Title</b>	<b>Mobile Communication Systems</b>		5
	2.1	Cellular network architecture: Cell structure, handoff, frequency reuse		
	2.2	Multiple access techniques: FDMA, TDMA, CDMA, and their comparisons GSM (Global System for Mobile Communications): Architecture, operation principles, and protocols (e.g., call setup, handover) LTE (Long-Term Evolution): Evolution from GSM, key features, and functionalities (e.g., MIMO, OFDM)		
	2.2	Introduction to 5G technology: Design principles, key features, and potential applications		
3	<b>Title</b>	<b>Wireless Networking Protocols</b>		5
	3.1	IEEE 802.11 standard for Wireless Local Area Networks (WLANs), Network architecture (ad-hoc, infrastructure), access methods (CSMA/CA), and security (WEP, WPA, WPA2)		
	3.2	Bluetooth technology: Architecture, communication protocols, and applications (e.g., wearables, data transfer) WiMAX (Worldwide Interoperability for Microwave Access): Technology overview, comparison to WiFi, and applications Introduction to internetworking protocols for wireless networks (e.g., Mobile IP)		
4	<b>Title</b>	<b>Antennas and Propagation in Wireless Communication</b>		5
	4.1	<input type="checkbox"/> Antenna fundamentals: Types of antennas (dipole, parabolic, microstrip), radiation patterns, and polarization. <input type="checkbox"/> Antenna parameters: Gain, directivity, radiation resistance, and efficiency.		



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	<b>4.2</b>	Propagation path loss models: Free space, two-ray, and log-distance path loss models. Large-scale path loss and small-scale fading: Impacts on signal reception and mitigation techniques		
<b>5</b>	<b>Title</b>	<b>Applications in Wireless Communication</b>		<b>4</b>
	<b>5.1</b>	Introduction to WSNs: Applications in environmental monitoring, smart agriculture, and industrial automation. Sensor node architecture: Sensing unit, processing unit, and communication module.		
	<b>5.2</b>	Network protocols and routing for WSNs: Energy efficiency considerations, Data aggregation and security challenges in WSNs.		
	<b>5.3</b>	Case studies of WSN deployment in real-world scenarios		
<b>6</b>	<b>Title</b>	<b>Applications: Mobile Ad Hoc Networks (MANETs) and 5G/6G Technologies</b>		<b>5</b>
	<b>6.1</b>	Introduction to MANETs: Characteristics, routing protocols (e.g., AODV, DSR), and applications (e.g., disaster relief, temporary networks) Security challenges and solutions in MANETs Emerging trends in wireless communication: 5G and 6G technologies Key features of 5G (enhanced mobile broadband, ultra-reliable low latency communication, massive machine-type communication) Potential applications of 5G and 6G technologies (e.g., connected vehicles, smart cities, AR/VR)		
			<b>Total</b>	<b>28</b>

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Wireless Communications & Networks	Second	William Stallings	Pearson Education	2009
2	Fundamentals of Wireless Communication		David Tse and Pramod Viswanath	Cambridge University Press	2005
3	Computer Networks and Internets	Fifth	Douglas E. Comer	Pearson Education	2013
4	Antenna Theory and Design	Third	Constantine A. Balanis	John Wiley & Sons	2016

## Additional Resources:

- 5G Americas website: <https://www.5gamericas.org/>
  - IMT-2020 (5G) specifications: <https://www.itu.int/en/ITU-R/Documents/ITU-R-FAQ-IMT.pdf>
- SPIT/UG Syllabus/2023-24/ pg. 59



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- International Conference on Wireless Sensor Networks (SECON): <https://conferences.sigcomm.org/sigcomm/2023/>
- National Telecommunications and Information Administration (NTIA): <https://www.ntia.gov/>
- IEEE 802.11 standard: <https://standards.ieee.org/beyond-standards/the-evolution-of-wi-fi-technology-and-standards/>
- Bluetooth website: <https://www.bluetooth.com/>
- WiMAX Forum website: <https://wimaxforum.org/>
- 3GPP website: <https://www.3gpp.org/>
- LTE white paper: <http://lightspeedt.com/wp-content/uploads/2015/10/LTE-Brochure.pdf>

## Case Studies and Projects (1 credit)

Case studies on real-world deployments of wireless communication technologies

Group projects on designing and simulating wireless networks using software tools (e.g., ns-3, MATLAB)

Presentation of project findings and discussions on current trends and future directions in wireless communication and networks

- **Case Studies Evaluation:**

- Assessment Criteria:

1. Understanding of real-world deployments of wireless communication technologies
2. Ability to analyze and critique case studies.

- Evaluation Method:

1. Individual or group-based written assignments analyzing assigned case studies.
2. Evaluation rubric assessing comprehension, critical thinking, and analytical skills.

- **Group Project Evaluation:**

- Assessment Criteria:

1. Design and simulation of wireless networks using software tools.
2. Application of theoretical concepts to practical scenarios
3. Collaboration and teamwork within the group

- Evaluation Method:



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1. Group project report detailing the design, implementation, and simulation results.
  2. Evaluation rubric assessing technical accuracy, creativity, teamwork, and presentation quality.
  3. Peer evaluation component to assess individual contributions within the group.
- **Presentation and Discussion Evaluation:**
    - Assessment Criteria:
      1. Presentation of project findings and analysis
      2. Discussion of current trends and future directions in wireless communication and networks
      3. Engagement and participation in discussions
    - Evaluation Method:
      1. Individual or group presentations of project findings
      2. Evaluation rubric assessing clarity, depth of analysis, engagement, and contributions to discussions
      3. Instructor-led or peer-led discussions assessing understanding of current trends and ability to articulate insights



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## **MDM-04**

## **VLSI**

## **For CE/CSE**



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-04	Hardware Description Language (HDL) Programming	2	0	2	5	9	2	0	1	3
		Examination Scheme								
M041		Component		ISE (%)	MSE (%)	ESE (%)	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

<b>Pre-requisite Course Codes, if any.</b>	Problem Solving using Imperative, Programming, Digital Systems and Microprocessors, Problem Solving using OOPs.
<b>Course Objective:</b> The course aims to familiarize students with the syntax, semantics, and constructs of Verilog HDL to design, simulate, and verify of digital logic design, including combinational and sequential logic, finite state machines, and synchronous circuits. This includes understanding synthesis process, where HDL descriptions are translated into actual hardware implementations. Students learn about synthesis tools, timing constraints, and optimizing designs for area, power, and performance. The course also aims to provide students with insights into industry practices, standards, and emerging trends in digital hardware and emerging technologies (e.g., hardware accelerators for AI/ML).	
<b>Course Outcomes (CO): At the end of the course students will be able to</b>	
M041.1	Demonstrate understanding of basic FPGA design flow and FPGA architecture
M041.2	Write Verilog code for a given digital design using fundamental concepts of Verilog language
M041.3	Construct combinational and sequential circuits in different modelling styles using Verilog HDL.
M041.4	Implement a given digital design problem using Verilog on FPGA platform

## CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M041.1	3		3		3			1	3	1		1
M041.2	3		3		3			1	3	1		1
M041.3	3		3		3			1	3	1		1
M041.4	3		3		3			1	3	1		1

## BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>FPGA Design Flow</b>	1,2	8
	1.1	India Semiconductor Industry and GoI policies.		
	1.2	Need of HDL, FPGA Design Flow and EDA tools		
	1.3	FPGA Architecture Fundamentals, Different FPGAs available in the market and their applications		
2	<b>Title</b>	<b>Fundamentals of Verilog</b>	1,2	4
	2.1	Verilog Program Structure and concept of testbench		
	2.2	Language constructs, Verilog datatypes, Operators etc.		
3	<b>Title</b>	<b>Design abstractions and Modeling Styles</b>	1,2	8
	3.1	Design Abstractions, Behavioral, Data flow, Gate level and Switch level modelling		
	3.2	Procedural Assignment and Continuous Assignment		
4	<b>Title</b>	<b>Finite State Machines</b>	1,2	8
	4.1	Verilog code for both Mealy & Moore FSM		
5	<b>Self Study</b>	<b>Verilog Models for Memories and Buses:</b> Static RAM Memory, a simplified 486 Bus Model, UART Design, Datapath and Controller Design	Online Resource 2	*5
<b>Total (*Not included)</b>				<b>28</b>

## Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Design, simulate and synthesis any combinational digital design using structural modelling and carry out physical verification on given FPGA. a. Logic Gates b. 4-bit Ripple Carry Full Adder by instantiating one-bit full adder c. 2:1 Mux: Using case Statement
2	Design, simulate and synthesis any sequential digital design with behavioral modelling and carry out physical verification on given FPGA. a. D Flip Flop using gates b. S-R Flip Flop c. 8-Bit Up Counter with Load
3	Create an ALU module capable of performing basic arithmetic and logical operations like addition, subtraction, AND, OR, XOR, etc.
4	Implement a floating-point arithmetic unit capable of performing operations on floating-point numbers following IEEE 754 standards.





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5	Design of greatest common divisor using both data-path and control path implementation in Verilog HDL.
6	Design and simulate Round Robin arbiter using behavioral modelling.
7	Design, simulate and synthesis Verilog code using FSM for any one of the following: i. Elevator operation with 4x4 hex key pad input and display the output in LCD. ii. Traffic Light controller using Finite State machine.
8	Develop a Verilog code for any of the concepts of computer organizations like: Implement an I2C controller module for communication with I2C-compatible devices like sensors, EEPROMs, and RTCs. ii. Develop a controller module for interfacing with SPI flash memory chips commonly used for program storage in embedded systems. iii. Design a module to convert UART serial data to Ethernet frames for network communication.
9	Develop a Verilog code for algorithms in the areas like machine learning or cryptography using specialized hardware, such as SoC for faster processing.
10	Mini projects as an application of Verilog programming.

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Verilog HDL: A Guide to Digital Design and Synthesis	2 <sup>nd</sup>	Samir Palnitkar	Pearson Education	2009
2	Advanced Digital Design with Verilog HDL	2 <sup>nd</sup>	Michel D. Ciletti	PHI	2009

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Verilog HDL Primer	3 <sup>rd</sup>	Bhasker J	BSP	2001
2	Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog	6 <sup>th</sup>	Michel D. Ciletti	Pearson Education	2018
3	Design through Verilog HDL	2 <sup>nd</sup>	Padmanabhan, Tripura Sundari	Wiley	2016

Online Resources: 1. <https://nptel.ac.in/courses/106/105/106105165/>  
2. <https://archive.nptel.ac.in/courses/106/105/106105165/>



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-04	Digital CMOS VLSI Design	3	0	2	5	10	3	0	1	4
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)		Total	
M042		Theory		20		20		60		100
		Laboratory		80		--		20		100

<b>Pre-requisite Course Codes, if any.</b>	Basic Electrical Engineering, Electronic Devices and Circuits (EDC), Analog Signal Integrated Circuits, Hardware Description Language (HDL) Programming
<b>Course Objective:</b> Today's growth in the electronics sector is due to improvements in semiconductor chip design. VLSI course is the foundation course introduced to teach fundamentals of MOSFET based logic circuit design. The primary objective of this course is to impart basic knowledge required to study advanced courses in VLSI domain.	
<b>Course Outcomes (CO):</b> <i>At the end of the course students will be able to</i>	
M042.1	Discuss structure, operation, scaling theory for MOSFET
M042.2	Design MOSFET based inverter circuits with given constraints
M042.3	Analyze MOSFET based combinational and sequential logic circuits
M042.4	Realize MOSFET based logic circuits with different design styles

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M042.1	3			3	3			1	3	1		
M042.2	3	3		3	3			1	3	1		
M042.3	3		3	3	3			1	3	1		
M042.4	3		3	3	3			1	3	1		

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Review of MOSFET Physics</b>	1	8
	1.1	Threshold Voltage Equation, MOSFET Structure and Operation		
	1.2	MOSFET Scaling, Types of scaling and small geometry effects		
2	<b>Title</b>	<b>MOSFET Inverters</b>	1	10
	2.1	Static Characteristics of resistive load and CMOS Inverter, comparison of all types of MOS inverters		
	2.2	Dynamic Characteristics of inverters, design of CMOS inverters with constraints		
3	<b>Title</b>	<b>Combinational MOS Logic Circuits</b>	1,2	10
	3.1	MOS Logic Circuits with Depletion NMOS Loads and CMOS Logic Circuits		
	3.2	Complex Logic Circuits and Concept of equivalent CMOS inverter		
4	<b>Title</b>	<b>Dynamic Logic Circuits</b>	1	10
	4.1	Static CMOS, pass transistor logic, transmission gate		
	4.2	Pseudo NMOS, Domino, NORA, Zipper, C <sup>2</sup> MOS		
5	<b>Title</b>	<b>Sequential MOS Logic Circuits</b>	1,2	4
	5.1	Behavior of Bi-stable Elements		
	5.2	<b>Circuit Realization:</b> SR Latch, JK FF, D FF		
	<b>Title</b>	<b>Semiconductor Memories</b>		
6	<b>Self Study</b>	ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits), DRAM (Operation 3T, 1T, operation modes, leakage currents, refresh operation, Input-Output circuits), Flash (mechanism, NOR flash, NAND flash), Peripheral Circuits: Sense amplifier, decoder	Online Resource 1	5*
<b>Total (*Not included)</b>				<b>42</b>

## Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	To develop a program using any programming language to plot the NMOS and PMOS Transistor VI characteristics.
2	To analyze NMOS and PMOS Transistor VI characteristics.
3	To simulate Resistive Load Inverter and CMOS Inverter, verify the VTC. Compare both the topologies. Comment on the Noise Margins.
4	Implement CMOS NAND, NOR, AND, OR using Static CMOS Logic.
5	Design and implement 2:1 Mux using different CMOS Logic styles.
6	Design and implement given Boolean equation using different CMOS Logic styles.



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7	Simulate Pseudo NMOS Inverter and comment on the result.
8	Design and implement given equation using Pseudo NMOS, Domino Logic and C <sup>2</sup> MOS Logic
9	To design, analyze and simulate the ring oscillator.
10	Simulate Clocked JK and D Flip Flop using Static CMOS Logic.

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Electronic circuits: analysis and design	3 <sup>rd</sup>	Donald Neaman	Tata McGraw Hill	2006
2	CMOS Digital Integrated Circuits Analysis and Design	4 <sup>th</sup>	Sung-Mo Kang, Yusuf Leblebici	Tata McGraw Hill	2003

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Integrated Circuits: A Design Perspective	2 <sup>nd</sup>	Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic	Pearson Education	2019
2	Introduction to VLSI Circuits and Systems	Student Edition	John P. Uyemura	Wiley	2013

Online Resource: 1. [https://onlinecourses.nptel.ac.in/noc21\\_ee09](https://onlinecourses.nptel.ac.in/noc21_ee09)



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-04	VLSI Physical Design	2	0	2	5	9	2	0	1	3
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)		Total	
M043		Theory		20		20		60		100
		Laboratory		80		--		20		100

<b>Pre-requisite Course Codes, if any.</b>	Basic Electrical Engineering, Electronic Devices and Circuits (EDC), Analog Signal Integrated Circuits, Basic CMOS VLSI Design, Hardware Description Language (HDL) Programming
<b>Course Objective:</b>	The objectives of the course to entail a basic understanding of CMOS technology, transistor-level design, and circuit implementation enough to navigate through the physical design flow. It focuses on understanding algorithms used for floorplanning, placement, routing, clock tree synthesis, and final verification using DRC and LVS checks while optimizing performance, power, and area metrics alongside introduction to industry-standard CAD tools for VLSI physical design.
<b>Course Outcomes (CO):</b>	<i>At the end of the course students will be able to</i>
M043.1	Sketch the layout of CMOS VLSI circuits.
M043.2	Understand physical design techniques, including partitioning, chip planning, placement, and routing to optimize performance, power, and area in VLSI circuits.
M043.3	Understand the principles and techniques of Static Timing Analysis (STA), analyze and ensure that synchronous circuits meet timing requirements, including setup, hold, and clock-to-q delays.
M043.4	Apply optimization algorithms to efficiently partition chips, plan layouts, and place and route VLSI circuits, as well as clock routing algorithms for analyzing performance and area utilization of VLSI design.
M043.5	Effectively utilize Electronic Design Automation (EDA) tool for physical design tasks, static timing analysis, and verification.

## CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M043.1	2		3		3			1	1	1		1
M043.2	2		3		3			1	1	1		1
M043.3	2		3		3			1	1	1		1
M043.4	2		3		3			1	1	1		1
M043.5	2		3		3			1	1	1		1



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## BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Introduction to VLSI Physical Design &amp; Static Timing Analysis</b>	1	8
	1.1	Introduction, Physical Design flow, Physical Verification, EDA Tools for Physical Design, Data Structures and Algorithms for Physical Design		
	1.2	Necessity of Design rules and Lambda based design rules, Layout of inverters and basic gates.		
	1.3	Introduction (STA, DTA, Behavior of synchronous circuit, Timing Arcs and Unateness, Definitions – Setup, Hold, Latch, Flipflop, STA for Flipflop and Latch		
2	<b>Title</b>	<b>Partitioning, Chip Planning and Placement</b>	1	8
	2.1	Introduction and Optimization goals, KL-Algorithm, Extensions of KL-Algorithm, FM-Algorithm, Multilevel Partitioning		
	2.2	Introduction and Optimization goals, Floor planning Representations, Floor planning Algorithms		
	2.3	Introduction and Optimization goals, Min-cut placement, Analytic Placement, Simulated Annealing, Modern Placement Algorithms		
3	<b>Title</b>	<b>Routing: Global and Detailed</b>	1,2	6
	3.1	Introduction and optimization goals, Single net routing (Rectilinear routing), Global routing in the connectivity graph, finding shortest paths with Dijkstra's Algorithm, Horizontal and vertical constraint graphs, Channel Routing Algorithms, Switch box routing algorithms, Over the cell routing algorithms, Power and Ground routing, Unified Power Format and Special cells used for Power Planning		
4	<b>Title</b>	<b>Routing: Clock Routing</b>	1	6
	4.1	Clocking Schemes and Design Considerations, Clock Routing algorithms – 1 (H-tree based and MMM algorithms), Clock Routing algorithms – 2 (Geometric matching and Weighted center algorithms), Clock Routing algorithms – 3 (Exact zero skew and DME algorithm), Skew, Latency, Uncertainty, and Jitter		



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	<b>Self Study</b>	<b>Machine Learning for Physical Design:</b> Machine Learning Models, Predict Path-Based Slack from Graph-Based Timing Analysis, Data collection, Model creation and predicting data	Online Resource 1	<b>5*</b>
<b>Total (*Not included)</b>				<b>28</b>

**Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)**

Sr. No	Title of the Experiment
1	Sketch the circuit and Layout for CMOS inverter using CAD tool.
2	Sketch the circuit and Layout for CMOS AND/OR gate using CAD tool.
3	Sketch the circuit and Layout for Flip Flop using CAD tool.
4	Use Electronic Design Automation (EDA) tool for physical design tasks including partitioning, chip planning, placement, and routing to optimize performance, power, and area in any VLSI circuit.
5	Use Electronic Design Automation (EDA) tool to perform Static Timing Analysis for latch and flip-flop using CAD tool.
6	Develop a program for chip partitioning algorithm and simulate VLSI chip partitioning
7	Develop a program for chip planning algorithm and simulate VLSI chip planning
8	Develop a program for placement algorithm and simulate placement of circuit modules
9	Simulate algorithm for global and detailed routing to simulate exact pathways for interconnecting standard cells, macros, and I/O pins.
10	Develop a program for clock routing algorithm to simulate interconnection of multiple clocked cells to a single clock generator.

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	VLSI Physical Design: From Graph Partitioning to Timing Closure	1 <sup>st</sup>	Kahng, A.B., Lienig, J., Markov, I.L., Hu, J.	Springer	2014
2	Algorithm for VLSI Physical Design Automation	2 <sup>nd</sup>	Sherwani, N.A.	Kluwer	2012

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Static Timing Analysis for Nanometer Designs: A Practical Approach	1 <sup>st</sup>	J. Bhasker and Rakesh Chadha	Springer	2009



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2	Advanced ASIC Chip Synthesis: Using Synopsys Design Compiler Physical Compiler and Prime Time	2 <sup>nd</sup>	Bhatnagar, H.	Kluwer Academic Publishers: New York	2013
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Online Resource: 1. [https://onlinecourses.nptel.ac.in/noc21\\_cs12/preview](https://onlinecourses.nptel.ac.in/noc21_cs12/preview)





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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-04	ASIC Verification	3	--	2	5	10	3	--	1	4
		Examination Scheme								
M044		Component		ISE (%)	MSE (%)	ESE (%)	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

<b>Pre-requisite Course Codes, if any.</b>	Basic Electrical Engineering, Problem Solving using Imperative, Programming, Problem Solving using OOPs, Hardware Description Language (HDL) Programming, Basic CMOS VLSI Design, VLSI Physical Design
<b>Course Objective:</b> The course aims to familiarize students and select the verification methodology like simulation-based verification, formal verification, and hardware emulation based on their strengths, weaknesses, and when to use each approach. It would lead to building proficiency in hardware description System Verilog, as well as verification languages like System Verilog Assertions (SVA) and Universal Verification Methodology (UVM). Learners will be able to develop comprehensive testbenches that thoroughly exercise the ASIC design under various conditions to identify bugs and ensure functional correctness. Proficiency in using industry-standard verification tool, formal verification tools and debugging tools.	
<b>Course Outcomes (CO): At the end of the course students will be able to</b>	
M044.1	Recognize trends in ASIC verification
M044.2	Apply System Verilog constructs for verification
M044.3	Create testbenches, threads and show inter-process communication
M044.4	Create test cases under constrained environment
M044.5	Validate design with System Verilog assertions and functional coverage

## CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M044.1	1							1	1	1		2
M044.2	3		3	3	3			1	1	1		1
M044.3	3		3	3	3			1	1	1		1
M044.4	3		3	3	3			1	1	1		1
M044.5	3		3	3	3			1	1	1		1



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## BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand√	Apply√	Analyze√	Evaluate√	Create√
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Basics of System Verilog</b>	1 (T), 5 (R)	4
	1.1	<b>Verification Basics:</b> Technology challenges, Verification methodology, Testbench creation, Verification languages, Verification IP reuse, Verification approaches, Verification plans		
2	<b>Title</b>	<b>Data types, procedural statements and testbench</b>	1 (T), 1 (R), 3 (R)	8
	2.1	<b>Data Types:</b> Built in, Fixed size array, dynamic array, queues, associative array, linked list, array methods, choosing a storage type, creating new types with typedef, creating user-defined structures, type conversion, enumerated types, constants, strings, expression width		
	2.2	<b>Procedural Statements and Routines:</b> Procedural statements, tasks, functions and void functions, task and function overview, routinearguments, returning from a routine, local data storage, time values		
	2.3	<b>Connecting the Testbench and Design:</b> Separating the testbench and design, the interface construct, stimulus timing, interface driving and sampling, top-level scope, program-module, interactions	1 (T), 1 (R), 3 (R)	
3	<b>Title</b>	<b>OOP and Randomization</b>	1 (T), 1 (R), 3 (R)	10
	3.1	<b>Basic OOP:</b> Class, creating new objects, Object deallocation, using objects, variables, class methods, defining methods outside class, scoping rules, using one class inside another, understanding dynamic objects, copying objects, public Vs local, building a testbench		
	3.2	<b>Randomization:</b> Randomization in system Verilog, constraint details, solution probabilities, controlling multiple constraint blocks, valid constraints, In-line constraints, pre-randomize and post-randomize functions, Random number functions, Constraints tips and techniques, common randomization problems, Iterative and array constraints, Atomic stimulus generation Vs scenario generation, random control, random number generators, random device configuration		
4	<b>Title</b>	<b>IPC and advanced OOP</b>	1 (T), 1 (R), 3 (R)	12
	4.1	<b>Threads and Interprocess Communication:</b> working with threads, disabling threads, interprocess communication, events,		



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		semaphores, mailboxes, building a testbench with threads and IPC		
	4.2	<b>Advanced OOP and Testbench Guidelines:</b> Inheritance, Blueprintpattern, downcasting and virtual methods, composition, inheritance and alternatives, copying an object, abstract classes and pure virtualmethods, callbacks, parameterized classes		
5	<b>Title</b>	<b>Assertions and Functional Coverage</b>	1 (T), 1 (R), 2 (R), 4 (R)	8
	5.1	<b>System Verilog Assertions:</b> Assertions in verification methodology, understanding sequences and properties, System Verilog Assertions in the Design Process, Formal Verification Using Assertions and System Verilog Assertions Guidelines		
	5.2	<b>Functional Coverage:</b> Coverage types, strategies, examples, anatomy of a cover group, triggering a cover group, data sampling, cross coverage, generic cover groups, coverage options, analyzing coverage data, measuring coverage statistics during simulation		
	<b>Self Study</b>	<b>Advanced Interfaces:</b> Virtual interfaces with the ATM router, connecting to multiple design configurations, procedural code in an interface, <b>A complete System Verilog Testbench:</b> Design blocks, testbench blocks, alternate tests, <b>Interfacing with C:</b> Passing simple values, connecting to a simple C routine, connecting to C++, simple array sharing, open arrays, sharing composite types, pure and context imported methods, communicating from C to system Verilog, connecting other languages	1 (T), 1 (R), 2 (R), 4 (R)	5*
<b>Total (*Not included)</b>				<b>42</b>

**Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)**

Sr. No	Title of the Experiment
1	Design MUX and D-FF modules with parameters to enable students to understand how different parameters influence module behavior and functionality.
2	Familiarization of simulation tool for verification of design using System Verilog. Simulate MUX and D-FF.
3	Complete the given task on literals and data types in System Verilog. Also write the simulation output for the given Procedural Statements
4	Write the simulation output for the given Interprocess Communication
5	Write the simulation output for the given randomization code
6	Write the simulation output for the given Interfaces, Program and Clocking Blocks
7	Write the simulation output for the given Processes
8	Write the simulation output for the given Functional Coverage
9	Write the simulation output for the given Assertions



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10	<p>Open-ended problem: Apply System Verilog concepts to any real-life application and its execution/implementation.</p> <p>i. <b>Designing and Verifying Peripheral Interfaces:</b> Design, verify, and simulate interfaces like UART, SPI, I2C, or PCIe using System Verilog to ensure compatibility and reliability in ASIC designs.</p> <p>ii. <b>Developing Verification IP (VIP):</b> Create Verification IP (VIP) for popular protocols or interfaces, such as USB, Ethernet, or HDMI, to be used in larger ASIC verification environments.</p> <p>iii. <b>Verifying ASIC Components for IoT Devices:</b> Verify ASIC components like sensors, communication modules, or processing units for Internet of Things (IoT) devices, ensuring low power consumption, reliability, and interoperability.</p> <p>iv. <b>ASIC Verification for Automotive Electronics:</b> Verify ASIC components used in automotive electronics, such as engine control units, safety systems, or infotainment systems, to ensure compliance with industry standards and safety requirements.</p> <p>v. <b>ASIC Verification for Consumer Electronics:</b> Verify ASIC components for consumer electronics devices like smartphones, tablets, or gaming consoles, ensuring functionality, performance, and compatibility with diverse hardware and software environments.</p>
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## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	System Verilog for Verification: A guide to learning the testbench language features	2 <sup>nd</sup>	Chris Spear	Springer	2010

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	System Verilog for Design: A guide to using system Verilog for hardware design and modeling	2 <sup>nd</sup>	Stuart Sutherland, Simon Davidmann, and Peter Flake	Springer	2006
2	System Verilog Assertions Handbook	4 <sup>th</sup>	Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper	VhdlCohen Publishing	2015
3	System Verilog Language Reference manual	--	--	--	--
4	System on Chip Verification Methodologies and Techniques	1 <sup>st</sup>	S Prakash Rashinkar, Peter Paterson and Leena Singh	Kluwer Academic	2003

## Online Resource:

<https://elearn.nptel.ac.in/shop/iit-workshops/completed/workshop-on-soc-verification/?v=c86ee0d9d7ed>  
SPIT/UG Syllabus/2023-24/ pg. 76



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## **M.D.M. Offered by CE/CSE Department for students of EXTC**



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# Bharatiya Vidya Bhavan's Sardar Patel Institute of Technology

(Autonomous Institute Affiliated to University of Mumbai)



## Department of Computer Science and Engineering

### SYLLABUS

### MDM Sequels for EXTC

w.e.f. AY 2023-24

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VII)
Computer Engineering	M051: Database Management Systems	M052: Data Structures and Algorithms	M053: Cloud Computing	M054: Internet and Web Technology + DevOps (Project)
Artificial Intelligence and Machine Learning	M061: Fundamentals of NNFL (NN, Fuzzy)	M062: Artificial Intelligence Machine Learning (AI, ML, Deep Learning)	M063: Natural Language Processing	M064: Image Processing and Pattern Recognition + Project
Data Science	M071: Fundamentals of Data Science	M072: Data Analytics and Visualization	M073: Decision Making and Business Intelligence	M074: Social Media Analytics
Interface and Experience Design	M081: UI/UX Fundamentals	M082: Design Thinking and Innovations	M083: Human Computer Interaction	M084: Total Experience Design



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<b>Course Category of Multidisciplinary Minor</b>	<b>MDM-I (Semester IV)</b>
<b>Computer Engineering</b>	<b>M051:</b> Database Management Systems
<b>Artificial Intelligence and Machine Learning</b>	<b>M061:</b> Fundamentals of NNFL
<b>Data Science</b>	<b>M071:</b> Fundamentals of Data Science
<b>Interface and Experience Design</b>	<b>M081:</b> UI/UX Fundamentals





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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-05	Database Management Systems	2	0	2	4	08	3	0	0	3
		<b>Examination Scheme</b>								
M051		<b>Component</b>		<b>ISE</b>		<b>MSE</b>		<b>ESE</b>	<b>Total</b>	
		<b>Theory</b>		<b>20</b>		<b>20</b>		<b>60</b>	<b>100</b>	
		<b>Laboratory</b>		<b>80</b>		<b>--</b>		<b>20</b>	<b>100</b>	

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b>	
<b>Learning Outcomes (LO): At the End of the course students will be able to</b>	
M051.1	Demonstrate understanding of given system to construct a database model
M051.2	Apply various Relational and SQL commands on the populated database
M051.3	Examine the functional dependencies to make a normalized database system and transaction processing techniques on a database
M051.4	Illustrate query processing and optimization method on a database

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze	Evaluate	Create
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### Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Database Concepts and ER Modeling</b>	1,2	05
	1.1	Introduction to basic concept of Database, File system V/s Database system, Users of Database system, Database Administrator, Data Independence		
	1.2	The Entity-Relationship (ER) Model, Extended Entity-Relationship (EER) Model, Database integrity		
2	<b>Title</b>	<b>Relational Algebra And SQL</b>	1,2	07
	2.1	Relational model, Relational query languages, Relational algebra, Tuple and domain calculus		
	2.2	Structured Query Language: Data Definition Commands, Data Manipulation commands, Data Control commands, Join expressions, views, Triggers		
3	<b>Title</b>	<b>Normalization And Transaction Processing</b>	1,2	05
	3.1	Design guidelines for relational schema, Functional dependencies		
	3.2	Normal Forms- 1NF, 2 NF, 3NF, BCNF		
4	<b>Title</b>	<b>Transaction Processing</b>	1,2	06
		Transactions, ACID properties, Concurrency Control, Recovery		
		Serializability, Recoverability, Lock-based, Timestamp-based, Validation-based protocols.		



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5	<b>Title</b>	<b>Indexing And Query Optimization:</b>	1,2	05
	4.1	Row-wise and column database, database buffering. Indexing, B+-tree indices		
	4.2	Query Processing, Query Optimization		
6	<b>Self Study</b>	NO SQL-Data type, Database creation, Basic command for creation, updating and querying the database, Mongo dB, Applications of Hyper Graph DB, cloud database		
<b>Total</b>				<b>28</b>

Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

SN	Title of the Experiment
1	Formulate a case study and create an E-R Diagram. Mapping of E-R model to Relational Model.
2	To create a database and populate using SQL commands (With constraints) • Data Definition Language- Create, Alter, Drop, Rename, Truncate • Data Manipulation Language- Insert, Update, Delete, Select Constraints-Not Null, Unique Key, Primary Key, Foreign Key, Check, Dropping a Constraint
3	To perform DCL, TCL commands • Data Control Language: Grant, Revoke, Roles • Transaction Control Language: Commit, Rollback, Save point
4	To perform Date, Time, Arithmetic and Set operation on database.
5	To perform Aggregate function and Group by- Having clause on database
6	To perform Join operations on database. • Equijoins, Non-Equijoins, Self Joins, Outer Join, cross Join
7	To retrieve data using a Subquery.
8	To Create a different view of the database.
9	To examine the integrity of the database using Triggers.
10	To study distributed databases/Normalization

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Database System Concepts	7 <sup>th</sup>	Korth, Slberchatz, Sudarshan	McGraw – Hill	2019
2	Fundamentals of Database Systems	6 <sup>th</sup>	Elmasri and Navathe	PEARSON Education	2011

## ©Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Database Management Systems	3 <sup>rd</sup>	Raghu Ramkrishnan and Johannes Gehrke	TMH	2003
2	Database Management Systems	1 <sup>st</sup>	G. K. Gupta	McGraw – Hill.	2018



Bharatiya Vidya Bhavan'

# Sardar Patel Institute of Technology

(Autonomous Institute Affiliated to University of Mumbai) Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-06	Fundamentals of NNFL	2	0	2	4	8	2	0	1	3
		<b>Examination Scheme</b>								
M061		<b>Component</b>		<b>ISE</b>	<b>MSE</b>	<b>ESE</b>	<b>Total</b>			
		<b>Theory</b>		<b>20</b>	<b>20</b>	<b>60</b>	<b>100</b>			
		<b>Laboratory</b>		<b>80</b>	<b>--</b>	<b>20</b>	<b>100</b>			

<b>Pre-requisite Course</b> Basic understanding of mathematics, probability, and programming.	
<b>Course Objective:</b> This course focuses on the fundamental of Neural networks and Fuzzy Logic along with its application. Students will be able to design an expert system using neural networks and Fuzzy logic system for implementation of real-world applications.	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M061.1	Identify the various characteristics of Neural Network techniques in building intelligent machines
M061.2	Apply the supervised and unsupervised Neural Network Learning algorithm to solve real world engineering problems.
M061.3	Design Fuzzy Logic Controller System

## CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO12	PSO1
M061.1	2	2	--	2	--	--	--
M061.2	2	2	--	2	3	2	1
M061.3	2	2	2	2	3	2	1

## BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	<u>Apply</u>	Analyze	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Neural Networks</b>	T1, T2 T3, R1	12
	1.1	<b>Basics of Neural Networks:</b> Introduction to Neural Networks, Biological Neural Networks, Models of ANN with its terminologies, Activation functions and its types		
	1.2	McCulloch-Pitts Model, Linear separability, Hebb Network		
	1.3	<b>Supervised Learning algorithms:</b> Perceptron (Single-Layer perceptron: Learning Rule and Applications), Multi-Layer Perceptrons (MLPs), Backpropagation Algorithm: Training MLPs Activation Functions Vanishing Gradient Problem and Solutions		
	1.4	<b>Un-Supervised Learning algorithms:</b> Hebbian Learning, Winner takes all, Self-Organizing Maps KSOFMN, Learning Vector Quantization.		
2	<b>Title</b>	<b>Fuzzy Logic, Classical Set and Fuzzy Relations</b>	T2, T3,T4, R1, R3	10
	2.1	Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Functions, Classical and Fuzzy set operations, and properties of classical and Fuzzy sets. Fuzzy Logic Operators: AND, OR, NOT		
	2.2	Classical and Fuzzy Relations: Cartesian product of relation, Fuzzy Max-Min and Max-Product Composition, Fuzzy extension principle		
3	<b>Title</b>	<b>Fuzzy control system design</b>	T2, T3 T4	6
	3.1	Fuzzy Inference System and its types, Fuzzification, Defuzzification, Designing Fuzzy logic control systems.		
	3.2	Mamdani and Sugano Fuzzy Inference Systems		
4	<b>Self-Study</b>	Associative Memory Network, Architecture of Neuro-Fuzzy Networks (ANFIS and CANFIS), Performance Metrics for Neural Networks and Fuzzy Logic Systems, Model Evaluation Techniques: Cross-Validation, ROC Analysis, Optimization Techniques: Genetic Algorithms, Particle Swarm Optimization	-	5
			<b>Total</b>	<b>28</b>



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## Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	To implement Transfer/Activation Functions for a given problem statement.
2	To design ANN to implement logic gates.
3	To implement Hebb Network for a given problem statement.
4	To design and implement ANN (perceptron) for a given problem statement using Joone Editor
5	Write a program using Single Layer perceptron
6	To implement the Supervised Learning algorithm.
7	To implement the Unsupervised Learning algorithm
8	To implement Fuzzy Sets for a given problem statement
9	To implement Fuzzy Relations for a given problem statement
10	To design and implement Fuzzy Logic controller for a given problem statement

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
T1	Introduction to Artificial Neural Systems	1st	Jacek M. Zurada	Jaico Publisher	1994
T2	Principles of Soft Computing	3rd	Sivanandan and Deepa	Pearson Edition	2019
T3	Fuzzy logic with engineering applications	3rd	Ross, Timothy J	John Wiley & Sons	2011
T4	Neural Networks, Fuzzy Logic and Genetic Algorithms	Kindle	S.Rajasekaran and G.A.Vijayalakshmi Pai	PHI Learning	2013

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
R1	Neural Network Design	2nd	Hagan, Demuth, Beale	CENGAGE Learning	2014
R2	Neuro-Fuzzy and Soft Computing	1st	J.-S.R.Jang .	Pearson	1996
R3	Introduction to Soft Computing	1st	Sameer Roy	Pearson	2013



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-07	Fundamentals of Data Science	2	0	2	5	10	2	0	1	3
		<b>Examination Scheme</b>								
M071		<b>Component</b>		<b>ISE</b>		<b>MSE</b>		<b>ESE</b>		<b>Total</b>
		<b>Theory</b>		<b>20</b>		<b>20</b>		<b>60</b>		<b>100</b>
		<b>Laboratory</b>		<b>80</b>		<b>—</b>		<b>20</b>		<b>100</b>

<b>Pre-requisite Course Codes, if any.</b>	—
<b>Course Objective:</b> To provide students with a comprehensive understanding of the fundamental concepts, tools, and techniques used in data science and data visualization. This course is designed to introduce students to the basic principles of data science and data visualization, including libraries used for Data Science, data exploration, data preprocessing, EDA, data visualization and basic model building.	
<b>Learning Outcomes (LO):</b> <i>At the End of the course students will be able to</i>	
M071.1	Demonstrate the need of libraries used in Data Science.
M071.2	Make use of different tools and techniques for Data Visualization
M071.3	Analyze the data performance using the EDA process.
M071.4	Develop Linear Regression and Logistic Regression Models for a given case study.

### LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
M071.1	-	2	-	2	3	-	-	-	-	-	-	-
M071.2												
M071.3	2	2	2	2	3	-	-	-	-	-	-	-
M071.4	-	2	2	-	3	-	-	-	1	1	-	-

### LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
M071.1							
M071.2							
M071.3							
M071.4							

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply	Analyze ✓	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Python for Data Science</b>		<b>06</b>
	1.1	Introduction to Data Science and its roles in Modern Society, Descriptive Statistics		
	1.2	Working with Numpy Basics of Numpy, Creating NumPy Arrays, Mathematical Operations on NumPy Arrays	1,2,3	
	1.3	Working with Pandas Basics of Pandas, Data Frames, Indexing and Slicing, Operations on Data Frames, Group By and Aggregate Functions, Merging Data Frames, Pivot Tables	1,2,3	
2	<b>Title</b>	<b>Data Visualization</b>		<b>06</b>
	2.1	Data Visualization using Matplotlib Bar Graphs, Scatter Plots, Line Graphs, Histogram, Box Plots, Sub Plots	1,3,7	
	2.2	Data Visualization using Seaborn Distribution Plots, Pie Charts, Bar Charts, Scatter Plots, Box Plots, Pair Plots, Heat Maps, Line Charts	1,3,8	
4	<b>Title</b>	<b>Data Preprocessing and Exploratory Data Analysis</b>		<b>06</b>
	4.1	Data Sourcing Public Data and Private Data, Web Scraping	5,6	
	4.2	Data Cleaning Fixing the rows and columns, Overfitting and Underfitting, Impute/Remove missing values, Feature Engineering Techniques, Feature Reduction Techniques, Handling Outliers, Standardizing values	5,6	
	4.3	Univariate Analysis Categorical Ordered and Unordered Univariate Analysis	5,6	
	4.4	Bivariate and Multivariate Analysis Numerical-Numerical Analysis, Numerical-Categorical Analysis, Categorical-Categorical Analysis	5,6	
5	<b>Title</b>	<b>Regression</b>		<b>10</b>
	5.1	Linear Regression Simple Linear Regression, Multiple Linear Regression	5,6	
	5.2	Logistic Regression Univariate Logistic Regression, Multivariate Logistic Regression Model Building and Evaluation	5,6	
6	<b>Self Study</b>	Portly, Different Visualization techniques other than Python and Tableau.	1,2,5	
			<b>Total</b>	<b>28</b>



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## Laboratory Component:

Sr. No	Title of the Experiment
1	Working with Python Basics
2	Working with Python Data Structures
3	Working with Python Numpy Library
4	Working with Python Pandas Library
5	Working with Python Matplotlib Library
6	Working with Python Seaborn Library
7	Exploratory Data Analysis on the given Case Study
8	Develop a Linear Regression Model on the given Case Study
9	Develop a Logistic Regression Model on the given Case Study
10	Mini Project based on a case study.

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Python for Data Science Handbook: Essentials Tools for Working with Data	Second	Jake VanderPlas	O'Reilly	2022
2	Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter	Third	Wes McKinney	O'Reilly	2022
3	Python Data Visualization Essentials Guide	First	Kalilur Rahman	BPB	2021
4	Data Visualization Through TABLEAU	First	George Peck	McGraw Hill	2020
5	Hands-On Exploratory Data Analysis with Python	First	Suresh Kumar Mukhiya, Usman Ahmed	Packt	2020
6	Python Data Science Essentials	Third	Alberto Boschetti, Luca Massaron	Packt	2018

## Web References:

- 7) <https://matplotlib.org/>
- 8) <https://seaborn.pydata.org/>





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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-08	UI/UX Fundamentals	2	0	2	4	8	2	0	1	3
		Examination Scheme								
M081	UI/UX Fundamentals	Component		ISE	MSE	ESE	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

<b>Pre-requisite Course Codes, if any.</b>	AI305
<b>Course Objective:</b> The aim of the UI/UX course is to provide students with the knowledge of user-centered design, user -centered methods in design, graphic design on screens, simulation and prototyping techniques, usability testing methods, interface technologies and user centered design in corporate perspective. The course is organized around a practical project with iterative design of a graphical user interface to organize information about users into useful summaries with affinity diagrams, to convey user research findings with personas and scenarios and to learn the skill of sketching as a process for user experience design. The students will be given exposure to wireframing and Prototyping software in the various UI/UX Design tools.	
<b>Learning Outcomes (LO):</b> <i>At the End of the course students will be able to</i>	
M081.1	Understand iterative user-centered design of graphical user interfaces
M081.2	Apply the user Interfaces to different devices and requirements
M081.3	Design prototype for the given design problems.

## LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation) CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M081.1	2	-	--	2	--	--	--	--	--	--	--	--
M081.2	-	-	2	-	2	--	--	--	--	--	--	--
M081.3	-	-	-	-	2	--	--	--	-	-	--	2

## BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand	Apply ✓	Analyze	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Introduction to UI and UX	T1-T4	06
	1.1	What is User Interface Design (UI) -The Relationship Between UI and UX , Roles in UI/UX, Menus, Tabs, Bottom tab bar, Buttons (including "Call to action" or CTA) ,Accordion ,Carousel		



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		,Breadcrumbs, Modals Forms ,etc		
	<b>1.2</b>	A Brief Historical Overview of Interface Design, Interface Conventions, Designer vs. developer, Skills to be a top designer.		
<b>2</b>	<b>Title</b>	<b>User Interface Design Elements</b>	T2,T 4	<b>06</b>
	<b>2.1</b>	Approaches to Screen Based UI, Template vs Content, Formal Elements of Interface Design, Active Elements of Interface Design, Composing the Elements of Interface Design, UI Design Process, Visual Communication design component in Interface Design, Spacing and the grid.		
<b>3</b>	<b>Title</b>	<b>Colors, Typography &amp; Fonts</b>	T1- T4	<b>05</b>
	<b>3.1</b>	Display Text (Such as Headings) versus Body Text , Legibility , Type Trends, Typeface Selection & Pairing, Where to Get Web Fonts, Ideal Line Height, Column Width (Line Length), Hyphenation & Justification		
	<b>3.2</b>	Color Harmonies, Creating Contrast with Color, Guidelines for Proper Color Usage		
<b>4</b>	<b>Title</b>	<b>Design Guidelines and Process</b>	T1- T4	<b>06</b>
	<b>4.1</b>	UX Basics- Foundation of UX design, Good and poor design, Understanding Your Users, Designing the Experience , Elements of user Experience, Visual Design Principles, Functional Layout, Interaction design, Introduction to the Interface, Navigation Design, User Testing, Developing and Releasing Your Design		
<b>5</b>	<b>Title</b>	<b>Design Tools</b>	T2,T 4	<b>03</b>
	<b>5.1</b>	Adobe Photoshop, Illustrator, Figma, AdobeXD, Pencil Project tool.		
	<b>Self Study</b>	Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications.		<b>02</b>
			<b>Total</b>	<b>28</b>

**Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)**

Sr. No	Title of the Experiment
1	Case Study to understand and know about UI elements for Zomato, Swiggy app.
2	To create logo for restaurant based on given scenario using Adobe XD.
3	To create basic app for creating your own profile using Adobe XD.
4	To create different icons for giving ratings using Pencil tool. Use your own creativity.
5	To customize typography for logo for fitness app in UI design using Pencil tool. Use your own creativity.
6	To evaluate Good and Bad Design of UI elements for IRCTC website
7	To customize typography for logo for selling variations of plants, pots and fertilizers in UI



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	design using Illustrator tool.
8	To create GUI for creating feedback form for taking feedback from students and teachers by using only icons which are familiar to users and choose colors based on the scenario and describe the reason for such selection for the same.
9	To create simple Web UI for newly developed Pencil company (like apsara, doms etc.) using different kinds of Menus in an application using Figma tool.
10	To create simple flower selling application in Mobile app layout, laptop screen layout and Desktop layout and compare using Figma tool.

### Refernces:

1. A Project Guide to UX Design: For user experience designers in the field or in the making (2nd. ed.). Russ Unger and Carolyn Chandler. New Riders Publishing, USA, 2012.
2. The Elements of User Experience: User-Centered Design for the Web and Beyond, Second Edition Jesse James Garrett, Pearson Education. 2011.
3. The Essential Guide to User Interface Design: An Introduction to GUI Design Principles and Techniques, Third Edition Wilbert O. Galitz , Wiley Publishing, 2007.
4. The UX Book Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson and Pardha S. Pyla, Elsevier, 20



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## **SYLLABUS for**

# **MDM Sequels offered by External Institutes / Industry**

**w.e.f. AY 2023-24**



Bharatiya Vidya Bhavan's

## Sardar Patel Institute of Technology

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# Multidisciplinary Minor-09 (MDM-09) Minor in Artificial Intelligence For EXTC (2023-27 Batch)

Offered By: **Vizuara Technologies Pvt Ltd**

Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VII)
<b>Artificial Intelligence</b>	<b>M091:</b> Foundations in AI and ML	<b>M092:</b> Machine Learning and Deep Learning Mastery	<b>M093:</b> NLP and CV Mastery, Capstone Project	<b>M094:</b> Large Language Models Theory and Deployment, Capstone Project





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**LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

LO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
M091.1	3						
M091.2	3						
M091.3	3						
M091.4	3		3				

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember✓	Understand✓	Apply✓	Analyze ✓	Evaluate	Create
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**Theory Component**

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Mathematics Foundations	1,2, 3	7
	1.1	Linear Algebra: Vectors, Matrices, Eigenvalues, Eigenvectors		
	1.2	Probability and Statistics: Bayes Theorem, Distributions, Hypothesis Testing		
	1.3	Calculus: Differentiation, Integration, Partial Derivatives		
2	Title	Programming Foundations	1,2, 3	8
	2.1	Python Programming: Data Types, Control Flow, Functions		
	2.2	Libraries for AI: NumPy, Pandas, Matplotlib		
3	Title	Introduction to Optimization	1,2, 3	7
	3.1	Optimization Algorithms: Gradient Descent, Stochastic Gradient Descent, Adam		
	3.2	Convex and Non-convex Optimization: Introduction and Examples		
4	Title	The AI Landscape: 2020-2030	1,2, 3	3
		Overview of Machine Learning and Deep Learning: Supervised, Unsupervised Learning		
		Generative AI: GANs, VAEs, and Future Trends in AI Research		



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<b>5</b>	<b>Title</b>	Data Storytelling and Visualization	1,2, 3	<b>3</b>
	<b>5.1</b>	Data Manipulation: Cleaning, Filtering, and Transforming Data using Pandas		
	<b>5.2</b>	Data Visualization: Creating Effective Visualizations with Matplotlib and Seaborn		
<b>Total</b>				<b>28</b>

**Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)**

<b>Sr. No.</b>	<b>Title of the Experiment</b>
1	Implement vector operations and matrix manipulations using Python (NumPy).
2	Develop Python scripts to demonstrate Bayes' Theorem and Probability Distributions.
3	Perform hypothesis testing using Python libraries like SciPy.
4	Write Python functions to compute derivatives and integrals of simple mathematical functions.
5	Implement a Gradient Descent algorithm for optimizing a quadratic function.
6	Use Python to explore convex and non-convex optimization problems.
7	Create Python visualizations for datasets using Matplotlib and Seaborn.
8	Clean and filter a dataset, then transform it using Pandas operations.
9	Design a basic supervised learning model and evaluate it on a sample dataset.
10	Explore and visualize the results of a Generative AI model (e.g., GAN or VAE) using Python.

**Textbooks**

<b>Sr. No</b>	<b>Title</b>	<b>Edition</b>	<b>Authors</b>	<b>Publisher</b>	<b>Year</b>
1	Grant Sanderson videos and notes	1st	Grant Sanderson	Youtube	2010

**Reference Books**

<b>Sr. No</b>	<b>Title</b>	<b>Edition</b>	<b>Authors</b>	<b>Publisher</b>	<b>Year</b>
2	Introduction to Linear Algebra	6	Gilbert Strang	MIT Press	2023
3	Introduction to Python		Ana Bell	MIT Press	







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**LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

LO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
M092.1	3	3					
M092.2	3	3					
M092.3	3	3					
M092.4	3	3	3				

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember✓	Understand✓	Apply✓	Analyze ✓	Evaluate	Create✓
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**Theory Component**

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Machine Learning Techniques	1,2	12
	1.1	Supervised Learning: Regression, Classification (Logistic Regression, SVM)		
	1.2	Unsupervised Learning: Clustering (K-Means, DBSCAN) 1,2 3		
	1.3	Decision Trees and Random Forests		
2	Title	Deep Learning Techniques	1,2	14
	2.1	Build a neural network from scratch: Forward pass		
	2.2	Build a neural network from scratch: Backward pass		
	2.3	Train and test the entire neural network		
3	Title	Big Data Techniques	1,2	6
	3.1	Handling Large Datasets: Data Preprocessing, Data Wrangling, Feature Selection		
4	Title	Machine Learning - Deep Learning Lab	1,2	5
	4.1	Hands-on Projects: Real-life datasets for ML/DL applications.		
5	Title	Projects to Research Papers	1,2	5



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	<b>5.1</b>	Converting Projects into Research Papers: Writing impactful papers		
<b>Total</b>				<b>42</b>

**Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)**

Sr. No.	Title of the Experiment
1	Real Estate Price Prediction using Regression and Random Forests
2	Email Spam Classification using Logistic Regression and SVM
3	Customer Segmentation with K-Means and DBSCAN
4	Forward Pass Implementation of a Simple Neural Network
5	Neural Network Backpropagation and Training
6	Medical Diagnosis using Decision Trees and Random Forests
7	Large-Scale Data Preprocessing and Feature Selection
8	Real-Life Image Classification using Custom Neural Networks
9	Enhancing Deep Learning Models with Hyperparameter Tuning
10	Converting a Data Science Project into a Research Paper.

**Textbooks**

Sr. No	Title	Edition	Authors	Publisher	Year
1	Deep Learning	1st	Ian Goodfellow	MIT Press	2015

**Reference Books**

Sr. No	Title	Edition	Authors	Publisher	Year
2	Hands-On Machine Learning with Scikit-Learn and TensorFlow	1st	Aurelien Geron	O'Reilly	2017





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**LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

LO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
M093.1	3	3					
M093.2	3	3					
M093.3	3	3					
M093.4	3	3	3				

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember✓	Understand✓	Apply✓	Analyze ✓	Evaluate	Create✓
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**Theory Component**

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	Natural Language Processing (NLP) Techniques	1,2	9
	1.1	Introduction to NLP: Text Preprocessing, Tokenization, and Parsing		
	1.2	NLP Techniques: N-grams, TF-IDF, Word Embeddings (Word2Vec, GloVe)		
	1.3	Language Models: RNN, LSTM, Transformer		
2	<b>Title</b>	Computer Vision (CV) techniques	1,2	9
	2.1	Introduction to Computer Vision: Image Preprocessing, Feature Extraction		
	2.2	CV Techniques: CNN, Transfer Learning, Object Detection		
	2.3	Advanced Topics: GANs for Image Generation, Vision Transformers		
3	<b>Title</b>	NLP and CV Lab	1, 2	5
	3.1	Hands-on Lab: Implementing NLP and CV Models using TensorFlow, Keras		
4	<b>Title</b>	Capstone Project	1, 2	5
	4.1	Industrial Capstone Project: Implementing a Real-world NLP or CV Project		
<b>Total</b>				<b>28</b>



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## Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No.	Title of the Experiment
1	Text Preprocessing and Tokenization
2	N-gram and TF-IDF Feature Extraction
3	Word Embeddings and Semantic Similarity
4	RNN/LSTM-based Language Modeling
5	Transformer-based NLP Task Implementation
6	Basic Image Preprocessing and Feature Extraction
7	Convolutional Neural Networks for Image Classification
8	Object Detection with Transfer Learning
9	GAN-based Image Generation
10	Industrial Capstone Project (NLP or CV)

## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Natural Language Processing with Python	1st	Steven Bird	O'Reilly	2009

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
2	Jay Alammar blogs	1st	Jay Alammar		2020



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-09	Large Language Models Theory and Deployment, Capstone Project	3	0	2	4	9	3	0	1	4
		Examination Scheme								
Component		ISE		MSE		ESE		Total		
Theory		20		20		60		100		
M094		Laboratory		80		--		20	100	

**Pre-requisite Course Codes, if any.**

**Course Objective: Master the concepts of Large Language Models for theory and deployment**

**Learning Outcomes (LO): At the End of the course students will be able to**

M094.1	Understand the basics of Large Language Models (LLMs) and the Transformer architecture. Apply pre-training techniques for LLMs, including Masked Language Modeling and Causal Language Modeling.
M094.2	Fine-tune pre-trained LLMs for specific tasks, adapting them to diverse applications. Learn the fundamentals of model deployment, covering infrastructure, scalability, and latency reduction.
M094.3	Deploy LLMs on popular cloud platforms like AWS, Google Cloud, and Azure. Gain hands-on experience in deploying an LLM for real-time applications in the lab.
M094.4	Understand Retrieval-Augmented Generation (RAG) techniques to supplement LLMs with additional information. Work on an industrial capstone project, deploying an LLM in a real-world application setting.

### LO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M094.1	3		3									
M094.2	3		3									
M094.3	3		3									
M094.4	3	2	3									

### LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

LO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
M094.1	3						
M094.2	3						
M094.3	3						
M094.4	3		3				



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**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember✓	Understand✓	Apply✓	Analyze ✓	Evaluate	Create✓
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**Theory Component**

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	Build your own GPT from Scratch	1, 2	16
	1.1	Introduction to LLMs: Understanding Transformer Architecture		
	1.2	Pre-training Techniques for LLMs: Masked Language Modeling, Causal Language Modeling		
	1.3	Fine-tuning LLMs: Adapting Pre-trained Models to Specific Tasks		
2	<b>Title</b>	LLM Deployment	1, 2	10
	2.1	Model Deployment Basics: Infrastructure, Scalability, and Latency Reduction		
	2.2	Deploying LLMs on Cloud: AWS, Google Cloud, and Azure		
3	<b>Title</b>	LLM Practical Deployment Lab	1, 2	12
	3.1	Hands-on Lab: Deploying an LLM for Real-time Applications.		
	3.2	Understanding RAG for supplementing LLM with additional information		
4	<b>Title</b>	Capstone Project	1, 2	4
	4.1	Industrial Capstone Project: Deploying an LLM in a Real-world Application		
<b>Total</b>				<b>42</b>





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**Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)**

Sr. No.	Title of the Experiment
1	Understanding Transformer Architecture
2	Implementing Masked Language Modeling
3	Implementing Causal Language Modeling
4	Fine-tuning LLMs for Text Classification
5	Fine-tuning LLMs for Question Answering
6	Setting Up LLM Deployment Infrastructure
7	Deploying LLMs on AWS
8	Deploying LLMs on Google Cloud
9	Real-time LLM Deployment Lab
10	Implementing RAG for Enhanced Contextual Responses

**Textbooks**

Sr. No	Title	Edition	Authors	Publisher	Year
1	Hands-On Large Language Models	1st	Jay Alammar	O'Reilly	2024

**Reference Books**

Sr. No	Title	Edition	Authors	Publisher	Year
2	Building LLMs from Scratch	1st	Sebastian Raschka	Manning	2024



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**Syllabus: Multidisciplinary Minor Courses  
For EXTC/CSE/CS  
(2023-27 Batch)**

**Offered By: Six Ladders**



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<b>Course Category of Multidisciplinary Minor</b>	<b>MDM-I (Semester IV)</b>	<b>MDM-II (Semester V)</b>	<b>MDM-III (Semester VI)</b>	<b>MDM-IV (Semester VII)</b>
<b>MDM-10 Entrepreneurship &amp; Innovation</b>	<b>M101:</b> Entrepreneurship And Innovation	<b>M102:</b> Entrepreneurship and Socio-Cultural Environment of Businesses in India	<b>M103:</b> Entrepreneurial Finance & Management	<b>M104:</b> Innovation: Learning By Doing
<b>MDM-11 Financial &amp; Strategic Management</b>	<b>M111:</b> Economics and Strategic Management	<b>M112:</b> Introduction to Financial Analysis	<b>M113:</b> Introduction to Finance	<b>M114:</b> Digital Signal Processor System Design
<b>MDM-12 AI in Digital Marketing</b>	<b>M121:</b> Digital Marketing	<b>M122:</b> Advanced Digital Marketing Techniques	<b>M123:</b> Introduction to AI for Digital Marketing	<b>M124:</b> Industry Project



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**MDM-10**  
**Entrepreneurship & Innovation**



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-10	Entrepreneurship And Innovation	2	1	0	4	7	2	1	0	3
		Examination Scheme								
M101		Component		ISE		MSE		ESE	Total	
		Theory		20		20		60	100	
		Tutorials		80		0		20	100	

<b>Pre-requisite Course Codes, if any.</b>	Nil
<b>Course Objective:</b> Imparting concepts of each component of <b>Entrepreneurship and Innovation</b> thoroughly with practical aspects	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M101.1	Classroom learning and concept building
M101.2	Understand the frameworks and key concepts in Entrepreneurship
M101.3	Knowledge of venture growth strategies
M101.4	Apply the model of the entrepreneurial process for new venture development
M101.5	Knowledge of Business Models and Fund Raising
M101.6	Create a business plan/model based on the concepts and innovative ideas

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M101.1														
M101.2														
M101.3														
M101.4														
M101.5														
M101.6														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

<b>Remember</b>	<input checked="" type="checkbox"/> <b>Understand</b>	<input type="checkbox"/> <b>Apply</b>	<input type="checkbox"/> <b>Analyze</b>	<input type="checkbox"/> <b>Evaluate</b>	<input type="checkbox"/> <b>Create</b>
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**Theory Component**

Module No.	Unit No.	Topics	Ref.	42 Hrs.
1	<b>Title</b>	<b>Entrepreneurship</b>		
	1.1	Definition, Evolution and Concept of Entrepreneurship What is entrepreneurship Entrepreneurship as a career option Thinking like an entrepreneur: How can it benefit any career one chooses, Myths about entrepreneurship What does it take to be an entrepreneur Life as an entrepreneur Support from your family and friends and when is the best time to take the plunge	1,2	5



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	<b>1.2</b>	Entrepreneurship & Businesses in India Impact of an entrepreneur and social entrepreneurship Wealth building and making an impact Entrepreneurship as a Career Choice	1,2	
	<b>1.3</b>	Introduction to various forms of business organization: Lean Start-ups Sole Proprietorship Partnership, Limited Liability Partnership (LLP) MSMEs, Family run businesses, Companies		
<b>2</b>	<b>Title</b>	<b>Types of Entrepreneurs and Types of Entrepreneurships</b>		<b>10</b>
	<b>2.1</b>	Innovators Creators, Market makers, Expanders and Scalers	2,3	
	<b>2.2</b>	Intra-preneurs, Social Entrepreneurs, Woman Entrepreneurs, Techno-preneurs	2,3	
	<b>2.3</b>	Rural And Agro based Entrepreneurship: Environment in India	2,3	
<b>3</b>	<b>Title</b>	<b>Entrepreneurial Pathways: Understanding New Venture Life-Cycle</b>		<b>12</b>
	<b>3.1</b>	Pre-Seed, Early Stage, Launch.	2	
	<b>3.2</b>	Business Life Cycle: Start-up, Launch, Growth, Maturity, Harvest, Re-Birth, Exit	2,4	
	<b>3.3</b>	<ul style="list-style-type: none"> <li>• Frameworks to develop Entrepreneurial mindsets</li> <li>• Introduction to Business Model Canvas,</li> <li>• Lean Model Canvas,</li> <li>• Design Thinking Process Path</li> <li>• Blue and Red Ocean Strategies</li> </ul>	2,3	
<b>4</b>	<b>Title</b>	<ul style="list-style-type: none"> <li>• <b>Overview of Start-up Eco System of India and World</b></li> </ul>		<b>5</b>
	<b>4.1</b>	Startup Eco system enablers of India Comparative Analysis of Start-up eco system of India and World	1,2	
	<b>4.2</b>	Ease of doing business Index –Comparative Picture and India's status Technological Environment and Tech enabled Start ups	1,2	
<b>5</b>	<b>Title</b>	<b>Problems/ Opportunities Identification</b>		<b>10</b>
	<b>5.1</b>	Recent inventions, innovations and Problems: - Education as a sector - Healthcare sector - Agricultural Sector - Techno Sector	3	
	<b>5.2</b>	Need of Marketing and Smart Communication in Solving Problems	4	
<b>Total</b>				<b>42</b>



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## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	The Dynamics of Entrepreneurial Development and Management”,	Sixth	Vasant Desai	Himalaya Publishing House,	2011
2	Entrepreneurship Development & Small Business Enterprises	Ninth	Poornima M. Charantimath	Pearson India Education Services pvt. Ltd.	2023
3	Fundamentals of Entrepreneurship	Third	H. Nandan,	PHI Learning pvt. Ltd.	2013

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Entrepreneurship	Ninth	Robert D Hisrich, Mathew J Manimala	Tata-McGraw Hill	
2	Entrepreneurship	Third	Robert D Hisrich, Michael P Peters, Dean A Shepherd	PHI	
3	Entrepreneurship - Successfully Launching New Ventures,		Barringer,	Pearson	



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-10	Entrepreneurship and Socio-Cultural Environment of Businesses in India	3	1	0	4	7	3	1	0	4
		Examination Scheme								
M102		Component		ISE		MSE		ESE		Total
		Theory		20		20		60		100
		Laboratory		--		--		--		--

Pre-requisite Course Codes, if any.	Digital Systems
<b>Course Objective:</b>	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M102.1	To learn the problem of Many
M102.2	Understand Socio cultural environment
M102.3	To develop a design thinking Approach
M102.4	To understand the legal framework of the country
M102.5	To locate where one needs to complete legal formalities
M102.6	To understand commercial significance of the IPs created

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO1	PSO2
M102.1														
M102.2														
M102.3														
M102.4														
M102.5														
M102.6														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	<input checked="" type="checkbox"/> Apply	Analyze	Evaluate	Create
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**Theory Component**

Module No.	Unit No.	Topics	Ref.	56 Hrs.
1	Title	<b>Introduction to Socio Economic Culture of India</b>		6
	1.1	Meaning Scope, Factors and Impacts Rapid changes brought in by Globalization	1,2	
	1.2	Macro and Micro Social Segments Classification of the general Psyche	1,2	
2	Title	<b>Consumer DataAnalysis</b>		10
	2.1	Market Survey How to gather data during Market Survey	2,3	
	2.2	Drawing Insights of impacts of Socio-cultural factors on the buying behaviours	2,3	





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	<b>2.3</b>	Use of Socio-cultural factors on effectively impacting buying behaviours and developing Global/ Glocalperspective Impact on the businesses in India	2,3	
<b>3</b>	<b>Title</b>	<b>The Concept of Enterprise Launching</b>		<b>12</b>
	<b>3.1</b>	<ul style="list-style-type: none"> <li>• Entrepreneurial Process; Product/ Project Identification.</li> <li>• Developing a Business Plan: Meaning and Purpose of a business plan,</li> <li>• Contents of a business plan, Guidelines for writing a Business Plan</li> <li>• Product/ Market Fit: Concept, Importance for startups. Minimum Viable Product,</li> </ul>	2	
	<b>3.2</b>	<ul style="list-style-type: none"> <li>• Prerequisites from the perspective of an investor, (Creating Pitch Deck)</li> <li>• Business Financing: Various Sources of Funding to Start-ups including venture capital finance and private equity Managing early growth of the business.</li> <li>• New venture expansion - strategies and issues</li> </ul>	2,4	
<b>4</b>	<b>Title</b>	<b>Institutions supporting business enterprises</b>		<b>8</b>
	<b>4.1</b>	<ul style="list-style-type: none"> <li>• Support Organizations for an entrepreneur and their role</li> </ul> Central level institutions - NBMSME, KVIC, The coir board, NSIC, NSTEDB, NPC, EDI, NRDCI, National entrepreneurship Development Institutes	1,2	
	<b>4.2</b>	State level Institutions - State Directorate of Industries & Commerce, DIC, SFC, SIDC, SIADB.	1,2	
	<b>4.3</b>	Other institutions: NABARD, HUDCO, TCO, SIDBI, Business incubators		
<b>5</b>	<b>Title</b>	<b>Legal framework for starting a business in India</b>		<b>20</b>
	<b>5.1</b>	<ul style="list-style-type: none"> <li>• The Make in India and Digital India Campaigns–</li> <li>• For Entrepreneurship support</li> <li>• Other Start-up Ecosystem in India</li> </ul>	3	
	<b>5.2</b>	Understanding the Legal Scenario in India and alternative dispute redressal system Compliances required to set up each type of business organization Employment Laws and Labour Codes in India Ethics in Business Environment - Code of Conduct and Ethics at the Workplace Understanding, Overview, and Identification of IPR, Patents, Trademarks, Copyrights Geographical Indications, Industrial Designs, Trade Secrets	4	

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	<b>Start Ups and New Venture Management</b>		<b>Jyoti Gogate</b>		
2.	<b>Socio Cultural Impact of Globalisation in India</b>		<b>Rajiv kumar Upadhyay</b>		



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3.	<b>Socio Cultural Stratification Of India</b>		<b>Iqtidar Karamat Cheema</b>	<b>Tata McGraw-Hill</b>	
4.	Blue Ocean Strategy :How to Create Uncontested Market Space and Make the Competition Irrelevant	Expanded Edition	<b>W. Chan Kim</b>	<b>Pearson</b>	

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Strategy for Start-ups,		Harvard Business Review Case study	<a href="https://hbr.org/2018/05/strategy-for-start-ups">https://hbr.org/2018/05/strategy-for-start-ups</a>	
2	<b>It's Logical: Innovating Profitable Models</b>		Kaustubh Dhargalkar		
3	Where Good Ideas Come From :The Natural History of Innovation		Steven Johnson		
4	Socio Cultural Perspective : Anew Intelligence Paradigm		Conference at MITRE	Mc Clean in Virginia	
5.	Narrative Analysis : Socio-Cultural Approach to Analysing Short Participant Stories		Carol Grebich		



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned				
		L	T	P	O	E	L	T	P	Total	
MDM-10	Entrepreneurial Finance & Management	2	0	2	4	8	2	0	1	3	
		Examination Scheme									
		Component		ISE		MSE		ESE		Total	
M103		Theory		20		20		60		100	
		Laboratory		80		--		20		100	

<b>Pre-requisite Course Codes, if any.</b>	Digital Systems
<b>Course Objective:</b> Imparting concepts of each component of computer architecture thoroughly with practical aspects including memory systems and I/O communications with interfacing	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M103.1	Understanding financial documents
M103.2	Knowing sources of funding and raising funds
M103.3	Developing understanding of markets
M103.4	Developing Research Project
M103.5	Overall financial literacy

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M102.1														
M102.2														
M102.3														
M102.4														
M102.5														
M102.6														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

<b>Remember</b>	<b>Understand</b>	<input checked="" type="checkbox"/> <b>Apply</b>	<b>Analyze</b>	<b>Evaluate</b>	<b>Create</b>
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Module No.	Unit No.	Topics	Ref.	42 Hrs.
1	<b>Title</b>	<b>Financial Management and Funding</b>		8
	1.1	- What is Cost Sheet - Building a cost for a product & service in the structured format - Live Costing assignment for a product Preparation of actual cost sheet for a product (Show the product & ask the learner to compute its estimated cost)	1,2	
	1.2	Concept of Marginal Costing, Variable cost, Fixed cost, Contribution Margin, Profit Volume Ratio, Break Even Point & Margin of Safety	1,2	
2	<b>Title</b>	<b>Budgeting</b>		14
	2.1	- Meaning of Budgeting & Forecasting Understanding the concept of budgeting & forecasting in business - Pricing Methodology How to price the product or service	2,3	



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		•		
	2.2	- P&L, Balance Sheet, Cash flow, Net Present Value, Internal Rate of Return, Payback period	2,3	
	2.3	- Sources of Funding Basics on how to raise funds • Resource Mobilization • Angel Investors & Venture capital	2,3	
<b>3</b>	<b>Title</b>	<b>Marketing Management and Methods of Market Research</b>		<b>20</b>
	3.1	Concept, Need and Importance of Marketing Introduction to Business Research. Need & Scope of Research. The Process of Research, Research Applications in Business Decisions Formulation of Research Problem & Development of Hypotheses	2	
	3.2	Digital Data Analytics: Uni-variate and Bi-variate, Analysis of Data, Cross-tabulation Frequency, Distribution Tables, Testing of Hypotheses Test of Significance - Single Population, TwoPopulation using t-test and Z-test. Analysis of Variance Techniques One-way ANOVA Two-way ANOVA Non-Parametric Tests Chi-Square Tests The Kruskal-Wallis Test Correlation & Regression Analysis	2,4	
	3.3	Strategy Formulation: Environmental Scanning SWOC/SOAR & PESTLE Analysis 3. Scenario Analysis Strategy Planning for Marketing Mix-4Ps Strategy Planning for Market- Offensive & Defensive Strategies (Competitor Strategies)	2,3	
<b>Total</b>				<b>42</b>

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Cost Accounting		N.K. Prasad, Charles Hongreen		
2	Cost Accounting		Saxsena & Vashisth		
3	Financial Management		Khan & Jain		
4	Strategic Management		N. Chandrasekaran & Ananthanarayanan		
5	Strategic Management: The Indian Context		Srinivasan R		
6	Research Methodology - Concepts and Cases		Deepak Chawla & Neena Sondhi		



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7	Marketing Research – An Applied Study		Naresh K Malhotra – Pearson	Orientation Publications	
8	Marketing Research		Rajen Nargundkar	(Macmillan)	

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Start Up & Fund raising		Prajakta Raut		
2	Funding your start up		Dhruv Nath		



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned				
		L	T	P	O	E	L	T	P	Total	
MDM-IV	Innovation: Learning By Doing	1	0	6	0	7	1	0	3	4	
		Examination Scheme									
		Component		ISE		MSE		ESE		Total	
M104		Theory		20		20		60		100	
		Laboratory		60		0		40		100	

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b> It helps student to finalize the idea or USP and thus knowledge gained from forth coming modules can be applied for developing the idea/ product further	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M104.1	Identifying his/her goals
M104.2	Understanding strengths and weaknesses
M104.3	Develop Strategies
M104.4	Develop Entrepreneurial Mindset
M104.5	Identify Entrepreneurial Style
M104.6	Develop Idea from the perspective of Commercial Feasibility

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M102.1														
M102.2														
M102.3														
M102.4														
M102.5														
M102.6														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	<input checked="" type="checkbox"/> Apply	Analyze	Evaluate	Create
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Module No.	Unit No.	Topics	Ref.	56 Hrs.
1	<b>Title</b>	<ul style="list-style-type: none"> <li><b>Entrepreneurial content creation (introduction)</b></li> </ul>		14
	1.1	Introduction to Entrepreneurial content creation its need & significance Types of content that needs to be developed by any entrepreneur <ul style="list-style-type: none"> <li>Visualization and manifestation of company's ideology from content</li> </ul>	1,2	
	1.2	<ul style="list-style-type: none"> <li>Content creation platforms and early stages of content development</li> <li>Traditional and Modern platforms for which content is to be created, their dynamism and effective use</li> </ul>	1,2	



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		<ul style="list-style-type: none"> <li>Trade letters and formats</li> <li>Content creation for social media</li> <li>Content creation for internal and external consumption</li> </ul> Integration of content for cohesive messaging		
<b>2</b>	<b>Title</b>	<b>Innovation</b>		<b>10</b>
	<b>2.1</b>	Basic Concepts & forms of innovations (Process Innovation, product innovation, innovative pricing etc.)- Creating your USP Innovation- IPR-Return on R &D	2,3	
	<b>2.2</b>	Commercialization of Innovation Diffusion of Innovation - locating the consumers (early adopters, early majority, and laggards) and framing marketing strategy	2,3	
	<b>2.3</b>	Studying commercial feasibility of the innovation - Revenue, cost & profitability analysis	2,3	
<b>3</b>	<b>Title</b>	<b>Project</b>		<b>12</b>
	<b>3.1</b>	<ul style="list-style-type: none"> <li>Capstone Projects</li> <li>Development of an Innovative Business Idea into a Proof-of-Concept</li> <li>Development of Business Idea into working Prototype</li> </ul> Entrepreneurship & Design Thinking	2	
<b>4</b>	<b>Title</b>	<b>Final Project of Developing Business PROPOSAL</b>		<b>12</b>
	<b>4.1</b>	Presenting the proposal to venture capitalists	1,2	
	<b>4.2</b>	Incubation of Project	1,2	
		<b>Title: Research Project:</b>		
<b>5</b>		: An Overview Upcoming Trends Questionnaire Designing, Pilot Testing of Questionnaire, Administering the Questionnaire		<b>8</b>
<b>6</b>	<b>Self-Study</b>	Data Processing & Editing Classification & Tabulation of Data Data Analysis using MS Excel & SPSS		
<b>Total</b>				<b>56</b>

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Start with Why		Simon Sinek		
2	Digital Content Creation		Mark Schacter		
3	Professional Business Communication		Aruna Koneru		
4					

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Crushing It		Gary Vaynerchuk		



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**MDM-11**

**Financial & Strategic Management**





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Course Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-11	Economics and Strategic Management	2	1	0	4	7	2	1	0	3
		Examination Scheme								
M111		Component		ISE	MSE	ESE	Total			
		Theory		20	20	60	100			
		Laboratory		--	--	--	--			

Pre-requisite Course Codes, if any.	Digital Systems
Course Objective: Imparting concepts of each component of computer architecture thoroughly with practical aspects including memory systems and I/O communications with interfacing	
Course Outcomes (CO): <i>At the End of the course students will be able to</i>	
M111.1	Understand the world of economics and its impact on businesses
M111.2	Learn what is management
M111.3	Learn role of management in developing strategies
M111.4	Learn its co-relation with business finance
M111.5	To encourage critical thinking and foster ambitions through an academically rigorous and highly practical learning experience

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
M111.1														
M111.2														
M111.3														
M111.4														
M111.5														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	✓ Understand	Apply	Analyze	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Introduction to Economics</b>		3
	1.1	Concept of Micro and Macro Economics	1,2	
	1.2	Law of demand and supply	1,2	
2	<b>Title</b>	<b>Money Matters</b>		9
	2.1	Circulations of money	2,3	
	2.2	Various currency standards	2,3	
	2.3	Types of money: physical, digital, crypto	2,3	
3	<b>Title</b>	<b>Factors of Production</b>		15
	3.1	Importance and Various types of Factors of Production	2	
	3.2	GDP, Balance of Trade, National Income	2,4	
	3.3	Monetary and Fiscal Policies	2,3	
	3.4	Direct and Indirect Taxation		
	3.5	Foreign Exchange Theories		
4	<b>Title</b>	<b>Strategic Management</b>		6
	4.1	PESTEL analysis Porter' 5 forces BCG Matrix, PLC	1,2	
	4.2	Marketing challenges and Strategies	1,2	
5	<b>Title</b>	<b>Marketing Management</b>		9
	5.1	Types of Markets: Financial Markets, Commodity markets Market Share as Innovators, Competitors, Challengers, Niche marketers	3	
	5.2	Market Strategies: Indian Markets and International Markets	4	
	5.3	Digital and Social Media Marketing	1,2,4	
			<b>Total</b>	<b>42</b>

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Economics	22nd	Campbell R. McConnell, Stanley L. Brue, Sean M. Flynn, Bibek Ray Chaudhuri	Mc Graw Hill	(2021)
2	Principles of Economics	7th	by <u>S.R. Myneni</u>	Allahabad Law Agency	
3	Micro Economics	4th	D. N. Dwivedi	Vikas Publication	2023
4	Managerial Economics	8th	<b>D N Dwivedi</b>	Vikas Publishing	



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## Text Books for Strategic management

Sr. No	Title	Edition	Authors	Publisher	Year
1	Strategic Management	1st	C B Gupta	S Chand	2024
2	Strategic Management		N Chandrasekaran, P S Anantnarayanan	Taxmann	2024
3	Strategic Management: Formulation, Implementation and Control	12th	John Pearce, Richard Robinson, Amita Mital	McGrawHill	2012
4	Marketing Management Text and cases	3rd	Tapan K Panda	Taxmann	
5	Digital marketing		Satinder Kumar and Supreet Kaur		



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-11	Introduction to Financial Analysis	3	0	2	4	9	3	0	1	4
		Examination Scheme								
Component		ISE		MSE		ESE		Total		
Theory		20		20		60		100		
M112		Laboratory		80		0		20		100

<b>Pre-requisite Course Codes, if any.</b>	Digital Systems
<b>Course Objective:</b>	Understanding the financial regulatory systems and the financial statements with ref of the companies listed on the stock markets
<b>Course Outcomes (CO):</b>	<i>At the End of the course students will be able to</i>
M112.1	Understand the Forms of organization Regulatory framework within which they operate
M112.2	Understand the contents of the report
M112.3	Decipher the broad contents of the financial statements and the various components hereof
M112.4	Calculate the key ratios, interpret them and come up with a reasoned analysis thereof
M112.5	Understand the broad process of budgeting
M112.6	Predict the financial projection by using financial modeling

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
M112.1														
M112.2														
M112.3														
M112.4														
M112.5														
M112.6														
PO Total														
Target PO Strength														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	✓ Apply	Analyze	Evaluate	✓ Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Forms of Organization</b>		6
	1.1	Various forms of Organization Proprietorships, Partnership, LLPs, Pvt. / Public Ltd Companies	1,2	
	1.2	Regulatory Frameworks like Partnership Act, Companies Act, listing requirements	1,2	
2	<b>Title</b>	<b>Understanding Annual Reports</b>		6
	2.1	Introduction to Annual Reports: Chairman's Statement, Management discussion and Analysis, Segmental reporting, Auditor's report, ESG reporting	2,3	
3	<b>Title</b>	<b>Three Pillars of Financial Statements</b>		24
	3.1	Understanding Income Statement, Statement of Financial Position, Cash Flow Statement, Various Schedules forming part of the annual accounts	2	
	3.2	Statement of Changes in equity	2,4	
	3.3	Fundamental concepts underlined in the preparation of Accounts	2,3	
4	<b>Title</b>	<b>Key ratios and their interpretation</b>		8
	4.1	Liquidity ratios, Solvency ratios, efficiency ratios, turnover ratios, working capital cycle and management	1,2	
5	<b>Title</b>	<b>Budgetary Exercise</b>		8
	5.1	Cash budget, Production, Sales budget, Preparation of Master Budget thereof	3	
	5.2	Concept of rolling budget and Zero Based budgeting	4	
	5.3	Budget as a tool to exercise control	1,2,4	
6	<b>Title</b>	<b>Financial Modelling</b>		
	6.1	Predicting the future financials based on the management discussion analysis		8
			<b>Total</b>	<b>56</b>

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1					
2					

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1					
2					



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Course Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-11	Introduction to Finance	2	0	2	4	8	2	0	1	3
		Examination Scheme								
M113		Component		ISE	MSE	ESE	Total			
		Theory		20	20	60	100			
		Laboratory		60	0	40	100			

<b>Pre-requisite Course Codes, if any.</b>	Digital Systems
<b>Course Objective:</b>	To Understand the basics of commercial terms and concepts underlying finance
<b>Course Outcomes (CO):</b>	<i>At the End of the course students will be able to</i>
M113.1	Understand basic financial calculations and evaluate the commercial feasibility of the projects
M113.2	Apply the basic financial concept to the given financial propositions
M113.3	Calculate the break-even point/s
M113.4	Determine the optimal sources of finance and Applications there off
M113.5	Calculate the IIR, NPV, Pay-back Period

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
M113.1														
M113.2														
M113.3														
M113.4														
M113.5														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	✓ Apply	Analyze	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topic	Ref.	Hrs.
1	<b>Title</b>	<b>Financial Arithmetic</b>		5
	1.1	Simple Interest, Compound Interest, Time Value of Money with Practical Exercises	1,2	
2	<b>Title</b>	<b>Break even Analysis</b>		10
	2.1	Concepts of Fixed costs, variable costs, semi variable costs and Marginal Costing	2,3	
	2.2	Concept and calculation of Break-even point including multi product break even analysis	2,3	
3	<b>Title</b>	<b>Various sources of finance</b>		12
	3.1	Debt (long term, medium and short term and other time durations),	2	
	3.2	Types of Share capital	2,4	
	3.3	Debentures, deposits, call money and application finances – retention of funds v/s distribution of funds by way of dividends in the light of future financial requirements	2,3	
4	<b>Title</b>	<b>Cost of Capital</b>		5
	4.1	Post tax effective cost of capital,	1,2	
	4.2	Impact of Debt,	1,2	
	4.3	financial and operating leverage		
	4.4	VAAC:		
5	<b>Title</b>	<b>Project Evaluation Techniques</b>		11
	5.1	Basics of Cash inflow – outflow	3	
	5.2	PV tables	4	
	5.3	NPV, IRR, Pay back and relevance of Time value of Money	1,2,4	
			<b>Total</b>	<b>42</b>

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1					
2					

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1					
2					



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Course Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-11	Industry Project	0	0	8	4	12	0		4	4
		Examination Scheme								
M114		Component		ISE	MSE	ESE	Total			
		Theory		00	0	0	0			
		Tutorials		60	0	40	100			

<b>Pre-requisite Course Codes, if any.</b>	Digital Systems
<b>Course Objective:</b>	Students should be able to apply the concepts studied so far and demonstrate their ability to apply them in a practical environment
<b>Course Outcomes (CO):</b>	<i>At the End of the course students will be able to</i>
M114.1	Demonstrate reasonable application of theoretical and practical learnings at a work place
M114.2	Learn practical and work on output
M114.3	Acquire enough knowledge to have an edge over other candidates
M114.4	Secure job in the desired company

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M114.1														
M114.2														
M114.3														
M114.4														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	✓ Understand	Apply	Analyze	Evaluate	Create
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**Theory Component**

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Faculty Supervised and Company Representative mentored, Company embedded live Project in any area of Finance such as Listing an IPO, Derivative Markets in currency, commodities, shares and stocks, weather Markets etc.		5





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## **MDM-12**

## **AI in Digital Marketing**



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Course (Category) Code	Course Name						Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-12	Digital Marketing	2	0	2	0	0	2	0	1	3
		<b>Examination Scheme</b>								
M121	Digital Marketing	Component		ISE		MSE		ESE		Total
		Theory		20		20		60		100
		Laboratory		80		-		20		100

<b>Pre-requisite Course Codes, if any.</b>	Nil
<b>Course Objective:</b> To introduce students to the fundamental concepts of digital marketing, covering its various channels, strategies, and basic tools.	
<b>Course Outcomes (CO):</b> <i>At the End of the course, students will be able to</i>	
M121.1	Set up and manage a basic WordPress website or blog
M121.2	Creating and managing social media profiles
M121.3	Conduct basic SEO and keyword research
M121.4	Analyze simple metrics through Google Analytics

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M121.1														
M121.2														
M121.3														
M121.4														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	Apply	Analyze	Evaluate	Create
	✓				



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Module No.	Unit No.	Topics	Ref.	42 Hrs.
1	<b>Title</b>	<b>Introduction to Digital Marketing</b>		3
	1.1	Evolution of marketing: Traditional vs. digital	1	
	1.2	Importance of digital presence for businesses	1	
	1.3	Current trends in digital marketing	1	
2	<b>Title</b>	<b>Key Digital Marketing Channels: SEO, SEM, Social Media, Email Marketing</b>		27
	2.1	<b>SEO (Search Engine Optimization):</b> - Basics of SEO - Keyword research - On-page optimization - Off page optimization	1	
	2.2	<b>SEM (Search Engine Marketing):</b> - Introduction to PPC - Google Search Ads - Google Display Ads - Creating Ad campaigns	1	
	2.3	<b>Social Media Marketing:</b> - Major platforms, - Creating a brand presence - Creating and managing social media profiles - Basics of Content Creation and Strategy	1,2	
	2.4	<b>Email Marketing:</b> - Building an email list - email campaign basics - email marketing and automations platform	1	
3	<b>Title</b>	<b>Understanding Consumer Behavior in Digital Age</b>		9
	3.1	- Digital consumer journey and touchpoints - Behavioral targeting and personalization	1,2	
	3.2	Introduction to Analytics and Key Metrics - Basics of analytics in digital marketing - Working with popular analytics tools (Google Analytics, Facebook Insights)	1	



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<b>4</b>	<b>Title</b>	<b>Overview of AI in Digital Marketing</b>		<b>3</b>
	<b>4.1</b>	What is AI, and its role in digital marketing?	1,4	
	<b>4.2</b>	Introduction to AI applications in marketing (personalization, automation)	4	
	<b>4.3</b>	Future of AI in digital marketing	4	
			<b>Total</b>	<b>42</b>

## INDICATIVE ASSIGNMENT BRIEF AND EVALUATION MATRIX:

"Developing a Basic Digital Marketing Strategy for a Local Business"

### Reference Books:

<b>Sr. No</b>	<b>Title</b>	<b>Edition</b>	<b>Authors</b>	<b>Publisher</b>	<b>Year</b>
<b>1</b>	Digital Marketing for Dummies	Second	Russ Henneberry & Ryan Deiss	John Wiley & Sons	2020
<b>2</b>	Permission Marketing: Turning Strangers into Friends, and Friends into Customers	First	Seth Godin	Simon & Schuster	1999
<b>3</b>	Building a Story Brand: Clarify Your Message So Customers Will Listen	First	Donald Miller	HarperCollins Leadership	2017
<b>4</b>	AI for Marketers: An Introduction and Primer	Third	Christopher S. Penn	independently published	2021





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Module No.	Unit No.	Topics	Ref.	56 Hrs.
<b>1</b>	<b>Title</b>	<b>Advanced SEO and Content Strategies</b>		<b>18</b>
	<b>1.1</b>	Advanced keyword research techniques	1	
	<b>1.2</b>	Link-building strategies and SEO tools	1	
	<b>1.3</b>	Content optimization for voice search and mobile		
<b>2</b>	<b>Title</b>	<b>Paid Advertising (Google Ads, Social Media Ads)</b>		<b>18</b>
	<b>2.1</b>	Google Ads: Campaign types, bidding	1	
	<b>2.2</b>	Facebook and Instagram Ads: Ad types, targeting options	1,3	
	<b>2.3</b>	Retargeting strategies for paid ads	1	
<b>3</b>	<b>Title</b>	<b>Email Marketing and Automation</b>		<b>9</b>
	<b>3.1</b>	Segmentation and targeting for email campaigns	2,3	
	<b>3.2</b>	A/B testing in email marketing	2,3	
	<b>3.3</b>	Basics of automation platforms (Mailchimp)		
<b>4</b>	<b>Title</b>	<b>Influencer Marketing and Community Management</b>		<b>11</b>
	<b>4.1</b>	Types of influencers and influencer partnerships		
	<b>4.2</b>	Building and managing online communities	3	
			<b>*Total</b>	<b>56</b>

**\*Total includes Lab Hours**

## INDICATIVE ASSIGNMENT BRIEF AND EVALUATION MATRIX:

"Creating an Integrated Digital Marketing Campaign for a Brand Launch"

### Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
<b>1</b>	Digital Marketing for Dummies	Second	Russ Henneberry & Ryan Deiss	John Wiley & Sons	2020
<b>2</b>	Permission Marketing: Turning Strangers into Friends, and Friends into Customers	First	Seth Godin	Simon & Schuster	1999
<b>3</b>	Building a Story Brand: Clarify Your Message So Customers Will Listen	First	Donald Miller	HarperCollins Leadership	2017



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-12	Introduction to AI for Digital Marketing	2	0	2	0	0	2	0	1	3
		<b>Examination Scheme</b>								
		Component		ISE		MSE		ESE		Total
M123		Theory		20		20		60		100
		Laboratory		80		-		20		100

<b>Pre-requisite Course Codes, if any.</b>	Nil
<b>Course Objective:</b> To provide foundational knowledge of AI concepts relevant to digital marketing and introduce students to AI-driven marketing tools and techniques.	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will have understanding of</i>	
M123.1	Using AI tools to automate marketing tasks
M123.2	Setting up and customizing chatbots for marketing
M123.3	Hands-on experience with predictive analytics and data visualization tools
M123.4	AI-enabled content creation and curation

Module No.	Unit No.	Topics	Ref.	42Hrs.
1	<b>Title</b>	<b>Basics of AI: Machine Learning, NLP, and Image Recognition</b>		6
	1.1	Introduction to machine learning	4	
	1.2	Natural Language Processing (NLP): Applications in marketing (chatbots, sentiment analysis)	4	
	1.3	Image recognition and visual search in digital marketing		
2	<b>Title</b>	<b>AI in Digital Marketing: Personalization, Predictive Analytics, Chatbots</b>		15
	2.1	AI-driven personalization in campaigns and websites	4	
	2.2	Predictive analytics for consumer behavior and trends	4	
	2.3	Using chatbots for customer service and lead generation		
3	<b>Title</b>	<b>Introduction to Data Analysis and Visualization</b>		6
	3.1	Data types and basics of data processing	4	
	3.2	Data visualization basics (charts, graphs)	4	
	3.3	Tools for data visualization		
4	<b>Title</b>	<b>Using AI for Content Creation and Curation</b>		15
	4.1	AI tools for content generation		



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		Generative Videos, Images (e.g., ChatGPT, Canva)		
	<b>4.2</b>	Content curation using AI (newsfeeds, personalized recommendations)	4	
			<b>Total</b>	<b>42</b>

## INDICATIVE ASSIGNMENT BRIEF AND EVALUATION MATRIX:

"Developing an AI-Powered Brand Presence and Content Optimization Strategy"

### Reference Books:

Sr. No	Title	Edition	Authors	Publisher	Year
1	Digital Marketing for Dummies	Second	Russ Henneberry & Ryan Deiss	John Wiley & Sons	2020
2	Permission Marketing: Turning Strangers into Friends, and Friends into Customers	First	Seth Godin	Simon & Schuster	1999
3	Building a Story Brand: Clarify Your Message So Customers Will Listen	First	Donald Miller	HarperCollins Leadership	2017
4	AI for Marketers: An Introduction and Primer	Third	Christopher S. Penn	independently published	2021





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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-12	Industry Project	0	0	8	0	0	0	0	4	4
		Examination Scheme								
M124		Component		ISE	MSE	ESE	Total			
		Theory		0	-	0	0			
		Laboratory		80	-	20	100			

<b>Pre-requisite Course Codes, if any.</b>	Nil
<b>Course Objective:</b> Working on real-world digital marketing project using AI & Developing a capstone project	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M124.1	Design and execute AI-driven marketing campaigns
M124.2	In-depth understanding of AI-driven marketing strategies
M124.3	Working on real-world digital marketing projects using AI
M124.4	Developing and presenting a capstone project

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

Correlation Levels: 1(Weak) 2(Medium) 3(Strong)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M124.1														
M124.2														
M124.3														
M124.4														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand ✓	Apply	Analyze	Evaluate	Create
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Module No.	Unit No.	Topics	Ref.	Hrs.
1	Title	Faculty Supervised and Company Representative mentored, Company embedded live Project		5



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## Reference Books:

<b>Sr. No</b>	<b>Title</b>	<b>Edition</b>	<b>Authors</b>	<b>Publisher</b>	<b>Year</b>
<b>1</b>	Digital Marketing for Dummies	Second	Russ Henneberry & Ryan Deiss	John Wiley & Sons	<b>2020</b>
<b>2</b>	Permission Marketing: Turning Strangers into Friends, and Friends into Customers	First	Seth Godin	Simon & Schuster	<b>1999</b>
<b>3</b>	Building a Story Brand: Clarify Your Message So Customers Will Listen	First	Donald Miller	HarperCollins Leadership	<b>2017</b>
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**MDM-13**  
**UI/UX Design**  
**For EXTC/CSE/CS**  
**(2023-27 Batch)**

Offered By: Pearl Academy Pvt Ltd

<b>Course Category of Multidisciplinary Minor</b>	<b>MDM-I (Semester IV)</b>	<b>MDM-II (Semester V)</b>	<b>MDM-III (Semester VI)</b>	<b>MDM-IV (Semester VII)</b>
<b>UI/UX Design</b>	<b>M131:</b> Foundations of UI/UX Design	<b>M132:</b> Intermediate UI/UX Design	<b>M133:</b> Advanced UI/UX Design and Specializations	<b>M134:</b> Advanced Research and Emerging Practices in UI/UX



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-13	Foundations of UI/UX Design	2	0	2	5	8	2	0	1	3
		Examination Scheme								
M131		Component		ISE	MSE	ESE	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b> This module introduces students to the fundamental building blocks of interface design. Students will learn how the features and functions of a product get translated into concrete visual interfaces which audiences find usable, useful, and desirable. The module will also introduce tools and methods commonly in interface design practice, including personas, user-flows, wireframes, etc. By the end of this module, students should have a firm grasp on designing visual interfaces through a user-centred design methodology.	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M133.1	Understand the core principles of UI/UX design and their relevance in product development.
M133.2	Conduct user research and create user personas to guide design decisions.
M133.3	Develop low-fidelity wireframes and demonstrate basic usability testing methods.

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M131.1														
M131.2														
M131.3														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	✓ Apply	Analyze	Evaluate	Create
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**Theory Component**

Module No.	Unit No.	Topics	Ref.	42 Hrs.
1	Title	<b>Introduction to UI/UX</b>	1,2	4
	1.1	Introduction to UI/UX, understanding the key differences and overlaps between UI and UX, and the importance of user-centered design.		



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	<b>1.2</b>	Overview of the role of UI/UX in engineering and its application in real-world products.		
<b>2</b>	<b>Title</b>	<b>Design Thinking &amp; User Research</b>	1,2	<b>6</b>
	<b>2.1</b>	Introduction to Design Thinking, its five stages, and its importance in solving user problems.		
	<b>2.2</b>	Introduction to user research methods like surveys, interviews, and observational studies, followed by hands-on exercises to create user personas.		
<b>3</b>	<b>Title</b>	<b>Information Architecture (IA)</b>	1,2	<b>6</b>
	<b>3.1</b>	Introduction to Information Architecture, organizing content, and understanding user flows.		
		Hands-on activity to create sitemaps and user journeys using card sorting techniques.		
<b>4</b>	<b>Title</b>	<b>Wireframing Basics</b>	1,2	<b>6</b>
	<b>4.1</b>	Introduction to low-fidelity wireframes, sketching wireframes by hand.		
	<b>4.2</b>	Using wireframing tools like Figma or Sketch to create low-fidelity.		
<b>5</b>	<b>Title</b>	<b>Visual Design Principles</b>	1,2	<b>6</b>
	<b>5.1</b>	Learning typography, color theory, and layout design.		
	<b>5.2</b>	Application of design principles with a focus on creating accessible designs.		
<b>6</b>	<b>Title</b>	<b>Usability and Testing</b>	1,2	<b>6</b>
	<b>6.1</b>	Introduction to usability testing, methods for gathering user feedback.		
	<b>6.2</b>	Hands-on usability testing exercise, conducting user interviews, and refining prototypes based on feedback.		
<b>7</b>	<b>Title</b>	<b>Final Presentation</b>	1,2	
	<b>7.1</b>	Presentation & Feedback		<b>6</b>
			<b>Total</b>	



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## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Don't Make Me Think		Steve Krug		
2	The Design of Everyday Things		Don Norman		

## Websites and Online Resources

- Smashing Magazine, UX Design CC, and Nielsen Norman Group offer articles, case studies, and resources on UX/UI design.
- Channels like The Futur, AJ&Smart, and UX Mastery offer videos on UX/UI design processes, tools, and tutorials.
- Platforms to explore UI/UX design projects and case studies. They provide inspiration and insights into current design trends and practices.
- Many UX/UI designers and experts share insights, case studies, and tutorials on Medium. You can follow specific UX/UI design publications or individual writers.
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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-13	Intermediate UI/UX Design	3	0	2	5	8	2	0	1	4
		Examination Scheme								
M132		Component		ISE		MSE		ESE	Total	
		Theory		20		20		60	100	
		Laboratory		80		--		20	100	

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b> Build upon the foundational knowledge and introduce interaction design, design systems, and responsive design.	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M132.1	Create mid to high-fidelity interactive prototypes with effective interactions and transitions.
M132.2	Apply responsive design principles to create adaptable interfaces for various devices.
M132.3	Conduct heuristic evaluations and usability testing to refine the user experience.

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M132.1														
M132.2														
M132.3														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	✓ Apply	Analyze	Evaluate	Create
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**Theory Component**

Module No.	Unit No.	Topics	Ref.	42 Hrs.
1	Title	<b>Advanced Interaction Design</b>		6
	1.1	Understanding micro-interactions, animations, and designing intuitive interactions.		
	1.2	Practical session on designing and testing micro-interactions using tools like Principle or Figma.		
2	Title	<b>UI Design Systems</b>		6
	2.1	Introduction to design systems (Material Design, Fluent Design) and their components.		
	2.2	Creating UI kits and maintaining consistency across design elements.		





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<b>3</b>	<b>Title</b>	<b>Responsive Design</b>		<b>6</b>
	<b>3.1</b>	Concepts of adaptive and responsive design, understanding media queries and breakpoints.		
	<b>3.2</b>	Building responsive layouts using Figma or Sketch.		
<b>4</b>	<b>Title</b>	<b>Advanced Prototyping</b>		<b>6</b>
	<b>4.1</b>	Introduction to high-fidelity prototypes, creating interactive prototypes with transitions.		
	<b>4.2</b>	Hands-on prototyping using Figma or Adobe XD, creating interactions and flow.		
<b>5</b>	<b>Title</b>	<b>Usability Testing &amp; Heuristic Evaluation</b>		<b>6</b>
	<b>5.1</b>	Conducting usability testing, introduction to Nielsen's Heuristics, and identifying UX problems.		
	<b>5.2</b>	Performing a heuristic evaluation and documenting feedback for iterative design.		
<b>6</b>	<b>Title</b>	<b>Project Development and Team Collaboration</b>		<b>6</b>
	<b>6.1</b>	Collaborative design using tools like Figma for team-based project work.		
	<b>6.2</b>	Design handoff to engineering, version control, and design documentation for developers.		
<b>7</b>	<b>Title</b>	<b>Final Presentation</b>		<b>4</b>
	<b>7.1</b>	Presentation & Feedback		

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.	Don't Make Me Think		Steve Krug		
2.	The Design of Everyday Things		Don Norman		

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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned				
		L	T	P	O	E	L	T	P	Total	
MDM-13	Advanced UI/UX Design and Specializations	2	1	0	4	7	2	1	0	3	
		Examination Scheme									
		Component	ISE	MSE	ESE	Total					
M133		Theory	20	20	60	100					
		Tutorials	100	--	--	100					

<b>Pre-requisite Course Codes, if any.</b>		
<b>Course Objective:</b> Focus on real-world applications of UI/UX, advanced topics such as accessibility, UX metrics, and emerging technologies.		
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>		
M133.1	Develop UX strategies and communicate design decisions effectively to stakeholders and teams.	
M133.2	Design for accessibility and inclusivity by applying WCAG guidelines.	
M133.3	Measure UX success using UX metrics and leverage analytics to inform design improvements.	

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M133.1														
M133.2														
M133.3														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	✓ Apply	Analyze	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	42 Hrs.
1	Title	<b>UX Strategy and Design Leadership</b>	1,2	6
	1.1	Introduction to UX strategy, road mapping, and communicating design decisions to stakeholders.		



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	<b>1.2</b>	Practical session on building a design portfolio, showcasing projects and design decisions.		
<b>2</b>	<b>Title</b>	<b>Inclusive Design &amp; Accessibility</b>	1,2	<b>6</b>
	<b>2.1</b>	Understanding inclusive design, diverse user needs, and designing for accessibility		
	<b>2.2</b>	Implementing WCAG guidelines and testing for accessibility using tools like Lighthouse.		
<b>3</b>	<b>Title</b>	<b>UX for Emerging Technologies</b>	1,2	<b>6</b>
	<b>3.1</b>	Designing for AR/VR, voice interfaces, and AI-driven experiences.		
		Hands-on session exploring contextual and conversational UI for emerging technologies.		
<b>4</b>	<b>Title</b>	<b>UX Metrics and Analytics</b>	1,2	<b>6</b>
	<b>4.1</b>	Introduction to UX metrics (task completion, time on task, satisfaction scores).		
	<b>4.2</b>	Using tools like Google Analytics and Hotjar to measure and analyze UX performance.		
<b>5</b>	<b>Title</b>	<b>Real-World UX Challenges</b>	1,2	<b>6</b>
		Exploring UX case studies from different domains (healthcare, fintech, e-commerce).		
	<b>5.2</b>	Conducting design critique sessions with peer feedback.		
<b>6</b>	<b>Title</b>	<b>Capstone Project &amp; Portfolio Development</b>	1,2	<b>6</b>
	<b>6.1</b>	Work on end-to-end project development based on a real-world challenge.		
	<b>6.2</b>	Portfolio development session and project presentation.		
<b>7</b>	<b>Title</b>	<b>Final Presentation</b>	1,2	
	<b>7.1</b>	Presentation & Feedback		<b>4</b>
			<b>Total</b>	<b>42</b>



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## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Don't Make Me Think		Steve Krug		
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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-13	Advanced Research and Emerging Practices in UI/UX	2	1	0	4	7	2	1	0	3
		Examination Scheme								
M134		Component		ISE		MSE		ESE		Total
		Theory		20		20		60		100
		Tutorial		100		--				100

Pre-requisite Course Codes, if any.	
<b>Course Objective:</b> Equip students with expertise in advanced research methodologies, design innovation, and staying ahead in the evolving field of UI/UX.	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M134.1	Implement advanced research techniques to derive deep user insights.
M134.2	Design innovative solutions for emerging technologies while addressing ethical considerations.
M134.3	Understand global UX challenges and apply cultural sensitivity in design practices.

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

Correlation Levels: 1(Weak) 2(Medium) 3(Strong)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M134.1														
M134.2														
M134.3														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	✓ Apply	Analyze	Evaluate	Create
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**Theory Component**

Module No.	Unit No.	Topics	Ref.	42 Hrs.
1	Title	<b>Advanced User Research Techniques</b>		6
	1.1	Ethnographic research, field studies, and diary studies.		
	1.2	Advanced survey design and analyzing qualitative data		
2	Title	<b>Behavioral Psychology in UX</b>		
	2.1	Understanding cognitive biases, decision-making, and user behavior.		



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	2.2	Applying psychology principles to enhance user engagement and satisfaction.		6
3	<b>Title</b>	<b>Design for Emerging Technologies</b>		
	3.1	Exploring ethics in AI-driven design and human-AI interaction.		
	3.2	Hands-on session exploring contextual and conversational UI for emerging technologies.		
4	<b>Title</b>	<b>Global Design Perspectives</b>		6
	4.1	Cultural considerations in UX and designing for global audiences.		
	4.2	Case studies on international UX challenges.		
5	<b>Title</b>	<b>Advanced Tools and Techniques</b>		6
	5.1	Introduction to advanced design tools like ProtoPie or Axure RP for complex prototypes.		
	5.2	Data visualization for UX research and presenting actionable insights.		
6	<b>Title</b>	<b>Future Trends in UI/UX</b>		6
	6.1	Speculative design and future-proofing interfaces.		
	6.2	How to stay updated in the evolving design landscape (resources, communities, and certifications).		
7	<b>Title</b>	<b>Final Presentation</b>		4
	7.1	Presentation & Feedback		

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
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Bharatiya Vidya Bhavan's

# **Sardar Patel Institute of Technology**

(Empowered Autonomous Institute Affiliated to University of Mumbai)  
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

## **MDM-14**

# **Time-Triggered Reliable Systems Engineering (T<sup>2</sup>RSE)**

**Offered by: Skills Universe Technologies**

**For CE/CSE**



Bharatiya Vidya Bhavan's

# Sardar Patel Institute of Technology

(Empowered Autonomous Institute Affiliated to University of Mumbai)  
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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-14	Programming ARM: The bare metal way	2	0	2	3	7	2	0	1	3
		Examination Scheme								
M141		Component		ISE (%)	MSE (%)	ESE (%)	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

<b>Pre-requisite Course Codes, if any.</b>	Digital Systems
<b>Course Objective:</b>	To develop ability to read the data sheet and reference manual of the microcontroller to develop device drivers in the C programming language and study similar code in C++ language
<b>Course Outcomes (CO):</b>	<i>At the end of the course students will be able to</i>
M141.1	Understand and recall the ARM architecture using the STM32 ARM CORTEX Mx
M141.2	Find and apply the information essential to build drivers for GPIO, UART, SysTick Timer, General Purpose Timers, Interrupts and ADC from the data sheet and the reference manual
M141.3	Set up the industry standard ARM KEIL toolchain for programming the STM32F103VB using C and C++ programming languages. Use the C++ Template based programming technique.
M141.4	Create device drivers in C and C++ programming language using bare-metal approach.
M141.5	Evaluate and justify the driver design decision
M141.6	Analyse and fix anomalies in 'C' code

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M141.1	2											
M141.2	3		3									
M141.3					3							
M141.4	3	3			3							
M141.5				3								
M141.6	2			3								

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate√	Create√
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Introduction to CORTEX-M processor family</b>	1	1
	1.1	CORTEX-M processor family, profiles, hardware architectures Cortex M-ArmV7-M, CORTEX M3 and CORTEX M4		
2	<b>Title</b>	<b>Developing software for CORTEX-M family</b>	1	1
	2.1	Introduction to KEIL MDK Community edition and software packs.		
	2.2	Third Party Configuration tools		
3	<b>Title</b>	<b>Inside the STM32</b>	1 ,online resource-2	12
	3.1	Pipeline, Programmers model, CPU operating modes, Thumb2-instruction set, Memory map, Buses		
	3.2	System timer, Interrupt handling, Nested Vectored Interrupt controller (NVIC), Advanced interrupt handling modes, Power modes Power supply, Reset circuitry, Oscillators, Clocking		
4	<b>Title</b>	<b>STM32 Peripherals</b>	1 ,online resource-1 and online resource 2	09
	4.1	GPIO (General purpose Input / output), AFIO (Alternate function Input / output), External Interrupts, General Purpose Timers, Backup domain, USART		
	4.2	NVIC, SysTick timer, System Control Block		
5	<b>Title</b>	<b>C++Foundations</b>	Lecture Notes	05
	5.1	Creating and LED class		
	5.2	Template programming fundamentals		
	5.3	GPIO template design		
6	<b>Self Study</b>	Material in the Online resources has to be read as told by the instructor for understanding the implementation details of the peripherals	Online resource -2	*42
<b>Total (Does not include* )</b>				<b>28</b>

## Laboratory Component

Sr. No	Title of the Experiment
1	Installation of KEIL MDK, Create the first blinky project Configuring the project from scratch Configuring the run time environment, Project configuration, Third party configuration tools



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2	GPIO (General purpose Input / output) C PROGRAM
3	AFIO (Alternate function Input / output) C PROGRAM
4	External Interrupts C PROGRAM
5	ADC C PROGRAM
6	General Purpose Timers C PROGRAM
7	Backup domain C PROGRAM
8	USART C PROGRAM
9	NVIC
10	SysTick timer

## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Designers Guide to Cortex-M processor Family	3 <sup>rd</sup> Edition	Trevor Martin	Newnes	2023

- Online Resources:
1. <https://developer.arm.com/documentation/dui0552/a/preface/about-this-book>
  2. [https://www.st.com/resource/en/reference\\_manual/cd00171190-stm32f101xx-stm32f102xx-stm32f103xx-stm32f105xx-and-stm32f107xx-advanced-arm-based-32-bit-mcus-stmicroelectronics.pdf](https://www.st.com/resource/en/reference_manual/cd00171190-stm32f101xx-stm32f102xx-stm32f103xx-stm32f105xx-and-stm32f107xx-advanced-arm-based-32-bit-mcus-stmicroelectronics.pdf)



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-14	Foundations of Time Triggered architectures	3	0	2	3	8	3	0	1	4
		Examination Scheme								
M142		Component		ISE (%)	MSE (%)	ESE (%)	Total			
		Theory		20	20	60	100			
		Laboratory		80	--	20	100			

<b>Pre-requisite Course Codes, if any.</b>	<b>Programming ARM: The bare metal way</b>
<b>Course Objective:</b> To develop the ability to create code that is safe and reliable by creating a simple scheduling mechanism	
<b>Course Outcomes (CO):</b> <i>At the end of the course students will be able to</i>	
M142.1	Apply the idea of safe coding techniques in C programming language for designing mission critical applications
M142.2	Determine that the written 'C' code is modular in nature using ideas similar to OOP's concepts.
M142.3	Understand the need for time triggered scheduling mechanisms by evaluating the need for such mechanisms
M142.4	Create a simple embedded OS and apply this scheduler for designing systems
M142.5	Understand how to make the code safe and reliable
M142.6	Analyze and fix timing issues in embedded 'C' code

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M142.1	2		3			3						
M142.2	3				3							
M142.3	3	3		3								
M142.4	2		3				3					
M142.5	3					3						
M142.6	2	2		3								

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand√	Apply√	Analyze√	Evaluate√	Create√
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Introduction and Overview of Embedded Systems</b>	1	04
	1.1	What is an embedded system? Embedded Systems metrics, Defining reliability and developing software for reliable embedded systems, why use the C language for designing reliable systems, The super-loop software architecture, Reading and writing to the PORT pins of the microcontroller, Reading and writing data to the PORTS, Changing or Reading a single PORT bit, Reading and writing a byte to the PORT, Strengths and weaknesses of software delays		
	1.2	Case study: Central heating controller		
2	<b>Title</b>	<b>Hardware issues affecting reliability and CMSIS</b>	1	06
	2.1	What is an Oscillator? , Crystal oscillator stability issues, Improving oscillator stability to improve reliability, Oscillator frequency and machine cycle period, What is CMSIS and some CMSIS functions related to clock and power saving, Driving DC loads and low power loads		
	2.2	<b>Switch interface (Reliably reading a switch)</b> Case study: Code for counting goats on a milking station with a switch sensor		
3	<b>Title</b>	<b>Adding structure to your code and Real-time behavior</b>	1	06
	3.1	Object Oriented programming with C, Creating file based classes in C without imposing significant memory or CPU load, Example code of O-O-C with project header, Common datatypes and creating user aliases, The purpose of the project header, The purpose of the PORT header, Creating the first structured C code, Restructuring the Goat counting example, The meaning of public, private, static, extern keywords and their implications on reliability of code.		
	3.2	<b>Meeting real-time Constraints</b> Software requirements while designing an embedded application for an automobile. What are real-time constraints? Implications of real-time systems. Understanding problems associated with the while statement when handling real-time systems. Creating hardware delays. Generating a precise 50ms delay. Creating a portable hardware delay. What is a timeout? The need for timeout. Creating loop timeouts. Testing loop		



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		timeouts. Analyzing loop timeouts in the performance analyzer. Using the timeout to make reliable switch interface. Creating hardware timeouts		
4	<b>Title</b>	<b>Creating and using a simple Embedded Operating System</b>	1	10
	4.1	Hard real time systems, the need for accurate timing, understanding tasks, Communication between tasks, What are event triggered and time triggered interrupts, Comparison of the event triggered and time triggered system, How do we implement a time triggered design, SysTick timer based interrupt at the core of the OS. Using the SysTick interrupt routine, Introducing the simple embedded OS, Setting the tick interval, saving power using software, Scalability of the simple embedded OS, Characterization of the simple embedded OS		
	4.2	<b>Case study: Implementing animatronic dinosaur</b>		
5	<b>Title</b>	<b>RS232</b>	1	12
	5.1	Asynchronous data transmission and baud rates, Software architecture, Why not to use printf, Strengths and weaknesses, Designing a software real-time clock using the simple embedded OS and sending data to terminal using the serial port		
	5.2	<b>Case study: Intruder Alarm system</b>		
6	<b>Title</b>	<b>Watchdog timer</b>	1	04
	6.1	What is a watchdog timer, Using a watchdog timer to make a system safe		
7	<b>Self-Study</b>	Material in the Online resources has to be read as told by the instructor for understanding the implementation details of the peripherals.	Online resource-1 and 2	*42
<b>Total (Does not include*)</b>				<b>42</b>

### Laboratory Component, if any.

Sr. No.	Title of the Experiment
1	Hello world
2	Switch debounce
3	Switch press count
4	Reliable switch test
5	Loop timeout
6	Software PWM
7	Software PWM multiple duty cycle
8	SysTick implementation



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9	Timer delay
10	Traffic lights
11	Watchdog
12	Real time clock with RS232
13	There are two coding exercises here related to port programming
14	An early prototype of a control system for lowering an aircraft undercarriage

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Embedded C	1st	Michael J. Pont	<b>Pearson education</b>	2007

## Reference Books

Sr. No.	Title	Edition	Author	Publisher	Year
1	The C programming Language	2nd	Dennis Ritchie and Brian Kernighan	<b>Pearson education</b>	2015

- Online Resource: 1. <https://developer.arm.com/documentation/dui0552/a/preface/about-this-book>  
2. [https://www.st.com/resource/en/reference\\_manual/cd00171190-stm32f101xx-stm32f102xx-stm32f103xx-stm32f105xx-and-stm32f107xx-advanced-arm-based-32-bit-mcus-stmicroelectronics.pdf](https://www.st.com/resource/en/reference_manual/cd00171190-stm32f101xx-stm32f102xx-stm32f103xx-stm32f105xx-and-stm32f107xx-advanced-arm-based-32-bit-mcus-stmicroelectronics.pdf)  
3. <https://www.keil.arm.com/cmsis>



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-14	Advanced Time-Triggered Systems Design	2	0	2	4	8	2	0	1	3
		Examination Scheme								
		Component	ISE (%)		MSE (%)		ESE (%)		Total	
M143		Theory		20		20		60		100
		Laboratory		80		--		20		100

<b>Pre-requisite Course Codes, if any.</b>	Foundations of Time Triggered architectures
<b>Course Objective:</b>	
<b>Course Outcomes (CO): At the end of the course students will be able to</b>	
M143.1	Understand about the benefits that can be obtained by developing reliable embedded systems using time-triggered (TT) architectures.
M143.2	Apply TT architectures in their own designs.
M143.3	Understand both the strengths and weaknesses of a Time-Triggered approach to the development of software for reliable embedded systems
M143.4	Create a time triggered co-op scheduler for designing systems
M143.5	Create a time triggered hybrid scheduler for designing systems
M143.6	Analyze the code and test the code for all the use cases since the system designed will always be deterministic due to the inherent nature of TT architectures
M143.7	Evaluate different scheduling strategies and decide which scheduling mechanism is best for the given scenario. Then apply the scheduling algorithm for the design.

### CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M143.1	3					3						
M143.2	3	3	3									
M143.3				3								
M143.4	3				3							
M143.5	3				3			2				
M143.6	3	3										
M143.7				3								

### BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember	Understand√	Apply√	Analyze√	Evaluate√	Create√
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>What is a time-triggered system?</b>	1	01
	1.1	Introduction, Information systems, Desktop systems, Embedded systems, Real-time systems.		
	1.2	Event-triggered systems		
	1.3	Time-triggered systems		
2	<b>Title</b>	<b>Software foundations</b>	1	04
	2.1	Rudimentary software architecture, Super loop, Project header, Delays, Hardware delay, Software delay.		
	2.2	Watchdog, Issues and challenges of using a standard RTOS in reliable embedded systems, Priority based pre-emptive scheduling, Challenges caused by shared resources, Mutual exclusion, Priority Inversion (PI)		
	2.3	From Priority inversion to deadlock, Dealing with deadlock, Example of PI to deadlock, Real challenges presented by PI, Challenges with dynamic RTOS.		
3	<b>Title</b>	<b>Time Triggered (TT) architectures for single processor systems</b>	1	04
	3.1	An introduction to schedulers, The desktop OS, Assessing the super loop architecture, Executing multiple tasks at different time intervals		
	3.2	What is a scheduler? Co-operative and pre-emptive scheduling, A closer look at pre-emptive schedulers, Task oriented design.		
4	<b>Title</b>	<b>Scheduler</b>	1	17
	4.1	Co-operative scheduler -TTC		
	4.2	Hybrid scheduler-TTH		
	4.3	Shared clock scheduler- SC		
5	<b>Title</b>	<b>Working with MISRA C (International guidelines and standard)</b>	1	02
	5.1	Vision and Objectives of MISRA C		
	5.2	Relationship to other guidelines		
	5.3	Applying MISRA C guidelines		
6	<b>Self-Study</b>	Material in the Online resources has to be read as told by the instructor for understanding the implementation details of the peripherals.	Online resource-1 and 2 and R.2	*56
			<b>Total</b>	<b>28</b>





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## Laboratory Component, if any. (Minimum 10 Laboratory experiments are expected)

Sr. No	Title of the Experiment
1	Repeat the early prototype of a control system for lowering an aircraft undercarriage exercise with the correct implementation of the sEOS learnt in the theory and deciding how many tasks would be needed in the system. Documenting the findings of the practical 2 and this practical w.r.t. the timing correctness and the deviation from the given specification is essential
2	Pulse Width Modulation on two different pins with different duty cycles. The system should stop after 40secs and restart when the system is reset again
3	Identify the startup file used with your $\mu$ Vision project for Exercise 4 and explaining how it operates.
4	There are three parts to this practical <b>Part a</b> deals with creating a task having a certain BCET, ACET and WCET. Use of Super Loop architecture is required here <b>Part b</b> deals with using sandwich delay architecture.
5	<b>Part c</b> of Laboratory 4. Use appropriate sEOS implementation to implement the system in Laboratory 4. Document the jitter level to arrive at a conclusion.
6	18 MISRA C rules will be provided. Participants need to explain the rules with help of code snippets
7	A task must be designed that runs at a given interval and has a given WCET. This task has a transitory overrun at some given interval. Two implementations are to be done, one with sEOS and the other with TTC. Using the timing measurements from the toolset, the major observations with both the implementations has to be documented
8	A short frequent task and a long task must be implemented using the hybrid scheduler
9	A report which compares the advantages and disadvantages of the C and Ada programming languages from the perspective of a company which develops reliable embedded systems. This report should compare MISRA C and SPARK ADA and mention what impact would you expect these subsets to have on system reliability?
10	A report has to be written relating the D0-178C aerospace guidelines investigating the impact on a software company following these guidelines

## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Patterns of Time Triggered Embedded Systems	1st	Michael J.Pont	Pearson	2014



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## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	The C programming Language	2nd	Dennis Ritchie and Brian Kernighan	<b>Pearson education</b>	2015
2	MISRA C :Guidelines	-	MISRA.ORG.UK	<b>MISRA</b>	2012

- Online Resource: 1. <https://developer.arm.com/documentation/dui0552/a/preface/about-this-book>  
2. [https://www.st.com/resource/en/reference\\_manual/cd00171190-stm32f101xx-stm32f102xx-stm32f103xx-stm32f105xx-and-stm32f107xx-advanced-arm-based-32-bit-mcus-stmicroelectronics.pdf](https://www.st.com/resource/en/reference_manual/cd00171190-stm32f101xx-stm32f102xx-stm32f103xx-stm32f105xx-and-stm32f107xx-advanced-arm-based-32-bit-mcus-stmicroelectronics.pdf)  
3. <https://www.keil.arm.com/cmsis>



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned				
		L	T	P	O	E	L	T	P	Total	
MDM-14	Engineering Reliable Time Triggered Systems	3	--	2	3	8	3	--	1	4	
		Examination Scheme									
		Component	ISE (%)	MSE (%)	ESE (%)	Total					
M144		Theory	20	20	60	100					
		Laboratory	80	--	20	100					

<b>Pre-requisite Course Codes, if any.</b>	Advanced Time-Triggered Systems Design
<b>Course Objective:</b> To develop the ability to create software for safety-critical systems designed according to Safety Integrity Levels (SIL) 0 to 3, using Time-Triggered Architectures, involves gaining a solid understanding of both the principles of safety-critical software engineering and the specifics of Time-Triggered systems.	
<b>Course Outcomes (CO):</b> <i>At the end of the course students will be able to</i>	
M144.1	<b>Understand, Apply, Create and Analyze code for Redundancy:</b> For SIL 2 and above, you'll need to design for redundancy (e.g., dual-channel architecture) to ensure that a failure in one channel does not result in system failure.
M144.2	<b>Understand, Apply Create and Analyze code for Fault Tolerance:</b> Understand how Time-Triggered Architectures can provide fault tolerance through time-based checks and fault isolation.
M144.3	<b>Understand, Apply Create and Analyze code for Error Detection and Handling:</b> Learn how to implement mechanisms such as watchdog timers, integrity checks, and redundancy management to detect and handle failures.
M144.4	<b>Understand, Apply Create and Analyze code for Diagnostic Coverage:</b> A significant aspect of SIL certification, ensuring that the system can detect and respond to faults appropriately.
M144.5	Relate and evaluate the design for compliance with international safety standards e.g. IEC 61508, ISO 26262, DO-178C to name a few

## CO-PO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
M144.1	3	3	3	3	3	3						
M144.2	3	3	3	3	3	3		3				
M144.3	3	3	3	3	3	3						
M144.4	3	3	3	3	3	3						
M144.5	3	3	3	3	3	3	3	3	3	3	3	3



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## BLOOM'S Levels Targeted (Pl. Tick appropriate)

Remember√	Understand√	Apply√	Analyze√	Evaluate√	Create√
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## Theory Component

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Introduction</b>	1	04
	1.1	A simple TTC scheduler		
2	<b>Title</b>	<b>Foundations of reliable systems</b>	1	08
	2.1	Polling and buffering		
	2.2	Data storage and data transfers		
3	<b>Title</b>	<b>Tasks and peripheral management</b>	1	14
	3.1	Interacting with peripherals		
	3.2	Diverse and Balanced tasks		
	3.3	Processor software state and Shared Clock and GALS system		
4	<b>Title</b>	<b>Modelling TTC designs</b>	1	03
	4.1	Modelling with tick lists		
5	<b>Title</b>	<b>Monitoring TTC designs</b>	1	13
	5.1	Performing POST's and BIST's		
	5.2	Making use of iWDT(internal watchdog timer) and WaranTTor unit		
6	<b>Self Study</b>	Participants have to read the reference material to dig out information from the reference material and the online resources to design the given systems as per the given specifications .	Online resources and R.3	*42
	<b>Total (*Not included)</b>			

**Laboratory Component, if any. (Each Laboratory experiment is a design problem needing at least 6hrs of development time or 3 practical sessions each)**

Sr. No	Title of the Experiment
1	Create a TTC scheduling mechanism: <ul style="list-style-type: none"> <li>• Build the project with the required .c and .h files with the requisite function prototypes</li> <li>• Create the required functions for the scheduler</li> <li>• Test the scheduler with some dummy tasks with different task arrival times</li> </ul>
2	Register Configuration checks



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	<ul style="list-style-type: none"><li>Use the scheduler created at Sr. No.1 to configure the various registers of the like the Systick timer, watchdog timer and UART register for correct configuration.</li><li>Build code to use the scheduler for checking the configuration of the various registers before application start</li></ul>
3	<p>Duplicated variables</p> <ul style="list-style-type: none"><li>Use the scheduler created at Sr. No.1 to create duplicate of each critical variable to verify that the configuration is not changed and is as per the requirement.</li><li>Write code to compare the duplicated variables with the original variables to ensure that there is no change in the values.</li><li>Apply this technique to check the configuration registers of used peripheral as well.</li></ul>
4	<p>Mode change: Processor in abnormal state</p> <ul style="list-style-type: none"><li>Use the Scheduler at Sr. No. 1 to write code for two processor states viz:</li><li>Processor in normal state</li><li>Processor in abnormal state</li><li>Conduct tests to ensure that the application is run only if the processor is in normal state.</li></ul>
5	<p>Buffered outputs</p> <ul style="list-style-type: none"><li>Use the Scheduler at Sr. No.1 to create output buffering.</li><li>Check the task times and ensure proper buffering is done at the output to ensure that task times become independent of the time it takes to send data to the output. ART could be used here.</li></ul>

## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Engineering Reliable Embedded Systems	2nd	Michael J. Pont	SafeTTY Systems	2016

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Patterns of Time Triggered Embedded Systems	1st	Michael J. Pont	Pearson	2014
2	The C programming Language	2nd	Dennis Ritchie and Brian Kernighan	Pearson education	2015
3	MISRA C: Guidelines	-	MISRA.ORG.UK	MISRA	2012

Online Resource: 1. <https://developer.arm.com/documentation/dui0552/a/preface/about-this-book>



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2. [https://www.st.com/resource/en/reference\\_manual/cd00171190-stm32f101xx-stm32f102xx-stm32f103xx-stm32f105xx-and-stm32f107xx-advanced-arm-based-32-bit-mcus-stmicroelectronics.pdf](https://www.st.com/resource/en/reference_manual/cd00171190-stm32f101xx-stm32f102xx-stm32f103xx-stm32f105xx-and-stm32f107xx-advanced-arm-based-32-bit-mcus-stmicroelectronics.pdf)
3. <https://www.keil.arm.com/cmsis>



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**MDM-15**  
**Management**  
**For EXTC/CSE/CS**  
**(2024-25)**

**Offered By: SPJIMR**

<b>Course Category of Multidisciplinary Minor</b>	<b>MDM-I (Semester IV)</b>	<b>MDM-II (Semester V)</b>	<b>MDM-III (Semester VI)</b>	<b>MDM-IV (Semester VII)</b>
<b>Management</b>	<b>M151:</b> Fundamentals of Accounting & Finance	<b>M152:</b> Operations and supply chain management	<b>M153:</b> IT for Business	<b>M154:</b> Marketing Management



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# Sardar Patel Institute of Technology

(Empowered Autonomous Institute Affiliated to University of Mumbai)  
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-15	Fundamentals of Accounting & Finance	2	1	0	3	6	3	0	0	3
		<b>Examination Scheme</b>								
		<b>Component</b>		<b>ISE (%)</b>		<b>MSE (%)</b>		<b>ESE (%)</b>		<b>Total</b>
M151		<b>Theory</b>		<b>30</b>		<b>30</b>		<b>40</b>		<b>100</b>
		<b>Laboratory</b>		<b>-</b>		<b>--</b>		<b>-</b>		<b>-</b>

**Pre-requisite Course Codes, if any.**

**Course Objective:** This course aims at explaining the basic concepts of Accounting and Finance to participant of Engineering course so as to enable them to apply these concepts for more informed decision making in their future work environment. This course enables the participants to understand the broad aspects of accounting, costing, and Indian financial system.

**Course Outcomes (CO): At the End of the course students will be able to**

M151.1	Understand basics of Financial Accounting
M151.2	Estimate the costs in an organization and their use in decision making
M151.3	Illustrate an overview of the financial system and markets

**Theory Component (Session-wise Plan)**

Module No.	Unit No.	Topics	Ref.	No. of sessions
1	<b>Title</b>			04
	1.1	Introduction to Financial Accounting	1	
	1.2	Understanding different Types of Accounts: Assets, Liabilities, Income, Expense and Capital	1	
2	<b>Title</b>			04
	2.1	Introduction to Income Statement and Balance Sheet	1	
	2.2	Making Sense of Income Statement and Balance Sheet Numbers – Ratio Analysis	1	
3	<b>Title</b>			08
	3.1	Introduction to Costs in Organizations	1	
	3.2	Understanding Classification of Costs	1	
	3.3	Understanding methods of Cost Absorption	1	
	3.4	Using Cost for Decision Making- CVP Analysis	1	
	3.5	Using Costs for Decision Making- Average Costing and Marginal Costing	1	
4	<b>Title</b>			04
	4.1	Banks and non-banking financial companies	1	
	4.2	Insurance Companies, Asset management Companies	1	
	4.3	Financial Markets	1	
<b>Total</b>				<b>20</b>

\* The duration of each session is 70 minutes.





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## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1	Finance Sense	Fifth	Prasanna Chandra	McGraw Hill Higher Education	2017

\*Handouts shall be provided before the class



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-15	Operations and supply chain management	2	2	0	4	8	4	0	0	4
		<b>Examination Scheme</b>								
M152		Component		ISE (%)		MSE (%)		ESE (%)	Total	
		Theory		30		30		40	100	
		Laboratory		-		--		-	-	

**Pre-requisite Course Codes, if any.**

**Course Objective:** To introduce students to the foundational concepts and principles of operations management and supply chain management. To analyze and improve business processes for efficiency, effectiveness, and productivity. To develop skills in measuring and improving operational performance.

**Course Outcomes (CO): At the End of the course students will be able to**

M152.1	Develop a strong foundation in the principles, tools, and techniques of operations management.
M152.2	Learn about different supply chain models and their applications in various industries.
M152.3	Solve complex operational and supply chain problems using analytical and quantitative methods.

**Theory Component (Session-wise Plan)**

Module No.	Unit No.	Topics	Ref.	No. of sessions
1	<b>Title</b>			04*
	1.1	Overview of the topics: Products, services, Production system, Production management, value chain, supply chain		
	1.2	Product Design, Functional design, design for manufacturing QFD		
	1.3	Process design, manufacturing processes, forming, cutting, joining, others		
	1.4	Classification of production systems, job, batch, mass production systems, Discrete vs continuous system, MTS, MTO, ATO systems		
2	<b>Title</b>			08 #
	2.1	Introduction to OM and Process flow analysis, Process flow chart		
	2.2	Process layout, product lay out, group lay out, line balancing		
	2.3	Demand management, Demand forecasting		
	2.4	Project Management, Scheduling, CPM network, Project viability study		
3	<b>Title</b>			08*
	3.1	Make buy decision, Strategic sourcing, Material planning, Procurement		



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	<b>3.2</b>	Production planning, Control, Introduction to MRP and ERP Management Information system		
	<b>3.3</b>	Inventory Management, cost associated with inventory, Replenishment models, Ordering systems		
	<b>3.4</b>	Quantitative techniques in decision making, Linear programming, applications in product mix decision and logistics		
<b>4</b>	<b>Title</b>			<b>04#</b>
	<b>4.1</b>	Quality Management, TQM, SQC, SPC, cost of quality		
	<b>4.2</b>	Service operations Management, Service facility design		
<b>Total</b>				<b>24</b>

The duration of each session is 70 minutes. # Session Instructor: AM \* Session Instructor: RSI

### Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1					



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-15	IT for Business	2	1	0	3	6	4	0	0	3
		<b>Examination Scheme</b>								
M153	IT for Business	<b>Component</b>		<b>ISE (%)</b>		<b>MSE (%)</b>		<b>ESE (%)</b>	<b>Total</b>	
		<b>Theory</b>		<b>30</b>		<b>30</b>		<b>40</b>	<b>100</b>	
		<b>Laboratory</b>		<b>-</b>		<b>--</b>		<b>-</b>	<b>-</b>	

**Course Objective:** The objective of this course is to provide participants with a comprehensive understanding of how IT-enabled digital technologies drive business transformation and create value in the modern economy. Through practical insights into business analytics, emerging technologies like RPA and chatbot's, and the integration of APIs, participants will develop the skills to analyze data, implement innovative solutions, and assess the impact of advancements such as 5G on business strategies.

**Course Outcomes (CO): At the End of the course students will be able to**

M153.1	To have an abroad understanding of Digital Economy and Digital Transformation.
M153.2	To have a broad experience of Business Analytics, Big Data Analytics and its Use Cases in Business.
M153.3	To have a general knowledge of the Emerging world of Bots, Robotic process automation and Chatbots and Use cases in Business.
M153.4	To have knowledge of Python, what are application programming Interfaces (APIs), How APIs can be used to Integrate Chatbots and RPA bots
M153.5	To know the coming age of 5G and It's the business impact.

**Theory Component (Session-wise Plan)**

Module No.	Unit No.	Topics	Ref.	No. of sessions
1	<b>Title</b>	Introduce to Digital: Trends and Technologies shaping Digital revolution		02
	1.1	Understand Technology Trends shaping the Digital Economy		
	1.2	Understand Different Digital Technologies driving Digital Transformation		
2	<b>Title</b>	Robotic Process Automation & Chatbots: New age of conversational automation		06
	2.1	RPA Part I <ul style="list-style-type: none"> <li>What is RPA, and what is not?</li> <li>Evolution of RPA Automation</li> <li>RPA v/s Test Automation</li> </ul>		



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	<b>2.2</b>	RPA-Part 2 <ul style="list-style-type: none"> <li>How to build a simple S/W robot?</li> <li>What is RPA the best fit for?</li> <li>Benefits, Risks and Challenges of RPA</li> <li>Automation Maturity Levels</li> </ul> Current RPA tools		
	<b>2.3</b>	RPA-Part 3 <ul style="list-style-type: none"> <li>Using iRobot &amp; Orchestrator</li> <li>Some examples of RPA</li> <li>Web Data Scraping Examples (2)</li> </ul> Use cases in Industry		
	<b>2.4</b>	RPA-Part 4 <ul style="list-style-type: none"> <li>PDF to text</li> <li>OCR to text</li> <li>Text to Speech – Reusable workflow</li> <li>Handwriting recognition</li> <li>Example use cases in the industry</li> </ul>		
	<b>2.5</b>	Chatbot-Part 1 & 2 <ul style="list-style-type: none"> <li>Introduction Chatbots,</li> <li>Introduction to DailogFlow</li> </ul>		
<b>3</b>	<b>Title</b>	Data Analytics: Different types of Analytics, Big data Analytics, Concepts and Tools		<b>06</b>
	<b>3.1</b>	Introduction to Business Analytics, Text Analytics		
	<b>3.2</b>	Working with tools to find insights from data		
	<b>3.3</b>	Data interpretation and action thereof from text analytics reports		
<b>4</b>	<b>Title</b>	Python scripting, AI/ML for data science		<b>06</b>
	<b>4.1</b>	Python for data science		
	<b>4.2</b>	Management of IT: Emerging Research areas		
	<b>4.3</b>	Preparation for Research paper publishing		
<b>5</b>	<b>Title</b>	Information management Research		<b>04</b>
	<b>5.1</b>	Python for data science Panda's library		
	<b>5.2</b>	No code, Low code Tools for AI/ML		
<b>Total</b>				<b>24</b>

\* The duration of each session is 70 minutes.

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1					



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## Other Notes:

1. **Attendance** in the course is to be governed by program rules.
2. Participants are expected to have a laptop with at least 8GB of memory, windows running on the laptop.
3. Please arrive **on** time. Attendance will not be given if you arrive late (10 minutes' post-class begins), although you may be allowed to attend the class.

## Group project

- Each academic group will work on a text analytics project as detailed below.
- Proposal should have the following:
  - 5 consumer Brands in India (please ensure NO groups select the same brands: coco of class to ensure this)
  - Collect 3 months of all brand posts and create dataset for analytics as follows
    - Date wise posts
    - For each post, video, text, gif and message
    - User engagement generated e.g. total reactions (likes), Comments, shares
  - Then carry out Text analytics on this data and generate following
    - Word cloud
    - Sentiment analysis of comments
    - Topic modelling for comments
  - Submission for evaluation
    - Dataset you created
    - A short report of your Text Analytics
      - Introduction
      - Data collection method for 5 consumer brands
      - Your method for text analytics
      - Your conclusion based on word cloud, topics and sentiment analysis of comment
    - You are free to use any open-source tools as it may be convenient to you to carry out this project work



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-IV	Marketing Management	2	2	0	3	6	2	2	0	4
		Examination Scheme								
		Component		ISE (%)		MSE (%)		ESE (%)		Total (%)
M154		Theory		30		30		40		100
		Laboratory		-		--		-		-

Pre-requisite Course Codes, if any.	
<p><b>Course Objective:</b> The objective of the course is to introduce basics of marketing and develop an appreciation of its pervasive role in business, political and social life. The specific objective of the course is to help students:</p> <ol style="list-style-type: none"> <li>1. Think strategically about marketing</li> <li>2. Use key frameworks to analyze situations and make decisions</li> <li>3. Understand how to create a strong marketing plan</li> </ol>	
<p><b>Course Outcomes (CO): At the End of the course students will be able to</b></p>	
M154.1	To Understand core marketing concepts, tools like Ansoff's Grid, 5Cs, and SWOT analysis, and the dual role of marketing in fulfilling needs and creating value.
M154.2	To understand consumer behavior, analyze decision-making processes, and evaluate business buying strategies to drive informed marketing actions.
M154.3	To effectively segment, target, and position markets by leveraging segmentation bases, crafting positioning strategies, and identifying points-of-difference and points-of-parity.
M154.4	To understand brand and customer equity while developing effective branding strategies, including decisions on extensions and portfolio management.
M154.5	To analyze product characteristics, manage product lines and mixes, and develop strategies for various stages of the product life cycle (PLC).
M154.6	To understand the functions and significance of marketing channels, make strategic channel design decisions, and effectively manage channel integration and conflicts.
M154.7	To apply the 6M framework, select communication vehicles, craft effective messages, and design an optimal communication mix.
M154.8	To develop understanding of pricing factors, value-based pricing principles, and strategies for managing price sensitivity and customization.

## Theory Component (Session-wise Plan)

Module No.	Unit No.	Topics	Ref.	No. of sessions
1	Title	Marketing as a value creation process.		02
	1.1	Introduction to Marketing	1	



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	<b>1.2</b>	Marketing Strategy	1	
<b>2</b>	<b>Title</b>	<b>Understanding Consumers</b>		<b>02</b>
	<b>2.1</b>	Understanding Consumer Behavior	1	
	<b>2.2</b>	Understanding Business Buying Behavior	1	
<b>3</b>	<b>Title</b>	<b>Choosing your customers</b>		<b>04</b>
	<b>3.1</b>	Segmentation	1	
	<b>3.2</b>	Targeting	1	
	<b>3.3</b>	Brand Positioning	1	
<b>4</b>	<b>Title</b>	<b>Branding</b>		<b>01</b>
	<b>4.1</b>	Brands and Brand Equity	1	
<b>5</b>	<b>Title</b>	<b>Creating a value proposition- Designing your offer</b>		<b>02</b>
	<b>5.1</b>	Creating Value – Product Policy and PLC	1	
<b>6</b>	<b>Title</b>	<b>Delivering Value- Going to Market</b>		<b>02</b>
	<b>6.1</b>	Delivering Value – Going to market	1	
<b>7</b>	<b>Title</b>	<b>Communicating the value proposition</b>		<b>02</b>
	<b>7.1</b>	Communicating Value	1	
<b>8</b>	<b>Title</b>	<b>Capturing Value</b>		<b>03</b>
	<b>8.1</b>	Pricing to Capture value	1	
	<b>8.2</b>	Marketing Research	1	
			<b>Total</b>	<b>18</b>

\* The duration of each session is 70 minutes.

## Textbooks

Sr. No	Title	Edition	Authors	Publisher	Year
1	Marketing Management 1	15 <sup>th</sup> edition	Philip Kotler and Kevin Lane Keller		

## Other Notes:

### Special Instructions:

1. This is not a course for spectators. It is a highly experiential/interactive course. **Thorough pre-class preparation is a MUST.**
2. All submissions are to be made before designated classes/ presentations.

**Class Participation:** Two main criteria will be used in reaching our judgment about your class participation:

### **1. Depth and Quality of Contribution**

This will be the most important dimension of participation concerning what it is that you are saying. A high-quality comment reveals depth of insight, rigorous use of case evidence, consistency of argument, and realism. To perform well on these criteria, it is important that you come to class with a definite action plan and be prepared to help your classmates appreciate the appropriateness of your plan/point.

### **2. Moving Your Peers' Understanding Forward**

This dimension looks into:





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*Relevance* —Effective listening, a good sense of timing, and a willingness to either integrate the work of others or challenge their ideas are the skills that lead to relevance.

*Clarity and Conciseness* — Clarity involves speaking with urgency, vividness, and persuasiveness. To be concise, make your best point in the shortest possible time.

*Involvement* — Involvement means thoughtful listening, concentration, tracking of the discussion, and a poised readiness to contribute selectively.

**Suggestions for Reading beyond the Assigned Materials:** A good general-purpose reference book is assigned as the textbook with relevant chapters marked in session details. Further to this, your time is better spent thinking and applying concepts to current situations for which you can choose to read up newspapers or business magazines available in your library.



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**Syllabus**

**Multidisciplinary Minor-16**

**(MDM-16)**

**Barclays Minor in Banking Technology**

**For EXTC/CSE/CS**

**(2023-27 Batch)**

**Offered By: Barclays**



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Course Category of Multidisciplinary Minor	MDM-I (Semester IV)	MDM-II (Semester V)	MDM-III (Semester VI)	MDM-IV (Semester VII)
<b>Banking Technology</b>	<b>M161:</b> Banking, Financial Services and Insurance Overview (BFSI) and Data Management & Analytics	<b>M162:</b> Enterprise Risk Management & Applied cyber security	<b>M163:</b> Agile Methodology	<b>M164:</b> Academic-Industry collab Project



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-16	Banking, Financial Services and Insurance Overview (BFSI) and Data Management & Analytics	2	0	2	4	8	2	0	1	3
		Examination Scheme								
M161		Component		ISE	MSE	ESE	Total			
		Theory		30%	30%	40%	100%			
		Laboratory		80%	--	20%	100%			

<b>Pre-requisite Course Codes, if any.</b>		Nil
<b>Course Objective:</b>		
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>		
M161.1	Comprehensive understanding of the banking, financial services, and insurance (BFSI) sector	
M161.2	Understand the roles and interactions of different participants in financial markets, including retail investors, corporations, banks, and regulatory bodies.	
M161.3	Evaluate the impact of emerging trends, particularly environmental, social, and governance (ESG) factors, on the future of the BFSI industry	
M161.4	Understand data lifecycle management process and its application in real-world scenarios, including data creation, ingestion, and archival	
M161.5	Apply analytics and business intelligence (bi) tools to derive insights	
M161.6	Demonstrate proficiency in using cloud technologies and tools for implementing data management and analytics solutions in financial services	

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M161.1														
M161.2														
M161.3														
M161.4														
M161.5														
M161.6														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	✓ Apply	Analyze	Evaluate	Create
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## Theory Component (BFSI)

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>BFSI Overview</b>		<b>1</b>
	1.1	Introduction to BFSI: Understanding the Banking, Financial Services, and Insurance sectors. Functions and Importance: Role of BFSI in the economy. Key Players: Overview of major institutions and their functions.		
2	<b>Title</b>	<b>Financial Products &amp; Services</b>		<b>3</b>
	2.1	Banking Products: Savings accounts, loans, credit cards, etc. Investment Products: Stocks, bonds, mutual funds, etc		
	2.2	Insurance Products: Life insurance, health insurance, etc. Emerging Financial Services: Fintech innovations and digital banking.		
3	<b>Title</b>	<b>Financial Markets Participants -Retail, Corporates, Banks, etc.</b>		<b>1</b>
	3.1	Retail Participants: Individual investors and their roles. Corporate Participants: How businesses interact with financial markets. Banks and Financial Institutions: Their role in facilitating transactions and providing services. Regulatory Bodies: Overview of regulatory authorities and their impact.		
4	<b>Title</b>	<b>Risk Management Basics</b>		<b>1</b>
	4.1	Introduction to Risk Management: Understanding different types of risks (credit, market, operational, etc.). Risk Management Frameworks: Tools and techniques for managing risks. Case Studies: Real-world examples of risk management in action.		
5	<b>Title</b>	<b>Future Trends - ESG</b>		<b>1</b>
		Introduction to ESG: Environmental, Social, and Governance factors. ESG in Banking: How banks are integrating ESG into their operations. Future Trends: Digital transformation, sustainability, and other emerging trends. Case Studies: Examples of ESG initiatives in the banking sector.		
6	<b>Title</b>	<b>Financial Crisis - Case Study</b>		<b>2</b>
	6.1	Overview of Financial Crises: Historical perspective on major financial crises. Case Study: In-depth analysis of a specific financial crisis (e.g., 2008 financial crisis).		



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		Lessons Learned: Key takeaways and how they have shaped the current financial landscape.		
			<b>Total</b>	

## Theory and lab component (Data Management & Analytics)

Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Introduction to Data Management &amp; Analytics</b>		<b>1</b>
	1.1	Data management overview Data lifecycle Data analytics overview		<b>Theory</b>
	<b>Title</b>	<b>Data ingestion – Identifying and acquiring data from the source</b>		<b>3</b>
	1.2	Data ingestion Data cleansing & preparation Handling missing Data		<b>Lab</b>
2	<b>Title</b>	<b>Data Modeling Techniques</b>		<b>1</b>
	2.1	Introduction to data modeling concepts Data transformation and curation Overview of common data storage architecture – lake, warehouse, mart Data temporality and snapshotting		<b>Theory</b>
	<b>Title</b>	<b>Data Pipelines – Batch &amp; Real-time</b>		<b>3</b>
	2.2	Batch vs Real-time data processing scenarios Components of data pipelines Change Data Capture (CDC) process		<b>Lab</b>
3	<b>Title</b>	<b>Data Pipelines – Batch &amp; Real-time</b>		<b>1</b>
	3.1	Batch vs Real-time data processing scenarios Components of data pipelines Change Data Capture (CDC) process		<b>Theory</b>
	<b>Title</b>	<b>Building ETL pipelines for batch &amp; real-time processing</b>		<b>3</b>
	3.2	Building batch ETL pipelines Building streaming data pipeline Implementing CDC techniques		<b>Lab</b>
4	<b>Title</b>	<b>Data Governance and Quality Management</b>		<b>1</b>
	4.1	Data governance framework Handling sensitive data Data quality management		<b>Theory</b>
	<b>Title</b>	<b>Implementing data governance and quality controls</b>		<b>3</b>
	4.2	Implementing data quality checks Implementing masking and tokenization on sensitive data Data access management techniques		<b>Lab</b>



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<b>5</b>	<b>Title</b>	<b>Management Information (MI) Reporting &amp; Visualization</b>		<b>1</b>
	<b>5.1</b>	Overview of MI reporting and its key concepts Building reports based on audience Common data visualization techniques		<b>Theory</b>
	<b>Title</b>	<b>Building MI reports and telling a story through them</b>		<b>3</b>
	<b>5.2</b>	Create MI report/dashboard Identify and visualize KPIs Trend reporting Basic analytics technique		<b>Lab</b>
<b>6</b>	<b>Title</b>	<b>Basic Data Analytics with Python</b>		<b>1</b>
	<b>6.1</b>	Introduction of data analytics and use cases Overview of simple analytics techniques - Regression and Clustering Python libraries for analytics and visualization		<b>Theory</b>
	<b>Title</b>	<b>Building Analytics Application with Jupyter and Python</b>		<b>3</b>
	<b>6.2</b>	Configuring Jupyter notebook for python Installing python libraries Implementing basic data operations using python Implementing regression and clustering techniques and visualizing data using python		<b>Lab</b>
<b>7</b>	<b>Title</b>	<b>Data Management Best Practices and Recap of the Course</b>		<b>1</b>
	<b>7.1</b>	Design and process best practices Bringing it all together		<b>Theory</b>
	<b>Title</b>	<b>Implementing an end-to-end data application</b>		<b>3</b>
	<b>7.2</b>	Build a data application with end-to-end ETL pipeline, data quality controls and MI reporting		<b>Lab</b>

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
<b>1</b>					

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
<b>1</b>					



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-16	Enterprise Risk Management & Applied cyber security	3	0	2	4	9	2	1	1	4
		Examination Scheme								
Component		ISE		MSE		ESE		Total		
Theory		30		30		40		100		
M162		Laboratory		80		--		20		100

Pre-requisite Course Codes, if any.	Nil
<b>Course Objective:</b>	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M162.1	Demonstrate a comprehensive understanding of fundamental cyber security concepts and their relevance to the BFSI sector
M162.2	Understand physical security measures and access management protocols for protecting organizational assets.
M162.3	Application of security best practices and utilize cryptography for data protection in financial systems.
M162.4	Employ data analytics techniques and digital forensics tools to investigate and respond to security incidents
M162.5	Comprehensive understanding business continuity and disaster recovery plans tailored to the needs of financial institutions
M162.6	Knowledge on security incidents and apply ethical hacking techniques to improve organizational security-posture.

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M162.1														
M162.2														
M162.3														
M162.4														
M162.5														
M162.6														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	✓ Apply	Analyze	Evaluate	Create
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**Theory Component (Enterprise Risk Management)**





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Module No.	Unit No.	Topics	Ref.	Hrs.
1	<b>Title</b>	<b>Enterprise Risk Management-ERM Overview</b>		<b>2</b>
	<b>1.1</b>	-Key Elements of ERM -Key Objectives and core components of ERM -Key Benefits. -Frameworks and Standards: Overview of different frameworks. COSO ERM Framework, ISO 31000, Basel Accords etc. -The Importance of Risk Culture in an organization -Role of the Risk Manager -Summary and Q&A		
2	<b>Title</b>	<b>3 Line Defense Models</b>		<b>2</b>
	<b>2.1</b>	-Introduction to BSFI and 3 line of defense Model and Explanation Responsibilities: -First Line of Defense: Operational Management -Second Line of Defense: Risk and Compliance Functions -Third Line of Defense: Internal Audit -Summary and Q&A		
3	<b>Title</b>	<b>Enterprise Risk Management-ERM -Introduction to Risk Identification</b>		<b>4</b>
	<b>3.1</b>	-Types of Risks to Identify -Risk Identification Techniques -Summary and Q&A		
	<b>Title</b>	<b>Enterprise Risk Management-ERM -Risk Assessment and Evaluation</b>		
	<b>3.2</b>	Introduction to Risk Assessment and Evaluation Key Concepts in Risk Assessment Heatmap/ Scale Risk Assessment Methods and Tools: Qualitative Methods/ Quantitative Methods. Risk Evaluation and Prioritization Summary and Q&A		
4	<b>Title</b>	<b>Enterprise Risk Management-ERM- Risk Mitigation and Control Strategies</b>		<b>2</b>
	<b>4.1</b>	Introduction to Risk Mitigation and Control Overview of Risk Response Strategies Mitigation and Control Techniques Developing a Risk Mitigation Plan Summary and Q&A		
5	<b>Title</b>	<b>Control Frameworks</b>		<b>2</b>
	<b>5.1</b>	Introduction to Control Frameworks Key Components of a Control Framework Designing and Implementing Controls Monitoring and Reporting Controls Summary and Q&A		
6	<b>Title</b>	<b>Enterprise Risk Management-ERM -Monitoring and Reporting Risk</b>		<b>2</b>



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	<b>6.1</b>	Introduction to Risk Monitoring and Reporting Key Principles of Risk Monitoring Key Risk Indicators-KRIs Escalation Processes Risk Trends Risk Reporting Process:  -Risk Dashboards -Tools and Techniques for Monitoring and Reporting -Automated Alerts. Performance Reviews and Audits Summary and Q&A		
<b>7</b>	<b>Title</b>	<b>Operational Resilience</b>		<b>2</b>
	<b>7.1</b>	Introduction to Operational Resilience Key Components of Operational Resilience  -Business Continuity Planning -Incident Response and Reporting in BSFI Summary and Q&A		
<b>Total</b>				

## Theory and lab component (Cyber Security)

Module No.	Unit No.	Topics	Ref.	Hrs.
<b>1</b>	<b>Title</b>	<b>Introduction to Cyber Security</b>		<b>1</b>
	<b>1.1</b>	-Principles of cyber security -Real Life Scenarios -Importance of security measures		<b>Theory</b>
	<b>Title</b>	<b>Introduction to Threats and Best Practices</b>		<b>2</b>
	<b>1.2</b>	-Diverse types of threats -Best practices for securing computer systems		<b>Theory</b>
<b>2</b>	<b>Title</b>	<b>Information Security and Risk Management</b>		<b>1</b>
	<b>2.1</b>	-Cover the domains addressing to the security framework and policies, procedure standards, governance structure, organization structure and risk management framework (entire life cycle of risk assessment)		<b>Theory</b>
	<b>Title</b>	<b>Data Privacy</b>		<b>3</b>
	<b>2.2</b>	NIST (National Institute of Standards and Technology) Control Framework -ISO 27001 -NIS Cyber Security Framework -Regulatory Requirements for various industry verticals -Security Assessments -Importance of Security Awareness training in an organization -GDPR		<b>Theory</b>



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<b>3</b>	<b>Title</b>	<b>Physical Security</b>		<b>1</b>
	<b>3.1</b>	-Physical Access Types -Crime Prevention Through Environmental Design CPTED -Measures		<b>Theory</b>
	<b>Title</b>	<b>Identity &amp; Access Management</b>		<b>3</b>
	<b>3.2</b>	-Identity, Authorization and Authentication -IDAM techniques: Authentication, Access Controls		<b>Theory</b>
<b>4</b>	<b>Title</b>	<b>Business Continuity &amp; Disaster Recovery Requirements - 1</b>		<b>1</b>
	<b>4.1</b>	-Course to cover understand about BC (Business Continuity) – RTP/RPO / RTO / MTPD (MW) - ISO 22301 Standard - Business Continuity Management - Importance - Difference between BCMS and DRMS - Risk Management - Testing - Maintenance		<b>Theory</b>
	<b>Title</b>	<b>Business Continuity &amp; Disaster Recovery Requirements - 2</b>		<b>2</b>
	<b>4.2</b>	Scenario based learnings on basis of 1st topic.		<b>Lab</b>
<b>5</b>	<b>Title</b>	<b>Third Party or Vendor Security</b>		<b>1</b>
	<b>5.1</b>	-Importance of TPRM -Risk Assessment -Due Diligence -Contractual Agreements -Ongoing Monitoring -Third Party Assessments -Continuous Improvements -Third Party Exit		<b>Theory</b>
	<b>Title</b>	<b>ISO Rules and Details</b>		<b>2</b>
	<b>5.2</b>	ISO Rules and certifications to cover risks		<b>Theory</b>
<b>6</b>	<b>Title</b>	<b>Network Security</b>		<b>1</b>
	<b>6.1</b>	-Network Security -Network Architecture & Design (MW) -Common Secure Network Devices and Protocols (MW) -Secure Communication (MW)		<b>Theory +Lab</b>
<b>7</b>	<b>Title</b>	<b>Cryptography</b>		<b>1</b>
	<b>7.1</b>	-Introduction to Cryptography - Importance of Cryptography (MW) - Types and Real-World Use Cases (MW) - Cloud Security - Security Assessment & Testing (MW) - Software Testing (MW)		<b>Theory</b>
	<b>Title</b>	<b>TBD</b>		<b>2</b>
	<b>7.2</b>	-TBD		<b>Lab</b>



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<b>8</b>	<b>Title</b>	<b>Data Analytics</b>		<b>1</b>
	<b>8.1</b>	-Data Analytics Tools -Techniques		<b>Theory</b>
	<b>Title</b>	<b>Digital Forensics</b>		<b>2</b>
	<b>8.2</b>	-What are Forensics Techniques? -Why is that important part of Cyber Security?		<b>Theory</b>
<b>9</b>	<b>Title</b>	<b>Security Incidents</b>		<b>1</b>
	<b>9.1</b>	-Evolution of Cyber Attacks -Threat Landscape -Scenarios & Types -Recovery		<b>Theory</b>
	<b>Title</b>	<b>Ethical Hacking</b>		<b>2</b>
	<b>9.2</b>	-Cyber Threats -Vulnerability		<b>Theory</b>

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1					

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1					



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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-16	Agile Principles and Software Engineering	3	0	2	4	9	3	0	1	4
		Examination Scheme								
M163	Agile Principles and Software Engineering	Component		ISE		MSE		ESE		Total
		Theory		30		30		40		100
		Laboratory		80		--		20		100

<b>Pre-requisite Course Codes, if any.</b>	Nil
<b>Course Objective:</b> Imparting concepts of each component of <b>Entrepreneurship And Innovation</b> thoroughly with practical aspects	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M163.1	Demonstrate a comprehensive understanding of fundamental cyber security concepts and their relevance to the BFSI sector.
M163.2	Application of security best practices and utilize cryptography for data protection in financial systems
M163.3	Comprehensive understanding Business Continuity and Disaster Recovery plans tailored to the needs of financial institutions
M163.4	Knowledge on security incidents and apply ethical hacking techniques to improve organizational security posture.

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**

**Correlation Levels: 1(Weak) 2(Medium) 3(Strong)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M163.1	3		3											
M163.2	3		3											
M163.3	3		3											
M163.4	3	2	3											

**LO-PEO/PSO Correlation Matrix (3-Strong, 2-Moderate, 1-Weak Correlation)**

LO	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3
MDCE64.1	3						
MDCE64.2	3						
MDCE64.3	3						
MDCE64.4	3		3				

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	✓ Apply	Analyze	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	42 Hrs.
1	<b>Title</b>	Introduction to Agile ways of working		
	1.1	What is Agile <ul style="list-style-type: none"> <li>• Why Agile</li> <li>• Roles and Responsibilities</li> </ul>		1
	<b>Title</b>	Introduction to software engineering in BFSI		
	1.2	<ul style="list-style-type: none"> <li>• Complex integrated tech landscape</li> <li>• Importance of managing tech debt</li> <li>• Code quality and maintainability</li> <li>• Importance of continuous refactoring</li> </ul>		2
2	<b>Title</b>	Scrum, kanban and agile 101		
	2.1	Scrum 101 • Kanban 101 <ul style="list-style-type: none"> <li>• When to use what</li> <li>• Agile Ceremonies</li> <li>• Measuring quality and effectiveness</li> <li>• Benefits of iterative execution</li> </ul>		1
	<b>Title</b>	The new ways of working in BFSI		
	2.2	How Org structure can support Agility <ul style="list-style-type: none"> <li>• POD model, feature team model</li> <li>• How tech stack and architecture needs to facilitate the org structure</li> <li>• Breaking down mental barriers</li> </ul>		3
3	<b>Title</b>	Efficiency and capacity optimization		
	3.1	How to measure productivity and efficiency? <ul style="list-style-type: none"> <li>• Agile data points</li> <li>• Capacity forecasting and allocation</li> </ul>		1



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		<ul style="list-style-type: none"> <li>• How tech funding works</li> <li>• Managing tech debt and funded work</li> <li>• Innovation and thought leadership</li> </ul>		
	<b>Title</b>	Basic engineering principles at BFSI		
		<ul style="list-style-type: none"> <li>• Build at speed</li> <li>• Build for stability, resiliency and scalability</li> <li>• Shift left</li> <li>• Observability</li> <li>• Governance framework</li> </ul>		<b>3</b>
<b>4</b>	<b>Title</b>	Architectural principles		
	<b>4.1</b>	<ul style="list-style-type: none"> <li>• Enterprise architecture, HLD, LLD</li> <li>• Architectural patterns</li> <li>• Architectural governance</li> <li>• Concept of “By design”</li> <li>• Design and create HLD, LLD for an application</li> </ul>		<b>1</b>
	<b>Title</b>	Infrastructure		
	<b>4.2</b>	<ul style="list-style-type: none"> <li>• Why designing and planning the right infra is important</li> <li>• Built for security, resiliency and scalability</li> <li>• Data centers</li> <li>• On prem, Private cloud, public cloud</li> <li>• Hybrid, colo</li> <li>• Optimizing cost</li> <li>• Design an infra strategy for an application</li> </ul>		<b>3</b>
<b>5</b>	<b>Title</b>	DevOps		
		<ul style="list-style-type: none"> <li>• What is devops and why does everyone need to know this</li> <li>• Whats in scope of devops (CI/CD, IAM etc)</li> <li>• What modern devops looks like (few case studies)</li> <li>• Build a basic CI/CD pipeline in jenkins</li> </ul>		<b>1</b>
	<b>Title</b>	Development principles		
	<b>5.2</b>	<ul style="list-style-type: none"> <li>• Basic coding principles</li> <li>• Unit testing, code quality, continuous refactoring</li> </ul>		<b>3</b>



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		<ul style="list-style-type: none"><li>• Principles of code reviews</li><li>• Introduction to TDD, BDD</li><li>• Create a small application</li></ul>		
<b>6</b>	<b>Title</b>	Testing		
	<b>6.1</b>	<ul style="list-style-type: none"><li>• Introduction to different types of testing. SIT, VPT, NFT, UAT, PreProd etc</li><li>• Automation</li><li>• Environment management</li><li>• How to measure quality of testing</li><li>• Create an automated test suite for the app built above</li></ul>		<b>1</b>
<b>7</b>	<b>Title</b>	Resiliency and stability		
	<b>7.1</b>	<ul style="list-style-type: none"><li>• Why is this one of the top priorities</li><li>• Strategies for meeting the targets</li><li>• Pattern, tools to achieve it</li><li>• Governance and controls for this</li></ul>		<b>1</b>
<b>Total</b>				<b>42</b>

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
<b>1</b>					

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
<b>1</b>					





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Course (Category) Code	Course Name	Teaching Scheme (Hrs/week)					Credits Assigned			
		L	T	P	O	E	L	T	P	Total
MDM-16	Academic-Industry collab Project	1	0	6	6	13	0	0	4	4
		<b>Examination Scheme</b>								
Component		ISE		MSE		ESE		Total		
Theory		60		--		40		100		
M164		Laboratory				--				

<b>Pre-requisite Course Codes, if any.</b>	
<b>Course Objective:</b> Enhance problem-solving and critical thinking skills by adapting to real-world scenarios and navigating industry-relevant challenges effectively. Collaborate with industry professionals to design and implement projects addressing real-world challenges, fostering hands-on experience and practical application of knowledge.	
<b>Course Outcomes (CO):</b> <i>At the End of the course students will be able to</i>	
M164.1	Develop the ability to work collaboratively with industry professionals to design and implement solutions for real-world challenges.
M164.2	Demonstrate proficiency in applying theoretical knowledge to practical scenarios, enhancing industry readiness and technical skills.
M164.3	Strengthen communication and teamwork skills by effectively engaging in collaborative project environments.

**Table1: Mapping of CO with PO: (correlation/ strength matrix)**  
Correlation Levels: 1(Weak) 2(Medium) 3(Strong)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO1 2	PSO 1	PSO 2
M164.1														
M164.2														
M164.3														
PO Total														
Target PO Strength														

**BLOOM'S Levels Targeted (Pl. Tick appropriate)**

Remember	Understand	✓ Apply	Analyze	Evaluate	Create
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## Theory Component

Module No.	Unit No.	Topics	Ref.	56 Hrs.
1	Title	<b>Academic-Industry collab Project</b>		
		Work on a collab project with the industry professionals to implement a project based on real world scenarios. Adapt to and navigate real-world scenarios and challenges encountered in industry projects and learning and enhancing problem solving and critical thinking skills.		

## Text Books

Sr. No	Title	Edition	Authors	Publisher	Year
1.					

## Reference Books

Sr. No	Title	Edition	Authors	Publisher	Year
1					