



MANUAL FOR DEGREE OPTIONS

- 1. MULTIDISCIPLINARY MINOR (EMBEDDED WITH BASIC DEGREE)**
 - 2. DOUBLE MINOR (DM) (OPTIONAL MINOR IN EMERGING AREAS)**
 - 3. HONOURS WITH RESEARCH (OPTIONAL)**
-

First to Final Year Engineering
(Sem. III to Sem. VIII)

REVISION: FRCRCE-3-25

Effective from Academic Year 2025-26
Board of Studies Approval: 28/02/2025 and 04/03/2026
Academic Council Approval: 14/02/2025 , 8/03/2025 & 27/03/2026



Dr. DEEPAK BHOIR
Dean Academics

Dr. SAPNA PRABHU
Principal



Society of St. Francis Xavier, Pilar's
Fr. Conceicao Rodrigues College of Engineering
Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050
(Autonomous College affiliated to University of Mumbai)

Preamble:

Fr Conceicao Rodrigues College of Engineering an autonomous institute from the year 2024-25. University Grant Commission vide letter No. F. 2-10/2023(AC-Policy) dated 23rd Nov 2023 conferred the autonomous status to Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai 400050 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations, 2023. We look towards autonomy as a great opportunity to design and implement curriculum sensitive to needs of Learner, Indian Society, and Industries. We commit to ourselves to the effective implementation of UGC Regulations and NEP 2020 in its spirit. Government of Maharashtra has directed Autonomous Colleges to revise their curriculum in line with National Education Policy (NEP) 2020 through Government Resolution dated 4th July 2023. Accordingly, degree options are given to the students admitted from academic year 2024-25 based on UGC circulars and DTE guidelines ref no. 17/DTE/NEP-2020/2024/111 dated 4th June 2024 related to implementation of NEP.

Based on recent recommendations of the GR, we are pleased to offer our holistic curriculum, a “H-Tree Model” of Engineering Education. A unique “**H-Tree Model**” of Engineering Education Curriculum is carefully designed to systematically develop IQ (Intelligence Quotient), PQ (Physical Quotient), EQ (Emotional Quotient) and SQ (Spiritual Quotient) of a learner. This curriculum aims at the development of an all-rounded personality with holistic approach to education in which learner receives 25% teacher-led learning, 25% peer learning, 25% self-learning and 25% experiential learning. The curriculum model is outcome based that focuses on learning by doing. Curriculum is designed to provide multiple learning opportunities for students to acquire and demonstrate competencies for rewarding careers. It ensures multiple choices to learner acquiring skills through systematic planning. It has 7 verticals aligned to GR recommendations with strong science, and mathematics foundation and program core, sequel of electives, Multidisciplinary Minor courses, humanities & management courses and sufficient experiential learning through projects and semester-long industry / research internship along with employable skill-based courses. Learner gets an opportunity to acquire skills through NSDC aligned courses during summer vacations. Learner also gets additional option to choose the kind of degree i.e. **Built in Multidisciplinary minor or Double Minor in emerging field or Honors with Research.**

Various steps are taken to transform teaching learning process to make learning a joyful experience for students. We believe that this curriculum will raise the bar of academic standards with the active involvement and cooperation from students, academic and administrative units.

Curriculum Structure for UG Programs at Fr CRCE w.e.f. A.Y. 2026-27:

Nomenclature of the courses in the Curriculum

BSESC -Basic Science & Engineering Science Courses

PCPEC- Program Core and Program Elective Courses

MDC -Multidisciplinary Courses

SC- Skill Courses

HSSM- Humanities, Social Sciences and Management

EL -Experiential Learning

LLC- Liberal Learning Courses

BSC -Basic Science Courses

ESC -Engineering Science Courses



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2. Learners will have the following options to earn B. Tech. in Engg. /Tech. degree in
- a. Major Engg./Tech Discipline with Double Minor (Multidisciplinary and Specialization Minor)
 - b. Honors with Research and Multidisciplinary Minor
 - a) Major Engg./Tech Discipline with Double Minor (Multidisciplinary and Specialization Minor) (additional 18 credits): $168 + 18 = 186$ Min Credits.
There will be four courses (4 credits each), one in each semester starting from the 3rd semester which will be from emerging areas of specialization. In 7th or 8th semester students will complete 2 credits seminar/project.
Admission eligibility min CGPA=7.5 after First year
 - b) B.Tech in Engg./ Tech.- Honors with Research and Multidisciplinary Minor (additional 18 credits by research): $168 + 18 = 186$ Min Credits. (Admission eligibility min CGPA=7.5 after First and should maintain CGPA=7.5 after Third year)
3. Learner can earn the certificate/Diploma/Degree based on his/her exit from the program as follows. College shall explore feasibility to offer NSDC aligned skill-based courses to the learners:
- a. UG Certificate: After a one-year (40 credits to be earned) and 8-credits summer workshop/vocational courses/internship
 - b. UG Diploma: After two-years (80 credits to be earned) and 8-credits summer workshop/vocational courses/internship/Project
 - c. B. Voc.: After three-years (120 credits to be earned) and 8-credits summer workshop/vocational courses/internship/Project

Salient Features of Curriculum:

- Framed as per Government Resolution dated 4th July 2023 in line with National Education Policy (NEP) 2020.
- Minimum 168 choice-based credit structure with options of Degrees earning additional credits
- Unique 'H-Tree' Model of Curriculum: Hybrid model for holistic development with happy learning
- environment having bridge connecting verticals providing unique path for each learner for 3-dimensional growth, Life Long Learning, multiple entry-exit, inclusive model indicating equal distribution of central resources
- More emphasis on laboratory based and experiential learning
- More weightage to continuous assessment to reduce examination stress
- Mandatory Semester-long internship, courses with emotional & spiritual learning and skill-based learning aligned with NSDC framework
- Well balanced curriculum to attain Program Outcomes and skills of 21st century learner



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Guidelines for 'MDM and DM Degree Option'

UG Basic Degree	MDM Options included in Basic Degree	Double Minor (Emerging Areas) Options
Computer Engineering Computer Science & Engineering	1. Communication Engineering 2. Mechanical Engineering 3. Business Management 4. Healthcare Management 5. Design	1. VLSI Design & Verification 2. Internet of Things 3. Automation a Robotics 4. Sustainability
Electronics & Computer Science	1. Communication Engineering 2. Mechanical Engineering 3. Business Management 4. Healthcare Management 5. Design	1. Data Science 2. Automation & Robotics 3. Blockchain Technology 4. Cyber Security 5. Sustainability
Mechanical Engineering	1. Computer Engineering 2. Electronics Engineering 3. Business Management 4. Healthcare Management 5. Design	1. Data Science 2. AI & ML 3. Internet of Things 4. Sustainability

Minor in Communication Engineering: (Offered to Comp, CSE & ECS)

Course Code	Communication Engineering Minor Courses	Credits
25MDMCM1	Signals and System	2
25MDMCM2	Analog and Digital Communication	2
25MDMCM3	Microcontrollers and Applications	2
25MDMCM4	Communication and Computer Networks	2
25MDMCM5	Mobile Communication and Computing	2

Minor in Mechanical Engineering: (Offered to Comp, CSE & ECS)

Course Code	Mechanical Engineering Minor Courses	Credits
25MDMME1	Elements of Mechanical Engineering	2
25MDMME2	Manufacturing Engineering	2
25MDMME3	Product Design and Development	2
25MDMME4	Industrial Engineering	2
25MDMME5	Supply Chain Management	2

Minor in Computer Engineering: (Offered to Mech)

Course Code	Computer Engineering Minor Courses	Credits
25MDMCE1	Data Structures and Algorithms	2
25MDMCE2	Database Management System	2
25MDMCE3	Microcontrollers and Applications	2
25MDMCE4	AI and Applications	2
25MDMCE5	Human Machine Interface	2

Minor in Electronics Engineering: (Offered to Mech)

Course Code	Electronics Engineering Minor Courses	Credits
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25MDMEL1	Signals and System	2
25MDMEL2	Digital Electronics	2
25MDMEL3	Microcontrollers and Applications	2
25MDMEL4	Linear Integrated Circuits	2
25MDMEL5	Industrial Electronics	2



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Minor in Business Management: (Offered to all branches)

Course Code	Business Management Minor Courses	Credits
25MDMBM1	Financial Accounting	2
25MDMBM2	Economics for Business	2
25MDMBM3	Business Administration	2
25MDMBM4	Human Resource Management	2
25MDMBM5	Digital Marketing	2

Minor in Healthcare Management: (Offered to all branches)

Course Code	Healthcare Management Minor Courses	Credits
25MDMHM1	Biomedical Instrumentation & Imaging	2
25MDMHM2	Hospital Administration Fundamentals	2
25MDMHM3	Operations Management for Healthcare Systems	2
25MDMHM4	Digital Transformation in HealthCare	2
25MDMHM5	Bioinformatics and Computational Biology	2

Minor in Design: (Offered to all branches)

Course Code	Design Minor Courses	Credits
25MDMDE1	Industrial and Product Design	2
25MDMDE2	Communication Design	2
25MDMDE3	Graphic Design and Animation	2
25MDMDE4	Interaction Design	2
25MDMDE5	Mobility and Vehicle Design	2



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List of Track related to Double Minor Degree in 'Emerging Areas':

- 1. Name: VLSI Design and Verification (offered to Comp and CSE)**
 1. **25DM11:** VLSI Design Flow
 2. **25DM12:** FPGA Programming
 3. **25DM13:** Verification using System Verilog
 4. **25DM14:** AI and ML for VLSI
- 2. Name: Internet of Things (offered to Comp, CSE and Mech)**
 1. **25DM21:** Sensors and Actuators
 2. **25DM22:** Fundamentals of IoT
 3. **25DM23:** Embedded System and RTOS
 4. **25DM24:** System Design
- 3. Name: Automation and Robotics (offered to Comp, CSE and ECS)**
 1. **25DM31:** Introduction to CAD/CAM
 2. **25DM32:** 3D Printing
 3. **25DM33:** Mechatronics
 4. **25DM34:** Industrial Robotics and Automation
- 4. Name: Sustainability (offered to all)**
 1. **25DM41:** Design Thinking for Sustainability
 2. **25DM42:** Green Computing
 3. **25DM43:** Emerging Technologies for Sustainability
 4. **25DM44:** Sustainable Product Design
- 5. Name: Data Science (offered to ECS, Mech)**
 1. **25DM51:** Statistics for Data Science
 2. **25DM52:** Data Analytics and Visualisation
 3. **25DM53:** Game Theory
 4. **25DM54:** Web and Social Media Analytics
- 6. Name: Artificial Intelligence and Machine Learning (offered to Mech)**
 1. **25DM61:** Statistics for Data Science
 2. **25DM62:** Fundamentals of AI & ML
 3. **25DM63:** Natural Language Processing
 4. **25DM64:** Artificial Intelligence for Mechanical Engineering
- 7. Name: Blockchain Technology (offered to ECS)**
 1. **25DM71:** Blockchain Basics
 2. **25DM72:** Bitcoin and Cryptocurrency
 3. **25DM73:** Blockchain Security
 4. **25DM74:** Industrial Blockchain
- 8. Name: Cyber Security (offered to ECS)**
 1. **25DM81:** Cyber Security Essentials
 2. **25DM82:** Web Application, Penetration Testing and Ethical Hacking
 3. **25DM83:** Digital Forensic
 4. **25DM84:** Cloud and IoT Security



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MULTIDISCIPLINARY MINOR (EMBEDDED WITH BASIC DEGREE)

Minor in Communication Engineering: (Offered to CE, CSE and ECS)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMCM1	Signals and Systems	2	--	-	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	20	50	100	

Pre-requisite Course Codes	Basic concepts of Mathematics	
Course Outcomes	CO1	Identify and differentiate between continuous and discrete time signals and systems
	CO2	Develop input output relationship for LTI systems
	CO3	Apply the concept of Laplace transform and understand conversion from time domain to frequency domain for continuous time systems.
	CO4	Apply the concept of Z transform and comprehend conversion from time domain to frequency domain for discrete time systems.
	CO5	Discuss various applications of signals and system

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Signals and Systems	1,2,3,4	4
	1.1	Introduction to Signals: Definition, Basic Elementary signals - exponential, sine, step, impulse, ramp, rectangular, triangular. Operations on signals. Classification of Signals: Analog and discrete time signals, even and odd signals, periodic and non-periodic signals, deterministic and non-deterministic signals, energy and power signals. Arithmetic Operations on Signals, Time Shifting, Time Scaling, Time Reversal of Signals		
	1.2	Systems and Classification of systems: System Representation, continuous time and discrete systems, system with and without memory, causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system		
2		Time Domain Analysis of Continuous and Discrete Systems	1,2,3,4	6
	2.1	Properties of Linear Time Invariant (LTI) systems, Impulse and Step Response		



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	2.2	Use of Convolution Integral and Convolution Sum and Correlation for Analysis of LTI Systems		
	2.3	Properties of Convolution Integral/Sum		
3		Laplace Transform and Continuous time LTI systems	1,2,3,4	6
	3.1	Need of Laplace Transform, Concept of Region of Convergence, Properties of Laplace Transform, , unilateral Laplace Transform, inverse Laplace Transform.		
	3.2	Analysis of continuous time LTI systems using Laplace Transform: Causality and stability of systems in s -domain, Total response of a system.		
4		z-Transform and Discrete time LTI systems	1,2,3,4	6
	4.1	Need of z -Transform, z -Transform of finite and infinite duration sequences, Concept of Region of Convergence, z -Transform properties, Standard z -transform pairs, one sided z -Transform. Inverse z -Transform: Partial Fraction method only.		
	4.2	Analysis of discrete time LTI systems using z-Transform: Transfer Function, plotting Poles and Zeros of a transfer function , causality and stability of systems, Total response of a system		
5		Applications of Signals and System		4
	5.1	Electrical and Electronics Engineering Applications		
	5.2	Computer Science and IT Applications		
	5.3	Mechanical and Civil Engineering Applications		
	5.4	Robotics and IoT Applications		
Total				26

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Tarun Kumar Rawat, "Signals and Systems", Oxford University Press, 2016.
2. A. Nagoor Kani, "Signals and Systems", Tata McGraw-Hill Education, 2014.
3. Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice-Hall of India, Second Edition, 2002.
4. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: - **Blooms level**

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMCM2	Analog and Digital Communication	2	-	-	2	2	-	-	2
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
	Theory	20	30	20	50	100			

Pre-requisite Course Codes	PCC11EC03 (Digital Electronics), MDMXX1(Signals & systems), PCC12EC05 (Electronic Devices)	
Course Outcomes	CO1	Explain types and parameters of noise and the need for modulation.
	CO2	Analyze various amplitude and angle modulation techniques.
	CO3	Discuss the operation of radio receivers and demodulators.
	CO4	Generate and detect pulse modulation techniques.
	CO5	Derive performance parameters of Digital modulation methods
	CO6	Simulate/implement various analog and digital modulation techniques.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Communication	2,6	3
	1.1	Types of Noise, Signal-to-noise ratio, Noise factor, Noise Figure, Noise Temperature		
	1.2	Need for modulation		
2		Amplitude Modulation	1,2, 3,6	6
	2.1	Amplitude Modulation: Representation of AM wave (Mathematical & Graphical), Frequency spectrum of AM wave, AM Power Distribution, AM for a Complex Modulating Signal: modulation index, power distribution, and Current Distribution		
	2.2	Types of AM: Generation of DSB-SC using diode based balanced modulator, Generation of SSB using phase shift method		
3		Angle modulation	1,2, 3,6	6
	3.1	Theory of Frequency Modulation (FM) & Phase Modulation (PM) - Basic Concepts, Spectrum Analysis of FM Wave, Noise triangle, Pre-emphasis, De-emphasis, Comparison of AM, FM and PM		



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	3.2	Radio Receivers: Superheterodyne Receiver, Receiver <small>(Autonomous College affiliated to University of Mumbai)</small> Characteristics: Sensitivity, Selectivity, Fidelity and Image frequency rejection ratio, choice of Intermediate frequency, Diode detector for AM, Frequency discriminator and Phase discriminator methods for FM		
4		Pulse Modulation	1,2, 3,6	6
	4.1	Sampling theorem, aperture effect and aliasing		
	4.2	Generation and Detection of Pulse Amplitude Modulation (PAM)		
	4.3	Pulse Code Modulation (PCM), Delta Modulation (DM), Advanced Delta Modulation (ADM)		
	4.4	Multiplexing Techniques: Time Division Multiplexing (TDM): T1 carrier system, Frequency Division Multiplexing (FDM)		
5		Digital Modulation Techniques	1,3, 4,5, 6	5
	5.1	Generation, detection, signal space diagram, power spectral density and bandwidth of: Binary Phase Shift Keying (BPSK), Quaternary Phase Shift Keying (QPSK), M-ary PSK, Binary Amplitude Shift Keying (BASK), Quadrature Amplitude Modulation (QAM), Binary Frequency Shift Keying (BFSK), Minimum Shift Keying (MSK).		
Total				26

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Principles of Communication Systems, Taub Schilling & Saha, Tata Mc-Graw Hill, Third Ed
2. Electronics Communication System, George Kennedy, Bernard Davis and Prasanna, Tata McGraw Hill, 6th Ed, 2018
3. Analog and Digital Communication, T. L. Singal, Tata Mc-Graw Hill, New Delhi, First Edition, 2012.



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4. Digital Communication: Fundamentals and Applications, Sklar B. & Ray P. R., Pearson, Dorling Kindersley (India), 2nd edition, 2006
5. Digital communication, Simon Haykin, John Wiley and sons, 2010
6. Electronics Communication Systems, Wayne Tomasi, Pearson Education, Third Edition, 2001.

Online Resources:

1. <https://www.mathworks.com/help/comm/ug/analog-baseband-examples.html>
2. <https://www.mathworks.com/help/comm/ug/analog-passband-modulation-examples.html>
3. https://github.com/Nikeshbajaj/ASK_PSK_FSK

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMCM3	Microcontrollers and Applications	2	-	-	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes	Digital Electronics, C programming	
	At the End of the course students will be able to:	
Course Outcomes (CO)	CO1	Explain the fundamental concepts of microcontrollers
	CO2	Develop programming skills for microcontrollers using Embedded C concepts
	CO3	Program various on-chip components of microcontrollers
	CO4	Interface various devices to the 8051 microcontroller
	CO5	Evaluate various enhancements in modern microcontrollers based on the ARM CORTEX cores

Module No.	Unit No.	Topics	Ref.	Hrs.
1		8051 Microcontroller Architecture		6
	1.1	Introduction to the concepts of Microprocessors and Microcontrollers	1,2	
	1.2	Concept of Buses, Read/write operations, T state, Machine cycle and Instruction cycle	1,2	
	1.3	8051 Architecture	1,2	
	1.4	8051 Memory organization	1,2	
	1.4	RISC and CISC Concepts, Harvard and Von Neumann Architectures	1,2	
	1.5	Overview of various available Microcontrollers, Applications of Microcontrollers	1,2	
2		Programming the 8051		4
	2.1	Assembly language programming, Addressing modes	1,2	
	2.2	Embedded C programming concepts: Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routines.	1,2	
3		8051 Internal Hardware		6
	3.1	I/O port programming	1,2	
	3.2	Timers/Counters programming	1,2	
	3.3	Serial port programming	1,2	
	3.4	Interrupts programming	1,2	



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	3.5	Low power modes of the 8051	1,2	
4	8051 Interfacing			
	4.1	Display interfacing: LED, 16x2 generic alphanumeric LCD display.	1	6
	4.2	Analog devices interfacing: 8-bit ADC, 8-bit DAC, temperature sensor (LM35)	1	
	4.3	Motor interfacing: Relay, DC motor (speed control using PWM), Stepper motor and Servo motor.	1	
5	ARM Cortex microcontrollers			4
	5.1	Introduction to the ARM Cortex family	3	
	5.2	Salient features of ARM Cortex cores: RISC design, Operating modes and states, NVIC, Low power modes	3	
			Total	26

Course Assessment:

Theory:

ISE:

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MSE:

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ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books

- 1.M.A.Mazidi, J.C.Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, Second Edition, 2007.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, Third Edition, 2005.
3. Joseph Yiu, "The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.

Reference Books:

- 1.Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2009.
 2. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014.
 3. Ajay V Deshmukh, "Microcontroller Theory And Applications ", Tata Mcgraw Hill, 2017
- Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand✓	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM14	Communication and Computer Networks	2	--	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max	100	
					20	50			

Pre-requisite Course Codes	25MDM11,12,13	
After the successful completion students should be able to:		
Course Outcomes	CO1	Describe signal modulation and digital Data representation techniques.
	CO2	Interpret network architectures, protocol layers, and their services.
	CO3	Apply channel allocation, framing, error and flow control techniques.
	CO4	Describe the functions of Network Layer i.e. Logical addressing, subnetting & Routing Mechanism
	CO5	Describe Transport layer Services and flow control techniques.
	CO6	Explain the functions of Application layer and Protocols

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Communication	1,2,3	3
	1.1	Introduction to signal modulation and transmission, Bandwidth, Bit rate and baud rate.		
	1.2	Data representation in binary format ,Line coding techniques.		
2		Introduction to Computer Networks	1,3,4	4
	2.1	Introduction to computer network, Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services.		
	2.2	Reference models: Layer details of OSI, TCP/IP models. Communication between layers.		
3		Physical Layer & Data Link Layer	1,4,5	5
	3.1	Introduction to physical-layer services and systems: Introduction to physical media – Twisted pair Coaxial cable, fiber optics, , DSL, HFLC.		
	3.2	Introduction To Data Link Layer, Error Detection and Correction (Hamming Code, CRC, Checksum).		
	3.3	Elementary Data Link Protocol, Sliding Window Protocol, MAC & LLC Sublayers. Local area networks and IEEE 802.11 wireless LANs		
	3.4	Elementary Data Link Protocol, Sliding Window Protocol, MAC & LLC Sublayers. Local area networks and IEEE 802.11 wireless LANs		
4		Network Layer	1,4,5	6
	4.1	Introduction to Network Layer, Virtual Circuit, Datagram		



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		Subnets, Routing, Routing Algorithm: Shortest Path Routing, Dijkstra Algorithm, Flooding, Link State Routing, Count to Infinity problem		
	4.2	Addressing: Physical Address, Logical Address IPV4 Address: Classful Address, Classless Addressing, Subnetting, CIDR & NAT. IPV6		
	4.3	Congestion Control Algorithm, Quality of Services: Leaky Bucket Algorithm, Token Bucket Algorithm.		
5		Transport Layer	4,5,9	4
	5.1	Introduction of Transport layer Services: Berkeley Sockets, Multiplexing & Demultiplexing, Flow control and congestion control. TCP and UDP. Port numbers.		
6		Application Layer	4,5,9	4
	6.1	Application layer protocols such as HTTP, FTP, and SMTP. Peer-to-Peer File Sharing Protocols and Architectures. ISPs and Domain name systems.		
Total			26	

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

SUGGESTED CO - PO articulation Matrix

Course Outcome s	Program Outcomes (POs)											(PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	2						2	1	1	3
CO2	3	3	1	2	2						2	1	1	3
CO3	3	3	2	2	2						2	1	2	3
CO4	3	3	3	2	3						2	1	3	3
CO5	3	2	1	1	1						2	1	2	3
CO6	3	2	1	1	1						2	1	2	3

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level



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Remember✓	Understand✓	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM15	Mobile Communication and Computing	2	--	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory	20	30	20i	30	100		

Pre-requisite Course Codes	25MDM12,13,14	
After the successful completion students should be able to:		
Course Outcomes	CO1	Identify the fundamental concepts and principles of computing and cellular network architecture.
	CO2	Describe the key components and operational mechanisms of mobile networking systems.
	CO3	Classify various security techniques used in mobile and wireless networks.
	CO4	Apply WLAN concepts for both local and remote networking applications.
	CO5	Describe the architecture, functional elements, and interfaces of Long Term Evolution (LTE) networks.

Module No.	Unit No.	Topics	Re f.	Hrs.
1	1.1	Introduction to Mobile Communication: Overview of mobile computing concepts, applications, advantages, and challenges. Evolution of wireless communication systems from 1G to present generations; comparison of features, services, and technologies.	1,2	2
	1.2	Electromagnetic spectrum allocation for wireless communication; Principles of multiplexing techniques and spread spectrum methods, including Direct Sequence Spread Spectrum (DSSS) and Frequency Hopping Spread Spectrum (FHSS).	1,2	3
2	2.1	GSM Mobile Services: Overview of GSM services, including voice, data, and supplementary services. Functional entities of GSM architecture and their roles within the network. GSM radio interface characteristics and protocol stack across different layers.	1,4	3
	2.2	Security architecture of GSM, including authentication and encryption algorithms A3, A5, and A8. Architecture of General Packet Radio Service (GPRS). Universal Mobile Telecommunications System (UMTS) architecture, including UTRAN and core network components.	1,4	2
3	3.1	Mobile Networking: Medium Access Protocol, Internet Protocol and Transport layer. IP Mobility, optimization, IPv6. Mobile IP: IP Packet	1,2	3



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		Delivery, Agent Advertisement and Discovery, Registration, Tunnelling and Encapsulation, Reverse Tunnelling.		
	3.2	Mobile TCP: Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Fast Retransmit/ Fast Recovery, Transmission/Timeout Freezing, Selective Retransmission.	1,2	3
4	4.1	Wireless Local Area Networks: IEEE 802.11: System architecture, Protocol architecture, Physical layer, Medium Access Control layer, MAC management, 802.11a, 802.11b standard	1.2	3
	4.2	Wi-Fi security: WEP, WPA, Wireless LAN Threats, Securing Wireless Networks. Bluetooth: Introduction, User Scenario, Architecture, protocol stack.	1,2	2
5	5.1	Long-Term Evolution (LTE) of 3GPP: LTE System Overview, Evolution from UMTS to LTE, LTE/SAE Requirements, SAE Architecture. EPS: Evolved Packet System, E-UTRAN, Voice over LTE (VoLTE).	3	3
	5.2	Self Organizing Network (SON-LTE), SON for Heterogeneous Networks (HetNet), Comparison between Different Generations (2G, 3G, 4G and 5G), Introduction to 5G	3	2
Total				26

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

- [1] Jochen Schilller, Mobile Communication —, Addison wisely, Pearson Education
- [2] William Stallings “Wireless Communications & Networks”, Second Edition, Pearson Education
- [3] Christopher Cox, “An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications”, Wiley publications



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[4] Raj Kamal, “Mobile Computing”, 2/e, Oxford University Press-New

Suggested CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-			-							1	1
CO2	3	3	3							2		1	1
CO3	3	3	3							2		1	1
CO4	3	3	3							2		1	1
CO5	3	3	3							2		1	1
CO6	3	3	3							2		1	1

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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MULTIDISCIPLINARY MINOR (EMBEDDED WITH BASIC DEGREE)

Minor in Mechanical Engineering: (Offered to CE, CSE and ECS)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMME1	Elements of Mechanical Engineering	2	-	-	2	2	-	-	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Understand the basic concepts of force systems, resultant force, and equilibrium.
	CO2	Identify different types of engineering materials and their mechanical properties.
	CO3	Explain the fundamentals of thermodynamics and the first and second laws.
	CO4	Understand the modes of heat transfer and explain the working of boilers, their types, mountings, and accessories.
	CO5	Explain fluid properties and their significance in fluid mechanics.
	CO6	Explain the layout and working of thermal and hydel power plants, and the significance of renewable energy sources.

Module No.	Unit No.	Topics	Ref	Hrs.
1	1.1	Fundamentals of Engineering Mechanics, Force Systems, Resultant Force, Coplanar Concurrent Force System, Numerical on Concurrent Force System Only. Non-Concurrent Coplanar Force System: Moment of Force, Varignon's Theorem (Theory Only)	1	4
	1.2	Concept of Equilibrium, Free Body Diagram, Numerical on lamis theorem	1	2
2	2.1	Engineering Materials: Scope and Importance, Materials Overview, Mechanical Properties, Stress-Strain Diagram	2	4
3	3.1	Basics of Thermodynamics, Zeroth Law, First Laws: (No numerical)	3	2
	3.2	Second Law of Thermodynamics: Comparison of Carnot Cycle and Rankine Cycle	3	2
4	4.1	Introduction to Heat Transfer, Conduction, Convection, Radiation (Theory Only)	4	2
	4.2	Boilers: Types, Boiler Mountings and accessories	4	2



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5	5.1	Fundamentals of Fluid Mechanics, Properties of Fluids, Bernoulli's Equation (Only Theory)	5	2
	5.2	Aerofoil theory	5	2
6	6.1	Introduction to Power Plant Engineering: Layouts of Thermal power plant, Hydel Plant and Gas Turbine Power Plant, Comparative Study	6	2
	6.2	Renewable Energy Sources: Solar, Wind, and Hydropower. Biomass & Geothermal: Energy from organic waste and Earth's heat	6	2
		Total		26

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Textbooks:

1. *Engineering Mechanics – S. S. Bhavikatti, New Age International Publishers (For Module 1: Fundamentals of Engineering Mechanics)*
2. *Strength of Materials – R. K. Bansal, Laxmi Publications (For Module 2: Engineering Materials, Stress-Strain)*
3. *Fundamentals of Thermodynamics – Sonntag, Borgnakke, Van Wylen, Wiley India (For Module 3: Basics of Thermodynamics)*
4. *Heat and Mass Transfer – J.P. Holman, McGraw Hill (For Module 4: Heat Transfer & Boilers)*
5. *Fluid Mechanics and Hydraulic Machines – R. K. Bansal, Laxmi Publications (For Module 5: Fluid Mechanics & Aerofoil Theory)*
6. *Power Plant Engineering – P.K. Nag, McGraw Hill (For Module 6: Power Plant Engineering & Renewable Energy)*

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMME2	Manufacturing Engineering	2	-	-	2	2	-	-	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes	None	
Course Outcomes	CO1	Identify and differentiate between various manufacturing processes.
	CO2	Explain different types of cutting off machines and their applications.
	CO3	Understand the different parts of lathe machine and lathe machine operations.
	CO4	Have knowledge of different types of drilling machines and operations.
	CO5	Describe types of milling operations and their differences.
	CO6	Explain the principles of grinding operations.

Module No.	Topics	Ref	Hrs.
1	Definition and need of various manufacturing processes. Classification of various manufacturing processes based on chip-less and chip-removal processes.	1, 2	04
2	Types of circular saws, Band saw, Power hacksaw, Friction saw, Abrasive cutting off machines. Advantages, Limitations, and Applications of different types of cutting off machines.	1, 2	04
3	Descriptions and functions of lathe parts. Lathe specifications, Lathe operations, and Taper turning. Single point cutting tool nomenclature. Work and tool holding devices & accessories.	1, 2	06
4	Drilling operations. Types of Drilling machines. Drill nomenclature. Work and tool holding devices. Deep hole drilling and Boring machines.	1, 2	04
5	Types of milling operations and their difference. Milling parameters. Types of milling machines. Types of Milling cutters.	1, 2	04
6	Principle of grinding. Types of grinding machines and operations. Grit, grade, and structure of grinding wheels. Balancing of grinding wheels. Truing, dressing, and shaping of grinding wheels.	1, 2	04
	Total		26



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Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE: The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Textbooks:

1. *Elements of Workshop Technology: Machine Tools (Volume – 2)* by S. K. Hajra Choudhary, A. K. Hajra Choudhary, Nirjhar Roy, Media promoters 15th Edition (2023).
2. *A Course in Workshop Technology Vol. II (Machine Tools)* by B. S. Raghuwanshi, Dhanpat Rai & Co. (2015).

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMME3	Product Design and Development	2	-	-	2	2	-	-	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	

Pre-requisite Course Codes	Machine Design	
Course Outcomes	CO1	Describe the process of product design & development.
	CO2	Employ engineering, scientific, and mathematical principles to develop and execute a design project from a concept to a finished product.
	CO3	Apply the principles of DFMA and other DFX principles in product design.
	CO4	Analyze products based on ergonomics and aesthetic aspects.
	CO5	Apply value engineering and software solutions in product design.
	CO6	Illustrate various modern approaches like concurrent engineering, product life cycle management, robust design, rapid prototyping / rapid tooling.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction: Definition of product design, Various phases in product development and Design, The Design Process, Considerations in product design	1-3	2
	1.2	Planning for products: Establishing markets - market segments - relevance of market research.	1-3	1
2	2.1	Identifying customer needs: Voice of Customer (VoC), Customer populations, Hierarchy of human needs, Need gathering methods, Establishing engineering characteristics, Competitive benchmarking, Quality Function Deployment (QFD), House of Quality (HoQ), Product design specification, Development of product design with specifications using QFD, Relevant case studies.	1-3	3
3	3.1	The design processes: Descriptive and prescriptive design models, Concept development & evaluation, Pugh's total design activity model	1-3	3



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		Conceptual Design: Market research, Generation, Selection and Embodiment of concept, Product Architecture, Customer centric product designing		
	3.2	Creativity: Role of creativity in problem solving, Vertical and lateral thinking, Brain storming, Synectics, Group working dynamics, Adaptation to changing scenarios in economics, social, cultural and technological fronts, Anticipation of new needs and aspirations.		1
4	4.1	Product Ergonomics: Anthropometry, Environmental conditions, thermal, noise, vibration, displays, illusions, Psycho and psychological aspects in design, Man-machine information exchange.	1-3	2
	4.2	Product Aesthetics: Visual awareness, Form elements in context of product design, Concepts of size, shape and texture, Introduction to colour and colour as an element in design, Colour classifications and dimensions of colour, Colour combinations and colour dynamics, Interaction / communication of colours, Psychological aspects of colours, generation of products forms with analogies from nature	1-3	1
	4.3	Product Graphics: Graphics composition and layout, Use of grids in graphics composition, Study of product graphics and textures. Industrial Design aspects applied in electromechanical design and user interface design.	1-3	2
5	5.1	Design for Manufacturing and Assembly: Guidelines and Methodology, DFA Index, Analysis of assembly requirements, Standardization, Ease of Assembly and disassembly, Modular concepts Concept of Lean Manufacturing and Six Sigma	1-3	2
	5.4	Other DFX Principles: Designs for Maintainability, Safety, Reliability, Sustainable Design	1-3	1
6	6.1	Value Engineering: Product value and its importance, Value analysis job plan, Steps to problem solving and value analysis, Value analysis tests, Value Engineering idea generation check list, Material and process selection in value engineering, Cost reduction, case studies and exercises.	1-3	1
	6.2	Software Solutions: Use of Computers for drafting, modeling, assembly, detailing, CAM interfacing, Rapid tooling/rapid prototyping.	1-3	3
	6.3	Modern Applications: Concurrent Engineering, Robust Design, Additive Manufacturing/Rapid Prototyping, Product Life Cycle Management techniques and application areas.	1-3	4
Total				26



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Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE: The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes

Recommended Books:

Text Books:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development,” 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.
2. Kevin Otto, Kristin Wood, “Product Design,” Indian Reprint 2004, Pearson Education, ISBN 9788177588217.
3. Product Design and Manufacturing - R.C. Gupta, A.K. Chitale PHI, 2011

Reference Books:

1. Clive L.Dym, Patrick Little, “Engineering Design: A Project-based Introduction,” 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7.
2. George E. Dieter, Linda C.Schmidt, “Engineering Design,” 4th Edition, McGraw-Hill International Edition, 2009, ISBN 978-007-127189-9.
3. Yousef Haik, T. M. M. Shahin, “Engineering Design Process,” 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.

Links for online NPTEL/SWAYAM courses:

1. Product Design and Manufacturing by Prof. J. Ramkumar, Prof. Amandeep Singh | IIT Kanpur https://onlinecourses.nptel.ac.in/noc21_me66/preview
2. Product Design and Development by Prof. Inderdeep Singh, IIT Roorkee https://onlinecourses.nptel.ac.in/noc21_me83/preview

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM24	Industrial Engineering	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE	MSE	ESE		Total		
		Theory	20	30	Min	Max	20	50	100

Pre-requisite Course Codes	25MDM23	
Course Outcomes	CO1	Learner will be able to understand evolution and revolution of Industry and basic productivity tools.
	CO2	Learner will be able to understand importance of Human factors and design consideration of Machine elements as interface.
	CO3	Learner will be able to understand and analyse method and time for productivity.
	CO4	Learner will be able to understand the importance and effect of Layout.
	CO5	Learner will be able to understand the importance of value creation and waste elimination in any product or process.

Module No.	Unit No.	Topics	Ref	Hrs.
1		Topics: Introduction to Industrial Engineering		
	1.1	Evolution of Industrial engineering; Industrial revolution	6	3
		Topics: Productivity philosophy & tools:		
	1.2	Productivity & Improvement tools: 5s, Poka- Yoke, Kaizen, Kanban etc.	2	4
2		Topics: Human Factor in Design	3	
	2.1	Human as a system, multi human machine dynamics		2
	2.2	Locating controls and displays, health and safety of employees.		2
3		Topics: Work Study	3	
	3.1	Method study, motion and time study,		3
	3.2	Rating factor, performance factor, allowances and standard data		3
4		Layout:	1	
	4.1	Significance of layout, Types of Layout,		3
	4.2	Factors influencing layout choices.	3	1
5		Value Engineering:		
	5.1	Distinction between value engineering & value analysis.	7	2
	5.2	Function analysis system techniques- FAST diagram (example)		3
Total				26



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Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Suggested CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes* (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand✓	Apply	Analyze	Evaluate	Create
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Recommended Books:

1. Facilities Planning 4th Edition by James A. Tompkins, John Wiley and Sons Inc.
2. Toyota Production System: An Integrated Approach to Just-In-Time, by Yasuhiro Monden ,CRC PRESS
3. Work Study Motion & Time Study by O. P. Khanna, Dhanpat Rai Publications (P) Ltd, ISBN: 9788189928414
4. Operations Management for Competitive Advantage by Richard B. Chase, MGH
5. Lean Thinking: Banish Waste and Create Wealth in Your Corporation, by James P. Womack, Free Press
6. Industry 5.0 The Future of the Industrial Economy by Uthayan Elangovan, CRC Press
7. Techniques of Value Analysis and Engineering by Lawrence D. Miles, McGraw-Hill



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM25	Supply Chain Management	2	--		2	2	--	-	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		
				20	50	100			

Pre-requisite Course Codes	25MDM24,25	
Course Outcomes	CO1	Demonstrate today's business environment and importance of Logistics and Supply Chain Management.
	CO2	Identify the drivers of supply chain performance and uncertainty in supply chain management.
	CO3	Understand the techniques of inventory management and rank the items using inventory management technique
	CO4	Understand strategies and techniques to minimize overall logistics cost
	CO5	Understand the role of digitization in supply chain management leading to sustainability
	CO6	Understand various supply chain sustainable and productivity terminology

Module No.	Topics	Ref	Hrs.
1	Objectives of a Supply Chain Management, Stages of Supply chain, Value Chain Process, Cycle view of Supply Chain Process, Push Pull in SC, Decision Phases in SC, logistics & SCM	1	04
2	Supply Chain Drivers /decisions and obstacles, Supply chain strategies & strategic fit.	2	04
3	Definition of Inventory, Inventory types, EOQ Model and Buffer Stock, Replenishment systems (Q and P system), Inventory Control- ABC Analysis, Numerical problems on ABC analysis, VED Analysis,	1,2	04
4	Bullwhip effect and measures, Balance delay, SCOR Model, Factors influencing distribution network design, Design options for distribution network	3,4	05
5	IT Framework and sustainable Supply Chain management, Transport Management System (TMS), Warehouse Management System (WMS). ERP (SAP) and integration of technology.	2,3	05
6	Value Stream Mapping (VSM), Order fill rate, Product fill rate, Order visibility, Lead time, Takt time, Logistics Vs Reverse Logistics, Third Party – Fourth Party Logistics and integration, Green SC	3	04
Total			26



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Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE: The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Reference Books:

1. Sunil Chopra, P. Meindl, “Supply Chain Management”, 6th Edition 2016, Pearson Education Asia.
2. D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, and Ravi Shankar, “Designing and Managing the Supply Chain concepts, Strategies and Case studies”, 3rd Edition, Tata McGraw Hill, New Delhi, 2008
3. Rahul V Altekar, “Supply Chain Management: Concepts and cases”, Edition 2009, PHI, ISBN: 9788120328594. Quality Control, 3rd edition, D. H. Besterfield, Pearson Education (2012).
4. R.P. Mohanty, S.G. Deshmukh, “Essentials of Supply Chain management”, 1st Edition 2004, Jaico Publishing House.

Suggested CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes* (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand✓	Apply	Analyze	Evaluate	Create
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MULTIDISCIPLINARY MINOR (EMBEDDED WITH BASIC DEGREE)

Minor in Computer Engineering: (Offered to ME)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMCE1	Data Structures and Algorithms	2	-	-	2	2	--	-	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		10

Pre-requisite Course Codes	ESC11EC03	
Course Outcomes	CO1	Explain the fundamental concepts of data structures, algorithm properties and complexity.
	CO2	Implement various operations of linear data structures.
	CO3	Implement various operations of non-linear data structures.
	CO4	Implement sorting algorithms and drive its complexity.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to Data structure and Algorithms Complexity Introduction to Data Structures, Concept of ADT, Types of Data Structures: Linear and Nonlinear Definition of an Algorithm, Properties of a Good Algorithm, Asymptotic Notations & Complexity Classes, Recursive algorithms	1,2,4	2
2	2.1	Stack and Queue: Stack: Introduction, Stack as ADT, Operations, Implementation using array, Applications of stack.	1,2,3	3
	2.2	Queue: Introduction, Queue as ADT, Operations, Implementation using array, Circular queue, Applications of queue	1,2,3	2
3	3.1	Linked List: Linked list as an ADT, Singly Linked List, Operation on Singly linked list, Applications of Linked List:	1,2,3	2
4	4.1	Tree: Basic Terminology, Linked Representation of Binary Tree ADT, Traversal of Binary Tree, Binary Search Tree and operations on it. Applications of these binary trees.	1,2,3	3
5	5.1	Graphs: Basics Terminology, Adjacency List and Adjacency Matrix Representation, Graph traversals BFS and DFS. Applications of Graph	1,2,3	2
6	6.1	Sorting Techniques: Insertion Sort, Selection sort, Quick sort, Merge sort, derivation of complexity of sorting algorithms	1,2,4	3
Total				17



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Module No.		Name of the experiment
1	1 2	Stack ADT a. Implement Stack ADT using array b. Convert Infix to Postfix and evaluate the postfix using Stack ADT..
2	3 4	Queue ADT a. Implement Linear Queue ADT using an array. b. Implement Circular Queue ADT using an array.
3	5 6	Linked List ADT a. Implement Singly Linked List ADT. b. Implement stack and queue using linked list.
4	7	Binary Search Tree a. Implement Binary Search Tree ADT using Linked List
5	8	Graph: Implement a program to represent a graph using an adjacency list or adjacency matrix data structure. And perform breadth-first search (BFS) or depth-first search (DFS) traversal algorithms.
6	9	Sorting Algorithm and its complexity Implement Bubble, Selection, Insertion, Merge and Quick sort
	10	Mini Project: (Suggested list of Mini Project Topics) (Any One) a. Text Edition Application: Implement a text editor with an undo feature. Every time a change is made to the text, save the previous state. When the user performs an undo operation, last state should be reverted. b. Develop a print job scheduler. Users submit print jobs to the printer, and they are processed in the order they were received. c. Design and implement a music application to manage and organize playlists efficiently. The application should allow users to perform the following operations: Add, Edit, delete and play song, d. Develop a browser history manager using a doubly linked list to efficiently track and navigate through the user's browsing history. The application should facilitate the following functionalities: Navigation forward and backward, Add page, remove page, search page, display history etc. e. Develop a word dictionary application to efficiently store and retrieve words and their definitions. The application should provide the following functionalities: Insertion, deletion, search, update etc. f. Given a network of cities connected by roads with different weights representing distances. Visit each city exactly once and print the sequence of all the cities visited.



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Self-learning:

3. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
4. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Laboratory Learning :

ISE: Laboratory ISE is divided into two components: 25 marks for performance and submission of experiments and 25 marks for oral/practical evaluation.

Reference Books:

1. Data Structures using C and C++ by Yedidyah Langsam, Moshe J. Augenstein, Aaron M.Tenenbaum, Second Edition.
2. Data Structures using C, Reema Thareja, Third Edition.
3. Data Structures and Program Design in C++, Robert L. Kruse, Alexander J. Ryba Prentice- Hall India.
4. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, The MIT Press, 4th Edition, 2022.

Further Reading:

1. Data Structures and Algorithm in Java, Goodrich and Tamassia, John Wiley and Sons, Sixth Edition 2014.
2. Data Structures and Pseudocode approach with C, 2nd Edition by Richard F. Gilberg & Behrouz A. Forouzan

Online Resources:

1. <https://nptel.ac.in/courses/106/102/106102064/>
2. <https://www.coursera.org/specializations/data-structures-algorithms>
3. <https://visualgo.net>
4. www.leetcode.com
5. www.hackerrank.com
6. <https://www.youtube.com/playlist?list=PLDV1Zeh2NRsB6SWUrDFW2RmDotAfPbeHu>
Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMCE2	Database Management Systems	2	-	-	2		--	-	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		
				20	50	100			

Pre-requisite Course Codes		
Course Outcomes	CO1	Explain the basic concepts and the applications of database management systems.
	CO2	Design ER/EER diagrams for real-world scenario.
	CO3	Convert ER/EER diagram to relational model and write relational algebra queries.
	CO4	Formulate SQL queries to retrieve, manipulate, and analyze data stored in a relational database.
	CO5	Apply the concept of normalization to relational database to improve the database design.
	CO6	Describe the concepts of transaction and concurrency control.

Module	Unit No.	Topics	Ref.	Hrs.
1		Module 1: Introduction To Database Systems	1,2,6	2
	1.1	Characteristics of Database systems		
	1.2	File System Vs. Database systems		
	1.3	Three Schema Architecture and Data Independence		
	1.4	DBMS Architecture, Applications of DBMS		
2		Module 2: Conceptual Data Modelling using Entity Relation Diagram	1,2,6	2
	2.1	The Entity-Relationship (ER) Model: Entity types, Types of Attributes, Types of Keys		
	2.2	Relationships: Types of Relationships (Unary, Binary, Ternary, N-ary), Constraints on Relationship (Cardinality and Participation)		
	2.3	Extended ER Diagram: Generalization, Specialization, and Aggregation.		
3		Module 3: Relational Model and Relational Algebra	1,2,6	2
	3.1	Introduction to Relational Model: Relational Schema and Concepts of keys.		
	3.2	Mapping the ER and EER Model to the Relational Model		
	3.3	Relational Algebra: Operators and Relational Algebra Queries		
		Module 4: Structured Query Language	1,2	3



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4	4.1	DDL commands: CREATE, ALTER, DROP, TRUNCATE (Auto: CREATE, ALTER, DROP, TRUNCATE of Mumbai) Integrity constraints: Key constraints, Domain constraints, Referential integrity constraints, and Check constraints		
	4.2	DML Commands: Insert, Update, Delete, WHERE clause, OrderBy clause.		
	4.3	Aggregate Functions, GroupBy – Having clause		
	4.4	SQL Joins, Set operations, Nested queries		
5		Normalization	1,2,	2
	5.1	Pitfalls in Relational Database designs, Concept of Normalization, Function Dependencies.	4,6	
	5.2	1NF, 2NF, 3NF, BCNF		
6		Transaction and Concurrency Control	1,2	2
	6.1	Introduction to Transaction, Transaction States, ACID properties, Serial and Concurrent Schedules, Serializability: Conflict and View serializability. Transaction Control Commands (TCL)		
	6.2	Introduction to Concurrency Control: Lock-based protocols, Timestamp-based protocols.		
Total			13	

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: - Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Korth, Silberchatz, Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 5th Edition, Pearson education.
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH.
4. G. K. Gupta, Database Management Systems, McGraw Hill., 2012.
5. [SQL Tutorial \(w3schools.com\)](http://www.w3schools.com)
6. Course: Database Management System By Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay IIT Kharagpur
7. https://onlinecourses.nptel.ac.in/noc22_cs91/preview

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Blooms level Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMCE3	Microcontrollers and Applications	2	--	-	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes	Digital Electronics, C programming	
	At the End of the course students will be able to:	
Course Outcomes (CO)	CO1	Explain the fundamental concepts of microcontrollers
	CO2	Develop programming skills for microcontrollers using Embedded C concepts
	CO3	Program various on-chip components of microcontrollers
	CO4	Interface various devices to the 8051 microcontroller
	CO5	Evaluate various enhancements in modern microcontrollers based on the ARM CORTEX cores

Module No.	Unit No.	Topics	Ref.	Hrs.
1		8051 Microcontroller Architecture		6
	1.1	Introduction to the concepts of Microprocessors and Microcontrollers	1,2	
	1.2	Concept of Buses, Read/write operations, T state, Machine cycle and Instruction cycle	1,2	
	1.3	8051 Architecture	1,2	
	1.4	8051 Memory organization	1,2	
	1.4	RISC and CISC Concepts, Harvard and Von Neumann Architectures	1,2	
	1.5	Overview of various available Microcontrollers, Applications of Microcontrollers	1,2	
2		Programming the 8051		4
	2.1	Assembly language programming, Addressing modes	1,2	
	2.2	Embedded C programming concepts: Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routines.	1,2	
3		8051 Internal Hardware		6
	3.1	I/O port programming	1,2	
	3.2	Timers/Counters programming	1,2	
	3.3	Serial port programming	1,2	
	3.4	Interrupts programming	1,2	



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	3.5	Low power modes of the 8051	1,2	
4	8051 Interfacing			
	4.1	Display interfacing: LED, 16x2 generic alphanumeric LCD display.	1	6
	4.2	Analog devices interfacing: 8-bit ADC, 8-bit DAC, temperature sensor (LM35)	1	
	4.3	Motor interfacing: Relay, DC motor (speed control using PWM), Stepper motor and Servo motor.	1	
5	ARM Cortex microcontrollers			4
	5.1	Introduction to the ARM Cortex family	3	
	5.2	Salient features of ARM Cortex cores: RISC design, Operating modes and states, NVIC, Low power modes	3	
			Total	26

Self-learning:

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Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books

- 1.M.A.Mazidi, J.C.Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, Second Edition, 2007.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, Third Edition, 2005.
3. Joseph Yiu, "The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.

Reference Books:

- 1.Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2009.
 2. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014.
 3. Ajay V Deshmukh, "Microcontroller Theory And Applications ", Tata Mcgraw Hill, 2017
- Legends :- High: 03, Medium: 02, Low: 01, No Mapping: - **Blooms level**

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM34	AI and Applications	2	--	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes	25MDM34
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After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the basic concepts and scope of AI in engineering applications.
	CO2	Interpret data for suitability in AI-based systems.
	CO3	Apply appropriate machine learning concepts to given engineering problem.
	CO4	Analyze the role of AI in manufacturing and industrial automation systems.
	CO5	Explain computer vision concepts for intelligent inspection and automation applications.
	CO6	Evaluate AI applications and case studies for sustainable engineering solutions.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Artificial Intelligence		5
	1.1	Overview of Artificial Intelligence Definition and evolution of AI, Narrow AI vs General AI, Role of AI in modern engineering systems	1	1
	1.2	AI, Machine Learning and Deep Learning Relationship between AI, ML and Deep Learning, Rule-based systems vs. learning-based systems	1	1
	1.3	Data-Driven vs Physical-Based Models Traditional analytical and numerical models, limitations of physics-based approaches, Motivation for data-driven modeling	1	1
	1.4	AI Problem-Solving Pipeline Problem formulation, Data collection and preparation, Model training, validation and deployment	1	1
	1.5	Ethics, Safety, and Trustworthy AI Reliability and robustness of AI systems, Bias, transparency, and explainability, Safety considerations in engineering AI	2	1
2		Data and Intelligence in Engineering Systems		5
	2.1	Types of Data in Engineering Systems	3,4	1



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		Sensor data, experimental data and operational data; Structured vs. Unstructured data; Static vs. Dynamic data		
	2.2	Data Acquisition in Mechanical Systems Sensors used in mechanical engineering; Data logging and sampling concepts; Noise and uncertainty in measurements	3,4	1
	2.3	Data Preprocessing Concepts Data cleaning and normalization; Handling missing and noisy data; Feature representation	3,4	1
	2.4	Time-Series Data in Mechanical Systems Characteristics of time-series data; Trends, patterns and anomalies; Examples of vibration and thermal data as time-series data	3,4	1
	2.5	Importance of Data Quality Impact of poor data on AI models; Overfitting and underfitting; Best practices for reliable datasets	3,4	1
3		Machine Learning Concepts for Industrial Systems		6
	3.1	Learning Paradigms Supervised learning; Unsupervised learning; Semi-supervised and reinforcement learning	5	1
	3.2	Regression Models Linear and Polynomial regression; Use cases in performance prediction; Error estimation and interpretation	5	1
	3.3	Classification Models Binary and multi-class classification; Fault diagnosis and condition classification; Confusion matrix and accuracy	5	2
	3.4	Clustering Purpose of clustering; Grouping operating conditions; Application in system behavior analysis	5	1
	3.5	Model Evaluation and Validation Training, testing and validation sets; Performance metrics: RMSE, accuracy, precision; Generalization of models	5	1
4		AI in Manufacturing and Industrial Automation		5
	4.1	AI and Industry 4.0 Evolution of manufacturing systems; Smart factories and cyber-physical systems; Role of AI in automation	6	1
	4.2	Smart Manufacturing Systems AI-enabled process monitoring; Adaptive and self-optimizing systems; Integration with IoT	6	1
	4.3	Predictive Maintenance Concept of condition-based maintenance; Failure prediction and remaining useful life; Benefits over preventive maintenance	6	1
	4.4	AI-Based Quality Control Inspection and defect detection; Process Parameter optimization; Reduction of scrap and rework	6	1
	4.5	Digital Twins Concept and components of digital twins; Applications in manufacturing and maintenance; Industrial case examples	6	1
5		Computer Vision and Intelligent Industrial Systems		5



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	5.1	Fundamentals of Computer Vision Human vision vs. machine vision; Image representation and pixels; Color spaces and resolution	7	1
	5.2	Image Acquisition and Processing Cameras and imaging systems; Image enhancement and filtering; Noise reduction	7	1
	5.3	Feature Extraction and Object Recognition Edges, shapes, and textures; Object detection concepts; Defect recognition	7	1
	5.4	Vision-Based Inspection Systems Automated visual inspection; Applications in manufacturing lines; Advantages and limitations	7	1
	5.5	Deep Learning for Vision: An Overview Convolutional Neural Networks (CNNs); Why deep learning works well for images; Industrial vision usecases	7	1
6		AI case studies, sustainability and Future Trends		4
	6.1	AI in Robotics and Autonomous Systems Intelligent robots and automation; Perception, planning and control; Collaborative robots (cobots)	8	1
	6.2	AI in Automotive, Aerospace, and Energy Systems AI for autonomous vehicles; AI in aerospace design and maintenance; Energy system optimization	8	1
	6.3	AI for Sustainability and Green Manufacturing Energy-efficient systems; Waste reduction and resource optimization; AI for sustainable engineering	8	1
	6.4	Future Directions Current challenges and limitations; Future scope of AI in industrial applications	8	1
			Total	30

Self-Learning:

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2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

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Recommended Books:



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- [1] Tom Taulli, "Artificial Intelligence Basics- A Non-Technical Introduction", Apress, 1st edition
- [2] Mark Coeckelbergh, "AI Ethics", MIT Press, 1st edition
- [3] Steven L. Brunton and J. Nathan Kutz, "Data-Driven Science and Engineering", Cambridge University Press, 1st edition
- [4] J.P. Holman, "Experimental Methods for Engineers", McGrawHill Publication, 7th edition
- [5] M Gopal, "Applied Machine Learning", McGraw Hill, 2nd edition
- [6] Robert Thornfield-Wells, "AI in Manufacturing", PublishDrive, 1st edition
- [7] Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Nature, 2nd edition
- [8] Henrik Skaug Sætra, "AI for the Sustainable Development Goals", CRC Press, 1st edition

Online Resources:

- [1] https://ocw.mit.edu/courses/6-034-artificial-intelligence-fall-2010/video_galleries/lecture_videos/
- [2] <https://www.kaggle.com/learn/data-cleaning>
- [3] Artificial intelligence-based design of assemblies in the FreeCAD software - <https://doi.org/10.7862/tiam.2025.1.6>
- [4] https://www.researchgate.net/publication/394318711_Data-Driven_Mechanical_System_Design_Using_Systems_Engineering_and_Big_Data_Principles
- [5] <https://publikationen.bibliothek.kit.edu/1000190670>
- [6] <https://www.sciencedirect.com/science/article/pii/S000785062400115X>
- [7] <https://www.sciencedirect.com/science/article/pii/S266635112100053X>

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	2	1	2	-	1	-	2
CO2	2	2	-	1	2	1	-	-	-	-	2
CO3	2	3	1	1	3	-	-	-	-	-	2
CO4	2	3	2	1	2	2	-	-	-	-	2
CO5	2	2	1	-	3	-	-	-	-	-	2
CO6	1	2	-	-	2	3	2	-	2	-	3

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate ✓	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM35	Human Machine Interaction	2	--		2	2	--	--	2
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
		Theory	20	30	20	50	100		

Pre-requisite Course Codes	25MDM34 ,35	
Course Outcomes	CO1	Identify User Interface (UI) design principles.
	CO2	Analysis of effective user friendly interfaces.
	CO3	Apply Interactive Design process in real world applications.
	CO4	Evaluate UI design and justify.
	CO5	Create applications for social and technical tasks.

Module No.	Unit No.	Topics	Ref	Hrs
1		FOUNDATIONS OF HMI:	1-8	4
	1.1	The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving.		
	1.2	The computer: Devices, Memory, processing and networks.		
	1.3	Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms.		
2		DESIGN & SOFTWARE PROCESS:	1-8	4
	2.1	Mistakes performed while designing a computer system, Human interaction with computers, importance of human characteristics human consideration, Human interaction speeds. Interactive Design		



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		basics, process, scenarios, navigation, Iteration and prototyping.		
	2.2	HMI in software process: software life cycle, usability engineering, Prototyping in practice, design rationale. Design rules: principles, standards, guidelines, rules. Recognize the goals, Goal directed design process.		
	2.3	Evaluation Techniques: Universal Design.		
3		GRAPHICAL USER INTERFACE:	1-8	4
	3.1	The graphical User Interface: Popularity of graphics, the concept of direct manipulation, graphical systems, Characteristics.		
	3.2	Web user Interface: Interface popularity, characteristics. The merging of graphical Business systems and the Web. Principles of user interface design.		
4		SCREEN DESIGNING:	1-8	4
4	4.1	Design goals, Screen planning and purpose, organizing screen elements, ordering of screen data and content, screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, Technological consideration in interface design.		
5		INTERFACE DESIGN FOR MOBILE DEVICES:	1-8	5
	5.1	Mobile Ecosystem: Platforms, Application frameworks: Types of Mobile Applications: Widgets, Applications, Games, Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.		
6		INTERACTION STYLES AND COMMUNICATION:	1-8	5
	6.1	Windows: Characteristics, Components, Presentation styles, Types of Windows, Management, operations. Text messages: Words, Sentences, messages and text words, Text for web pages. Icons, Multimedia and colours		
Total				26

Self-learning:



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1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

Text Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "*Human Computer Interaction*", 3rd Edition, Pearson Education, 2004.
2. Wilbert O. Galitz, "*The Essential Guide to User Interface Design*", Wiley publication.
3. Alan Cooper, Robert Reimann, David Cronin, "*About Face3: Essentials of Interaction Design*", Wiley publication.
4. Jeff Johnson, "*Designing with the Mind in Mind*", Morgan Kaufmann Publication.
5. Donald A. Normann, "*Design of Everyday Things*", Basic Books; Reprint edition 2002.
6. Brian Fling, "*Mobile Design and Development*", First Edition, O'Reilly Media Inc., 2009.
7. Rogers Sharp Preece, "*Interaction Design: Beyond Human Computer Interaction*", Wiley.
8. Guy A. Boy, "*The Handbook of Human Machine Interaction*", Ashgate Publishing Ltd.
9. Kalbnde, Kanade, Iyer, "*Galitz's Human Machine Interaction*", Wiley Publications.

SUGGESTED CO - PO articulation Matrix



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Course Outcomes	Program Outcomes (POs)										Program Specific Outcomes* (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	3	-	3	-	-	-	-	-	-	-	-
CO4	1	3	2	-	-	-	-	1	-	-	-	-	-
CO5	2	2	3	-	3	2	1	1	2	2	1	-	-

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply ✓	Analyze ✓	Evaluate	Create
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MULTIDISCIPLINARY MINOR (EMBEDDED WITH BASIC DEGREE)

Minor in Electronics Engineering: (Offered to ME)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMEL1	Signals and Systems	2	-	-	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max	100	

Pre-requisite Course Codes	Basic concepts of Mathematics	
Course Outcomes	CO1	Identify and differentiate between continuous and discrete time signals and systems
	CO2	Develop input output relationship for LTI systems
	CO3	Apply the concept of Laplace transform and understand conversion from time domain to frequency domain for continuous time systems.
	CO4	Apply the concept of Z transform and comprehend conversion from time domain to frequency domain for discrete time systems.
	CO5	Discuss various applications of signals and system

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to Signals and Systems Introduction to Signals: Definition, Basic Elementary signals - exponential, sine, step, impulse, ramp, rectangular, triangular. Operations on signals. Classification of Signals: Analog and discrete time signals, even and odd signals, periodic and non-periodic signals, deterministic and non-deterministic signals, energy and power signals. Arithmetic Operations on Signals, Time Shifting, Time Scaling, Time Reversal of Signals	1,2,3,4	4
	1.2	Systems and Classification of systems: System Representation, continuous time and discrete systems, system with and without memory, causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system		
2		Time Domain Analysis of Continuous and Discrete	1,2,3,4	6
	2.1	Properties of Linear Time Invariant (LTI) systems, Impulse and		



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	2.2	Use of Convolution Integral and Convolution Sum and Correlation for Analysis of LTI Systems		
	2.3	Properties of Convolution Integral/Sum		
		Laplace Transform and Continuous time LTI systems	1,2,3,4	6
3	3.1	Need of Laplace Transform, Concept of Region of Convergence, Properties of Laplace Transform, , unilateral Laplace Transform, inverse Laplace Transform.		
	3.2	Analysis of continuous time LTI systems using Laplace Transform: Causality and stability of systems in s -domain, Total response of a system.		
		z-Transform and Discrete time LTI systems	1,2,3,4	6
4	4.1	Need of z -Transform, z -Transform of finite and infinite duration sequences, Concept of Region of Convergence, z -Transform properties, Standard z -transform pairs, one sided z -Transform. Inverse z -Transform: Partial Fraction method only.		
	4.2	Analysis of discrete time LTI systems using z-Transform: Transfer Function, plotting Poles and Zeros of a transfer function , causality and stability of systems, Total response of a system		
		Applications of Signals and System		4
5	5.1	Electrical and Electronics Engineering Applications		
	5.2	Computer Science and IT Applications		
	5.3	Mechanical and Civil Engineering Applications		
	5.4	Robotics and IoT Applications		
Total				26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

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ESE:

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(20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Tarun Kumar Rawat, “Signals and Systems”, Oxford University Press, 2016.
2. A. Nagoor Kani, “Signals and Systems”, Tata McGraw-Hill Education, 2014.
3. Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice-Hall of India, Second Edition, 2002.
4. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMEL2	Digital Electronics	2	-	2	2	2	--	1	3
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Lab		20	-	-	-	50			

Pre-requisite Course Codes	Binary number system and codes, binary arithmetic
Course Outcomes	After the successful completion students should be able to
	CO1 Compare TTL and CMOS families w.r.t. their characteristic parameters
	CO2 Construct combinational circuits using given MSI devices.
	CO3 Apply the knowledge of flip-flops and MSI devices to design sequential circuits.
	CO4 Analyze the given sequential circuits to identify the state transitions and race conditions.
CO5 Implement the given logic function using programmable logic devices.	

Module No.	Unit No.	Topics	Ref	Hrs.
1		Implementation of Logic functions		
	1.1	Logic gates, Implementation of functions using basic gates and using Universal gates	1,2,3,4	4
	1.2	Formulating a logic function, Sum of Products (SOP), Product of Sums (POS), Minimization using Boolean Algebra, De Morgan's Theorems, Minimization using Karnaugh map (upto 4 variables), Quine-McClusky Technique	1,2,3,4	
2		Logic Families		
	2.1	Characteristic parameters of logic families: Voltage and Current parameters, Fan in, Fan out, Noise margin, Power Dissipation, Propagation Delay	1,2,3,4	3
	2.2	TTL NAND gate and its transfer characteristics, CMOS inverter and transfer characteristics, comparison of TTL and CMOS logic families		
3.		Combinational Circuit Design		
	3.1	Full adders, ripple carry adders, Carry Look ahead Adders, Binary Subtractors	1,2,3,4	5
	3.2	Multiplexer/ Demultiplexer, Encoders, Priority Encoders, Parity Generators, Code Converters, comparator, ALU		
	3.3	Static and dynamic hazards in combinational circuits		
4.		Elements of Sequential Circuit		
	4.1	Storage elements: Latches and Flip-flops (S-R, J-K, D, T Flip- flop), Master Slave Flip-flop	1,2,3,4	5
	4.2	Synchronous and Asynchronous counters, Shift registers and their	1,2,	



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		applications	3,4
		Analysis of Sequential circuits	
	5.1	Analysis of Moore and Mealy type Finite State Machines (FSM), State Reduction	1,2,3,4
	5.2	Introduction to Asynchronous Sequential circuits, Essential hazards in asynchronous sequential circuits	1,2,3,4
		Programmable devices	
		Structure of Programmable Logic Devices (PLDs), Function implementation with PAL and PLAs, Introduction to CPLD and FPGA	1,2,3,4
Total			26

Laboratory Experiments:

Sr. No.	Title of experiment	Module	Ref
1.	To implement the combinational logic for a given function using basic gates and Universal gates.	1	1,2
2.	To simulate a CMOS inverter and to plot the transfer characteristics (using SPICE)	2	1,2
3.	a. To verify the function of 8 bit binary adder IC7483 b. To implement a BCD adder using IC7483	3	1,2
4.	a. To implement the function of 8 bit Multiplexer using IC74151 b. To implement a given 4 variable Boolean function using Multiplexer IC 74151	3	1,2
5.	To implement an 8 bit binary comparator using IC 7485	3	1,2
6.	a. To implement a Mod n asynchronous counter using flip-flops b. To implement a Mod n counter using IC 74163	4	1,2
7.	Implementation of a combinational circuit using reconfigurable devices a. To write an HDL code for the parity generator and simulate verify the operation by simulation. b. To implement the HDL code on FPGA and verify the operation.	6	7,8
8.	Implementation of a sequential circuit using reconfigurable devices a. To write an HDL code for a 4 bit shift register and verify the operation by simulation. b. To implement the HDL code on FPGA and verify the operation.	6	7,8



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Course Assessment:

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. John F. Wakerly, “Digital Design Principles and Practice”- Pearson Publications, 4th edition
2. Morris Mano, Michael D. Ciletti, “Digital Design with introduction to Verilog HDL” Pearson, 5th edition
3. John M. Yarbrough, “Digital Logic Applications and Design” – Thomson Publications
4. Stephen Brown and Zvonko Vranesic, “Fundamentals of digital logic design with Verilog design”, McGraw Hill, 3rd Edition
5. Roth and Kinney, “Fundamentals of Logic Design”, Cengage learning, 7th edition
6. William I. Fletcher, “An Engineering Approach to Digital Design”, Prentice Hall of India
7. J. Bhaskar, A Verilog HDL Primer, Third Edition, Star Galaxy Publishing
8. Sameer Palnitkar, “Verilog HDL: A guide to digital design and synthesis”

Online References:

<https://archive.nptel.ac.in/content/storage2/courses/106108099//Digital%20Systems.pdf>

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMEL3	Microcontrollers and Applications	2	--	-	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
Theory		20	30	20	50	100			

Pre-requisite Course Codes	Digital Electronics, C programming	
	At the End of the course students will be able to:	
Course Outcomes (CO)	CO1	Explain the fundamental concepts of microcontrollers
	CO2	Develop programming skills for microcontrollers using Embedded C concepts
	CO3	Program various on-chip components of microcontrollers
	CO4	Interface various devices to the 8051 microcontroller
	CO5	Evaluate various enhancements in modern microcontrollers based on the ARM CORTEX cores

Module No.	Unit No.	Topics	Ref.	Hrs.
1		8051 Microcontroller Architecture		6
	1.1	Introduction to the concepts of Microprocessors and Microcontrollers	1,2	
	1.2	Concept of Buses, Read/write operations, T state, Machine cycle and Instruction cycle	1,2	
	1.3	8051 Architecture	1,2	
	1.4	8051 Memory organization	1,2	
	1.4	RISC and CISC Concepts, Harvard and Von Neumann Architectures	1,2	
	1.5	Overview of various available Microcontrollers, Applications of Microcontrollers	1,2	
2		Programming the 8051		4
	2.1	Assembly language programming, Addressing modes	1,2	
	2.2	Embedded C programming concepts: Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routines.	1,2	
3		8051 Internal Hardware		6
	3.1	I/O port programming	1,2	
	3.2	Timers/Counters programming	1,2	
	3.3	Serial port programming	1,2	
	3.4	Interrupts programming	1,2	
	3.5	Low power modes of the 8051	1,2	
4		8051 Interfacing		



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	4.1	Display interfacing: LED, 16x2 generic alphanumeric LCD display.	1	6
	4.2	Analog devices interfacing: 8-bit ADC, 8-bit DAC, temperature sensor (LM35)	1	
	4.3	Motor interfacing: Relay, DC motor (speed control using PWM), Stepper motor and Servo motor.	1	
5		ARM Cortex microcontrollers		4
	5.1	Introduction to the ARM Cortex family	3	
	5.2	Salient features of ARM Cortex cores: RISC design, Operating modes and states, NVIC, Low power modes	3	
			Total	26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books

- 1.M.A.Mazidi, J.C.Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, Second Edition, 2007.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, Third Edition, 2005.
3. Joseph Yiu, "The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.

Reference Books:

1. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design",
 2. Pearson Education, 2009.
 3. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014.
- Ajay V Deshmukh, "Microcontroller Theory And Applications ", Tata Mcgraw Hill, 2017

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM44	Linear Integrated Circuits	2	--		2	2	--		2
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	

Pre-requisite Course Codes		25MDM43
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the fundamentals of integrated circuits and identify their major application areas. Analyze important types of integrated circuits
	CO2	Demonstrate the ability to design practical circuits that perform the desired operations.
	CO3	Analyze and compare theoretical, practical, and simulated results in integrated circuits to evaluate performance variations
	CO4	Select the appropriate integrated circuit modules to build a given application

Module No.	Unit No.	Topics	Ref.	Hrs.
1.		Introduction to operational amplifiers	1,2,3	04
	1.1	Analysis of differential amplifier circuit configurations using FETs, Effect of Swamping resistor, Current sources using FETs,		
	1.2	Ideal & Practical Operational Amplifiers, Operational amplifier characteristics, Operational amplifier parameters, Operational amplifier, open loop and closed loop configurations.		
2		Applications of Operational Amplifier	1,2	06
	2.1	Amplifiers: Inverting, non-inverting, buffer, summing & difference amplifiers, integrator & differentiator (ideal & practical), current amplifier, instrumentation amplifier, log and antilog amplifiers..		
	2.2	Converters: Current to voltage converters, voltage to current converters, voltage to frequency converter, frequency to voltage converter		
	2.3	Active Filters: Second order active low pass, high pass, band pass and band reject filters, Introduction to switch capacitor filters.		
	2.4	Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.		
3		Non-Linear Applications of Operational Amplifier	1,2,3	06
	3.1	Comparators: Inverting comparator, non-inverting comparator, zero crossing detector, window detector, peak detector, sample & hold circuits.		
	3.2	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.		



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	3.3	Waveform Generators: Square wave generator and triangular wave generator.		
	3.4	Precision Rectifiers: Half wave and full wave precision rectifiers		
		Special Purpose Integrated Circuits	1,2,4	05
4	4.1	Functional block diagram and working of IC 555, design of astable and monostable multivibrator using IC 555, application of IC 555 as pulse position modulator, pulse width modulator and Schmitt Trigger.		
	4.2	Functional block diagram and working of VCO IC 566 and application as frequency modulator, Functional block diagram and working of PLL IC 565 and application as FSK Demodulator, Functional block diagram and working of multiplier IC 534 and application as a phase detector, Functional block diagram and working of waveform generator XR 2206 and application as sinusoidal FSK generator		
5		Voltage Regulators	4	05
	5.1	Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM 337) voltage regulators.		
	5.2	Functional block diagram, working and design of general purpose 723 (LVLC, LVHC, HVLC and HVHC) with current limit and current fold-back protection, Switching regulator topologies, Functional block diagram and working of LT1070 monolithic switching regulator.		
Total				26

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Reference Books:

1. Sergio Franco, "Design with operational amplifiers and analog integrated circuits", Tata McGraw Hill, 3rd Edition.



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2. David A. Bell, “Operation Amplifiers and Linear Integrated Circuits”, Oxford University Press, Indian Edition.
3. R. F. Coughlin and F. F. Driscoll, “Operation Amplifiers and Linear Integrated Circuits”, Prentice Hall, 6th Edition.
4. J. Millman, Christos CHalkias, and Satyabratajit, Millman’s, “Electronic Devices and Circuits,” McGrawHill, 3rdEdition”.

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes* (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	03	02	-	-	-	-	-	-	-	-	-	-		
CO2	03	03	02	-	02	-	-	-	-	-	-	-		
CO3	02	02	03	02	02	-	-	-	-	-	-	-		
CO4	02	03	02	02	02	03	-	-	-	-	-	-		3
CO5	02	03	02	02	03	02	-	-	-	-	-	2	3	

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Remember	Understand	Apply	Analyze	Evaluate	Create
	√	√	√		



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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned				
		L	T	P	L	T	P	Total	
25MDM45	Industrial Electronics	L	T	P	L	T	P	Total	
		2	--	2	2	--	--	2	
		Examination Scheme							
			ISE	MSE	ESE		Total		
			Min	Max					
	Theory	20	30	20	30		100		

Pre-requisite Course Codes	25MDM45	
Course Outcomes	CO1	Explain the importance of electronics in modern industrial application.
	CO2	Interpret the characteristics of major power semiconductor devices and their applications.
	CO3	Identify automation components used in industry.
	CO4	Describe control techniques used in industrial motor drives.
	CO5	Apply artificial intelligence concept in various Industrial control applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Industrial Electronics	1,2	3
	1.1	Role of electronics in automation, Evolution from conventional control to electronic control, Industrial standards and safety.		
	1.2	Applications in Automation and robotics, Role in manufacturing, process industries, EVs, renewable energy.		
2		Power Semiconductor Devices and Controlled Rectifier	1,2,3	6
	2.1	Power Diode, SCR Construction, Operating Principle and V-I characteristics, Comparison of Power MOSFET and IGBT, selection of devices for various industrial applications.		
	2.2	Controlled Rectifiers - Principle of operation Single phase Half wave and full wave Rectifier(R Load)		
3		Introduction to Industrial Control Elements	1,4,5	6
	3.1	Sensors (temperature, pressure, proximity sensors, Hall sensors), Actuators (relays, contactors, solenoids),encoder, smart sensors.		



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	3.2	Concept of Open loop control , control Closed loop control system, PID control ,PWM control technique .		
4		Industrial Motors and Drives:	1,3	7
	4.1	Overview of various industrial motors, DC motor, Stepper motor, Servo motor and BLDC motor ,construction and characteristics. Selection of electric motor and drive system for an application.		
	4.2	Electric drive system overview, Block diagram with power source, power modulator (converter/inverter), motor, controller and feed back. Overview of stepper motor drive and Servo motor drives ,speed ,torque and position control .		
5		Artificial Intelligence in Industrial Electronics	4,8	4
	5.1	Overview of Data acquisition and cloud-based analytics, Fuzzy logic controllers for industrial drives ,AI based fault detection ,predictive maintenance using machine learning.		
			Total	26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Paul & Biswanath , “*Industrial Electronics and Control* ”, 3rd Edition, P H I Publication
2. M. H. Rashid, “Power Electronics”, Prentice-Hall of India
3. M.D. Singh and K. B. Khanchandani, “*Power Electronics*”, Tata McGraw Hill
4. M.B Patil, V Ramanarayanan ,” Simulation of Power Electronics Circuits” ,Narosa
5. Bogdan M. Wilamowski & J. David Irwin, Branko, “*Fundamentals of Industrial Electronics*”



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Online Resources:

NPTEL/Swayam Course:

1. Course: Power Electronics By Prof. G. Bhuvaneshwari (IIT Delhi) https://swayam.gov.in/nd1_noc20_ee97/preview
2. Course: Advance Power Electronics And Control – Prof. Avik Bhattacharya (IIT Roorkee) <https://nptel.ac.in/courses/108/107/108107128/>

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											(PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2		2						2			
CO2	3	3	2		2						2			
CO3	3	3	2		2						2			
CO4	3	3	2		2		1				2			
CO5	3	3	2		2		1				2			

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	✓ Apply	Analyze	Evaluate	Create
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MULTIDISCIPLINARY MINOR (EMBEDDED WITH BASIC DEGREE)

Minor in Business Management: (Offered to ME, CE, CSE and ECS)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMBM1	Financial Accounting	2	-	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
Theory		20	30	20	50	100			

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explain the fundamental concepts and principles of financial accounting.
	CO2	Prepare financial statements such as the balance sheet, income statement, and cash flow statement
	CO3	Analyze financial transactions and record them using journal entries and ledger accounts.
	CO4	Interpret financial statements to assess a company's performance and financial health.
	CO5	Apply accounting standards and regulatory requirements in financial reporting.
	CO6	Utilize accounting software and tools for modern financial analysis and decision-making.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Financial Accounting		4
	1.1	Meaning, Scope, and Importance of Financial Accounting Accounting Principles and Concepts (GAAP & IFRS)		
	1.2	The Accounting Cycle: Transaction to Financial Statements Financial vs. Management Accounting		
	1.3	Regulatory Framework of Accounting (Indian Accounting Standards, IFRS, Companies Act)		
	1.4	Case Study: Evolution of Financial Accounting & its role in business decision-making		
2		Recording Financial Transactions		4
	2.1	Double-Entry System of Accounting		
	2.2	Journal Entries and Ledger Posting Trial Balance: Preparation and Adjustments		
	2.3	Subsidiary Books (Cash Book, Sales Book, Purchase Book) Rectification of Errors		
	2.4	Practical Application: Recording transactions in Tally / QuickBooks / Zoho Books		
3		Preparation of Financial Statements		5
	3.1	Components of Financial Statements (Balance Sheet, Profit & Loss, Cash Flow Statement)		



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	3.2	Preparation of Final Accounts (Trading Account, P&L Account, Balance Sheet)		
	3.3	Adjustments in Final Accounts (Depreciation, Bad Debts, Accrued Income & Expenses) Notes to Accounts and Disclosure Requirements		
	3.4	Case Study: Analysis of financial statements of a listed company (e.g., Tata, Reliance)		
4		Accounting for Special Transactions		
	4.1	Depreciation Accounting (Methods: Straight-Line, Reducing Balance)		4
	4.2	Bank Reconciliation Statement (BRS)		
	4.3	Inventory Valuation Methods (FIFO, LIFO, Weighted Average) Accounting for Non-Profit Organizations		
	4.4	Practical Exercise: Preparation of BRS for a corporate entity		
5		Financial Statement Analysis		4
	5.1	Ratio Analysis (Liquidity, Profitability, Solvency, Efficiency) Comparative and Common-Size Statements		
	5.2	Cash Flow Analysis and Statement of Changes in Equity Interpretation and Decision-Making Based on Financial Data		
	5.3	Industry Application: Financial analysis of startup vs. established company		
6		Contemporary Issues in Financial Accounting		5
	6.1	Introduction to Digital Accounting and Blockchain in Accounting, Forensic Accounting & Fraud Detection		
	6.2	Corporate Social Responsibility (CSR) and Financial Reporting		
	6.3	Emerging Trends: AI & Automation in Accounting		
	6.4	Case Study: Impact of AI and Automation on accounting jobs and decision-making		
			Total	26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.



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Recommended Books:

1. “Financial Accounting: A Managerial Perspective” – R. Narayanaswamy
2. “Advanced Accountancy” – S.P. Jain & K.L. Narang
3. “Accounting for Management” – Dr. Jawaharlal
4. “Principles of Financial Accounting” – Belverd Needles & Marian Powers
5. “Financial Accounting: Tools for Business Decision Making” – Paul D. Kimmel, Jerry J. Weygand

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMBM2	Economics for Business	2	-	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explain fundamental economic concepts and their application in business decision-making.
	CO2	Analyze demand, supply, and market equilibrium to assess business opportunities.
	CO3	Evaluate cost structures, production functions, and pricing strategies for firms.
	CO4	Examine macroeconomic factors such as inflation, GDP, and monetary policies affecting business.
	CO5	Apply economic principles in competitive strategy, international trade, and economic policy analysis.
	CO6	Show an economic perspective for managerial decision-making in various market conditions.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Business Economics	1,2	4
	1.1	Nature, Scope, and Importance of Economics in Business Fundamental Economic Concepts: Opportunity Cost, Marginalism, Scarcity		
	1.2	Microeconomics vs. Macroeconomics Role of Economics in Managerial Decision-Making		
	1.3	Business Cycle and Economic Indicators		
	1.4	Case Study: Impact of Economic Conditions on Business Performance		
2		Demand, Supply, and Market Equilibrium	1,2	4
	2.1	Demand Analysis: Determinants of Demand, Elasticity of Demand (Price, Income, Cross Elasticity) Supply Analysis: Law of Supply, Elasticity of Supply		
	2.2	Market Equilibrium and Changes due to Government Intervention (Price Ceiling, Price Floor)		
	2.3	Demand Forecasting Techniques in Business		
	2.4	Practical Application: Estimating Demand for a New Product		
3		Production, Cost, and Pricing Decisions	3,4	5
	3.1	Theory of Production: Production Function, Short-Run vs. Long-Run Production		



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	3.2	Law of Diminishing Returns, Economies of Scale Cost Concepts: Fixed, Variable, Marginal, and Total Costs		
	3.3	Pricing Strategies: Cost-Plus Pricing, Penetration Pricing, Price Discrimination Profit Maximization and Break-even Analysis		
	3.4	Case Study: How firms set prices in competitive and monopoly markets		
4		Market Structures and Business Strategies	3,4	
	4.1	Perfect Competition, Monopoly, Monopolistic Competition, and Oligopoly		4
	4.2	Game Theory and Strategic Business Decisions		
	4.3	Barriers to Entry and Competition Policy Pricing and Output Decisions in Different Market Structures		
	4.4	Industry Application: Competition Analysis of Major Brands (e.g., Amazon vs. Flipkart, Apple vs. Samsung)		
5		Macroeconomic Factors Affecting Business	5	4
	5.1	National Income and GDP Measurement Inflation, Unemployment, and Business Cycles		
	5.2	Monetary and Fiscal Policies & Their Impact on Business Exchange Rates, Interest Rates, and Foreign Trade Policies		
	5.3	Case Study: How Inflation and Interest Rates Affect Investment Decisions		
6		Globalization, Trade, and Economic Policies		5
	6.1	International Trade Theories and Business Implications Balance of Payments and Exchange Rate Determination		
	6.2	WTO, Free Trade Agreements, and Trade Barriers		
	6.3	Sustainable Economic Growth & Environmental Economics		
	6.4	Case Study: Global Supply Chain Disruptions and Business Strategies		
Total			26	

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.



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Recommended Books:

1. “Managerial Economics” – Paul G. Keat & Philip K.Y. Young
2. “Principles of Economics” – N. Gregory Mankiw
3. “Microeconomics for Business” – Jeffrey M. Perloff
4. “Macroeconomics: Theory and Policy” – Rudiger Dornbusch & Stanley Fischer
5. “Economic Analysis for Business” – Norman Never

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMHM3	Business Administration	2	-	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explain the fundamental principles of business administration and management
	CO2	Analyze various business functions, including finance, marketing, human resources, and operations
	CO3	Apply decision-making techniques for effective business strategy and planning
	CO4	Evaluate organizational structures, leadership styles, and corporate governance
	CO5	Demonstrate critical thinking and problem-solving skills to handle business challenges.
	CO6	Demonstrate ethical business practices and sustainability in modern business operations

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Business Administration	1,2	4
	1.1	Definition, Nature, and Scope of Business Administration Evolution of Management Thought (Classical, Behavioral, Contingency Theories)		
	1.2	Functions of Management: Planning, Organizing, Leading, and Controlling Business Ethics and Corporate Social Responsibility (CSR)		
	1.3	Role of Business Administration in a Competitive Environment		
	1.4	Case Study: Evolution of Successful Companies (Apple, Google, Tata, etc.)		
2		Organizational Structure and Business Operations	1,2	4
	2.1	Types of Business Organizations (Sole Proprietorship, Partnership, Corporation) Business Processes and Workflow Optimization		
	2.2	Organizational Structure: Hierarchical, Matrix, Flat, and Networked Models Delegation of Authority, Responsibility, and Accountability		
	2.3	Decision-Making Process in Business Administration		
	2.4	Industry Application: Organizational Structure Analysis of a Multinational Company		
3		Human Resource Management & Leadership	5	5



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	3.1	Functions of Human Resource Management (HRM)		
	3.2	Recruitment, Selection, and Employee Retention Strategies Performance Appraisal and Employee Motivation		
	3.3	Leadership Theories and Their Application in Business Workplace Culture and Diversity Management		
	3.4	Case Study: How HR Strategies Impact Employee Productivity		
4		Financial Management & Business Economics	3,4	
	4.1	Basics of Financial Management in Business Administration Understanding Financial Statements (Balance Sheet, P&L Account)		4
	4.2	Budgeting, Forecasting, and Cost Control Capital Structure and Investment Decision-Making		
	4.3	Business Economics and Market Analysis		
	4.4	Practical Application: Financial Analysis of a Company Using Annual Reports		
5		Marketing & Customer Relationship Management (CRM)	3,4	4
	5.1	Introduction to Marketing & Market Research Marketing Mix (4Ps: Product, Price, Place, Promotion)		
	5.2	Digital Marketing & E-Commerce Trends Consumer Behavior & Customer Relationship Management (CRM) Branding and Positioning Strategies		
	5.3	Case Study: How Digital Marketing Transformed Retail Business (Amazon, Flipkart)		
6		Business Strategy, Entrepreneurship, and Sustainability		5
	6.1	Business Strategy and Competitive Advantage (Porter's Five Forces)		
	6.2	Entrepreneurship and Startup Ecosystem Risk Management and Crisis Handling in Business Sustainable Business Practices and Corporate Governance		
	6.3	Emerging Trends: AI in Business, Blockchain, and Data-Driven Decision Making		
	6.4	Case Study: How Startups Scale from Small Businesses to Global Brands		
Total				26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.



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ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. “Principles of Business Management” – Harold Koontz & Heinz Weihrich
2. “Management: A Global Perspective” – Stephen P. Robbins & Mary Coulter
3. “Business Administration: Theory and Practice” – Peter F. Drucker
4. “Strategic Management: Concepts and Cases” – Fred R. David
5. “Human Resource Management” – Gary Dessler

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM 54	Human Resource Management	2	--	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes	25MDM54	
After the successful completion students should be able to:		
Course Outcomes	CO1	Examine the concept, nature, scope, and evolution of Human Resource Management. (<i>Analyse</i>)
	CO2	Identify and explain Human Resource Planning (HRP) processes and Job Analysis methods in organizations. (<i>Understand</i>)
	CO3	Investigate and apply the principles, methods, and significance of Training and Development in HRM. (<i>Create</i>)
	CO4	Analyse the objectives, methods, and effectiveness of Performance Appraisal systems. (<i>Analyse</i>)
	CO5	Understand the concept, scope, and functions of Human Resource Development (HRD) in organizational growth. (<i>Understand</i>)
	CO6	Evaluate HRM applications and case studies for sustainable solutions in competitive environment

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to HRM		4
	1.1	Human Resource Management (HRM) is the process. Nature, scope. Functions of HRM. HRM policies & principles.	1	1
	1.2	Evolution of HRM; Traditional HRM vs Strategic HRM Challenges in contemporary HRM. Contemporary Challenges in HRM	1	
	1.3	Human Resource Planning (HRP) Human Resource Planning – concept, importance, process.	1	1
	1.4	Importance of HRP, Process in HRP	1	
	1.5	Forecasting manpower needs and factors affecting HRP.	1	
2				4
	2.1	Human Resource Planning, Job Analysis and Design Human Resource Planning – concept, Importance of HRP, process of HRP	3,4	1
	2.2	Job analysis Job analysis – meaning, objectives and methods.	3,4	1
	2.3	Job description & job specification.	3,4	



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3		Training & Development		5
	3.1	Importance and need for training	5	2
	3.2	Training process & identification of training needs	5	3
4		Performance Appraisal & Compensation Management		4
	4.1	Performance appraisal – meaning, objectives and process	6	1
	4.2	Methods of performance appraisal (traditional & modern)	6	1
	4.3	Human Resource Development (HRD). Concept and Scope of Human Resource Development (HRD)	6	1
	4.4	Ethical Issues in HRM: Discrimination, harassment, employee privacy, fair wages.	6	
	4.5	Managing Diversity: Gender, cultural diversity, inclusion practices. Globalisation: Impact on recruitment, training, and global HR practices.	6	1
Total				26

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

- **Human Resource Management by Gary Dessler: A widely used, comprehensive text covering core functions.**
- **Armstrong's Handbook of Human Resource Management Practice by Michael Armstrong: A foundational, practical guide for HR professionals.**



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- **Human Resource Management: Text and Cases by K. Aswathappa & Sadhna Dash: Known for its strong academic structure.**
- Aswathappa — *Human Resource Management*
- Dessler & Varkkey — *Human Resource Management*
- Pattanayak — *Human Resource Management*
- Chhabra — *Human Resource Management*

Online Resources:

1. [1 <https://www.drnishikantjha.com/booksCollection/hrm-basic-notes.pdf>
2. https://www.youtube.com/watch?v=aPEUKLxxh_k
3. <https://onlinelibrary.wiley.com/journal/1099050x>

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	2	1	2	-	1	-	2
CO2	2	2	-	1	2	1	-	-	-	-	2
CO3	2	3	1	1	3	-	-	-	-	-	2
CO4	2	3	2	1	2	2	-	-	-	-	2
CO5	2	2	1	-	3	-	-	-	-	-	2
CO6	1	2	-	-	2	3	2	-	2	-	3

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand✓	Apply✓	Analyze✓	Evaluate✓	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM55	Digital Marketing	2	--	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
Theory		20	30	20	50	100			

Pre-requisite Course Codes		25MDM54, 55
After the successful completion students should be able to:		
Course Outcomes	CO1	Understand the issues in transitioning from traditional marketing to digital marketing ,practical skills for managing digital marketing channels including SEO, SEM, social media, and email marketing.
	CO2	Analyse outbound and inbound marketing programs and impact on consumer behaviour through frameworks
	CO3	Apply the learnings to critique F2C and D2C communications and its effectiveness on company revenues and profits
	CO4	Evaluate digital marketing programs across channels using and frameworks learnt in the course
	CO5	Design a comprehensive digital marketing strategy integrating multiple channels to achieve business objectives
	CO6	To foster understanding of ethical, legal, and privacy considerations in digital marketing practices, develop strategic thinking around content marketing, online reputation management, and digital branding.

Mod ule No.	Uni t No.	Topics	Ref.	Hrs.
1		Fundamentals of Digital marketing		4
	1.1	Significance, Traditional marketing Vs Digital Marketing, Evolution of Digital Marketing, Digital Marketing Landscape, Key Drivers, Digital Consumer & Communities		2
	1.2	Gen Y & Netizen's expectation & influence wrt Digital Marketing., challenges for traditional firms to go digital; consumer adoption and radical changes in consumer behaviour online		
	1.3	New tools for consumer research – micro-blogging, blog posts to monitor social chatter and buzz online,measure of consumer exposure, interest, reactions to advertising messages, offers, purchases across a variety of contexts		2



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2		Frameworks for Digital Marketing	4
	2.1	Outbound (Firm initiated) marketing – traditional: print, radio, TV advertising; digital: search, display, video advertising. Inbound (Consumer Initiated) marketing – firm websites aligned with consumer's search process	2
	2.2	Search engine algorithms, search engine optimization process; Social Media – digital platforms where consumers actively create content on X, Facebook; Native Advertising - preview of websites, influence on other consumers' buying behaviour;	
	2.3	Role of mobile phones in consumer search and purchase process; alternative to online/offline ads, emulate voice of unsponsored editorials by third party writers, reporters on website	2
3		Search Engine Optimization	4
	3.1	On page, Off page SEO, bidding on keywords, budgeting for search advertisements, Metric – Cost per Click, Click Through Rate (CTR), Impressions, Conversion rate, Profit Margin	2
	3.2	Quality of landing page, Relevance to Consumers; keyword portfolio, keyword proliferation, Branded versus generic keywords;	
	3.3	Impact on consideration set of buyers, repositioning of keywords to auction ; respond to competitor tactics; generalized Second Place auction; bids v/s Willingness to Pay-	2
4		Digital Advertising and Promotions	4
	4.1	Bi-directional communication, gathering attitudinal and behavioral feedback in real time, real time market research	2
	4.2	Online tools to talk with and listen to consumer to consumer conversations; role of social networks like X, Facebook; purpose of online communication	
	4.3	Understand what customers value, communicate value to them, provide value; advertising v/s promotions – display ads, viral ads; benefits of online ads – interactive, finer selection of audience	2
5		FIRM, CONSUMER ADVERTISING	5
	5.1	Firm – to Consumer (F2C) and Consumer – to – Consumer Advertising (C2C): F2C – firm creates, consumers consume content, C2C- consumers propagate and others	2.5
	5.2	Consume content; use of text, static messages, audio/video content, use influencers to talk with other consumers through viral marketing or modified content through electronic Word of Mouth (e WOM)	2.5
6		Framework for Selection of Digital and Social Media	5
	6.1	Purpose of the medium – listen/talk?; persuasion element – deals/arguments?; ; who initiates contact – firm/consumer? content provider – firm/ consumer?	2.5
	6.2	Select from a broad class of tools; identify precise tools; importance of high-involvement versus lowinvolvement products in deciding tools-	2.5
Total			26



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Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Digital Marketing for Dummies – Ryan Deiss & Russ Henneberry
2. Marketing 4.0: Moving from Traditional to Digital – Philip Kotler, Hermawan Kartajaya, Iwan Setiawan
3. The Art of Digital Marketing – Ian Dodson
4. Social Media Marketing: A Strategic Approach – Melissa Barker, Donald Barker, Nicholas Bormann, Krista Neher
5. Google Analytics Demystified – Joel Davis

Reference Books

6. Driving Digital Strategy. A Guide to Reimagining Your Business. Sunil Gupta. Harvard Business Review Press
7. Starting Small to Winning Big: The Definitive Digital Marketing Guide for Startup Entrepreneurs. Shishir Mishra. Business Expert Press

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		1	-	2			2	-	1	-	3
CO2		2	-	1			2	-	2	-	2
CO3		2		2		-	2	-	2	-	3
CO4		2		2			2	-	2	-	2
CO5		2		2		-	2	-	2	-	3
CO6		2	-	2			2	-	2	-	2

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: - **Blooms level**

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate ✓	Create ✓
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MULTIDISCIPLINARY MINOR (EMBEDDED WITH BASIC DEGREE)

Minor in Health Care Management: (Offered to ME, CE, CSE and ECS)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMHM1	Biomedical Instrumentation & Imaging	2	-	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max	100	

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explain the fundamental concepts of biomedical instrumentation and imaging techniques.
	CO2	Analyze the working principles of medical diagnostic and therapeutic instruments.
	CO3	Evaluate the role of biomedical imaging modalities in disease diagnosis and treatment.
	CO4	Identify the emerging trends in biomedical instrumentation and imaging

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Fundamentals of Biomedical Instrumentation	1,2	4
	1.1	Introduction to Biomedical Engineering & Instrumentation		
	1.2	Market Trends in the Global Medical Device Industry		
	1.3	Patient Monitoring Systems		
	1.4	Physiological Signals and Measurements (ECG, EMG, EEG, Blood Pressure)		
2		Biomedical Signal Processing	1,2	4
	2.1	Sensors and Transducers in Medical Devices		
	2.2	Bioelectric Signals and Their Processing		
3		Diagnostic and Therapeutic Equipment	1,2	5
	3.1	Clinical Laboratory Instruments (Hematology Analyzers, Blood Gas Analyzers)		
	3.2	Cardiac Care Instruments (ECG, Defibrillators, Pacemakers)		
	3.3	Respiratory Care Devices (Ventilators, Spirometers) Dialysis and Renal Care Instruments		
	3.4	Laser and Ultrasound-based Therapeutic Systems		
4		Medical Imaging Techniques	5	5
	4.1	X-ray and CT Imaging: Principles, Image Acquisition, and Applications		
	4.2	Magnetic Resonance Imaging (MRI): Working Principles and Clinical Applications		
	4.3	Ultrasound Imaging: Doppler Ultrasound and 3D Ultrasound		
	4.4	Nuclear Medicine Imaging (PET, SPECT): Functional Imaging in Diagnosis		
5		Healthcare Technology Management	1,2	3



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	5.1	Medical Device Lifecycle: Development to Deployment		
	5.2	Hospital Equipment Planning & Maintenance		
	5.3	Biomedical Equipment Procurement and Cost Analysis Regulatory Framework: FDA, ISO 13485, CE Marking		
6		Emerging Trends in Biomedical Instrumentation & Imaging	3,4	5
	6.1	Wearable Health Devices & Remote Monitoring Biomedical Robotics & AI-Assisted Surgery		
	6.2	Point-of-Care Testing & Portable Diagnostics 3D Printing in Biomedical Applications		
	6.3	AI and Deep Learning in Medical Imaging Future of Personalized Medicine and Imaging		
	6.4	Industry Application: Integration of Blockchain & AI in Healthcare Data Management		
Total			26	

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. “Biomedical Instrumentation and Measurements” – Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer
2. “Handbook of Biomedical Instrumentation” – R.S. Khandpur
3. “Introduction to Biomedical Engineering” – John Enderle, Joseph Bronzino
4. “Principles of Biomedical Instrumentation” – Andrew G. Webb
5. “Medical Imaging Signals and Systems” – Jerry L. Prince, Jonathan Links

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMHM2	Hospital Administration Fundamentals	2	-	-	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explain the structure and functioning of hospitals and healthcare institutions
	CO2	Analyze key administrative processes, including hospital operations, human resource management, and financial planning
	CO3	Evaluate hospital accreditation, regulatory frameworks, and legal compliance
	CO4	Apply principles of hospital facility management and patient care services
	CO5	Demonstrate skills in strategic hospital planning and decision-making.
	CO6	Demonstrate ethical considerations in healthcare administration.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Hospital Administration	1,2	4
	1.1	Definition and Scope of Hospital Administration Role of Hospital Administrators in Healthcare Systems		
	1.2	Types of Healthcare Facilities (Public, Private, Multi-Specialty, Tertiary Care)		
	1.3	Overview of Healthcare Delivery Systems in India & Global Perspectives		
	1.4	Challenges in Hospital Administration		
2		Hospital Operations & Patient Care Services	1,2	4
	2.1	Inpatient & Outpatient Department Management Emergency and Trauma Care Services		
	2.2	Pharmacy and Diagnostic Services in Hospitals		
	2.3	Infection Control and Waste Management		
	2.4	Quality Assurance & Patient Safety		
3		Human Resource Management in Hospitals	1,2	5
	3.1	Workforce Planning & Talent Acquisition in Healthcare		
	3.2	Training & Development for Healthcare Professionals Employee Performance Evaluation & Retention Strategies		
	3.3	Work Ethics and Stress Management in Hospital Settings		
	3.4	Legal Aspects of HR in Healthcare (Labor Laws, Medical Staff Rights)		
4		Financial Management in Hospitals	4,5	4
	4.1	Hospital Budgeting & Cost Control Techniques		
	4.2	Revenue Cycle Management (Billing & Insurance Processes) Financial Planning for Healthcare Infrastructure & Equipment		



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	4.3	Pricing Strategies for Medical Services		
	4.4	Government & Private Health Insurance Schemes		
5		Healthcare Regulations, Accreditation, and Legal Framework	4,5	4
	5.1	Hospital Accreditation Systems (NABH, JCI, ISO)		
	5.2	Healthcare Laws & Policies (Clinical Establishments Act, MCI Regulations) Medico-Legal Cases & Patient Rights Medical Records Management & Data Privacy (HIPAA, PDPA)		
	5.3	Ethical Considerations in Healthcare Administration		
6		Strategic Hospital Planning & Emerging Trends	4,5	5
	6.1	Hospital Infrastructure Planning & Facility Management		
	6.2	Role of IT & AI in Hospital Administration (Telemedicine, Digital Health Records) Future Trends in Healthcare Delivery Models		
	6.3	Crisis Management & Disaster Preparedness in Hospitals		
	6.4	Entrepreneurship & Innovation in Healthcare Administration		
			Total	26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. "Hospital Administration and Management" – D.C. Joshi & Mamta Joshi
2. "Principles of Hospital Administration and Planning" – B.M. Sakharkar
3. "Essentials of Hospital Management & Administration" – Arun Kumar
4. "Hospital and Healthcare Organization: Management Strategies" – Sujata Gaur & Rajesh Arora
5. "Healthcare Operations Management" – Daniel B. McLaughlin & John R. Olson

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMHM3	Operations Management for Healthcare Systems	2	-	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explain the fundamental principles of operations management in healthcare.
	CO2	Analyze healthcare workflows, process efficiency, and capacity planning.
	CO3	Evaluate inventory management, supply chain logistics, and resource allocation in hospitals.
	CO4	Apply quality management techniques to enhance patient care and operational efficiency.
	CO5	Develop strategic approaches for optimizing healthcare service delivery.
	CO6	Utilize data analytics, AI, and digital tools to improve hospital operations and decision-making.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Healthcare Operations Management	1,2	4
	1.1	Definition and Scope of Operations Management in Healthcare Role of Operations Managers in Healthcare Organizations		
	1.2	Healthcare Service Delivery Models & Process Flows		
	1.3	Key Performance Indicators (KPIs) in Healthcare Operations Challenges in Managing Healthcare Operations		
	1.4	Case Study: Improving Patient Flow in a Multi-Specialty Hospital		
2		Healthcare Facility Planning & Capacity Management	1,2	4
	2.1	Hospital Facility Layout & Space Utilization Capacity Planning for Emergency & Critical Care Units		
	2.2	Demand Forecasting for Healthcare Services		
	2.3	Resource Optimization & Bed Occupancy Rate Management		
	2.4	Hospital Infrastructure Planning & Expansion		
3		Healthcare Supply Chain & Inventory Management	1,2	5
	3.1	Procurement & Logistics in Healthcare Systems Inventory Control Techniques for Medical Supplies & Equipment		
	3.2	Pharmaceutical Supply Chain Management		
	3.3	Cold Chain Logistics for Vaccines & Biologics		
	3.4	Cost-Effective Supply Chain Strategies in Healthcare		
4		Quality & Performance Improvement in Healthcare	3,4	4
	4.1	Lean Healthcare & Six Sigma Applications		
	4.2	Patient Safety & Risk Management		



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	4.3	Compliance with Healthcare Quality Standards (NABH, JCI, ISO) Reducing Medical Errors & Waste in Healthcare Operations		
	4.4	Patient Satisfaction & Experience Improvement		
5		Technology & Data Analytics in Healthcare Operations	3,4	4
	5.1	Role of AI & Automation in Hospital Administration Electronic Health Records (EHR) & Hospital Information Systems (HIS)		
	5.2	Data-Driven Decision Making in Healthcare Operations Telemedicine & Remote Patient Monitoring Systems Cybersecurity & Data Privacy in Healthcare IT		
	5.3	Case Study: AI-Powered Predictive Analytics for Hospital Resource Planning		
6		Strategic Planning & Crisis Management in Healthcare Operations	5	5
	6.1	Healthcare Policy & Strategic Planning for Hospitals Disaster Management & Emergency Preparedness in Healthcare		
	6.2	Financial Aspects of Healthcare Operations Management		
	6.3	Sustainable Practices in Healthcare Facilities Future Trends: Smart Hospitals & Green Healthcare Systems		
Total			26	

Self-learning:

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2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. "Healthcare Operations Management" – Daniel B. McLaughlin & John R. Olson
2. "Operations Management in Healthcare" – James R. Langabeer II & Jeffrey Helton
3. "Managing Healthcare Operations" – John R. Olson
4. "Essentials of Health Care Operations Management" – Amar P. Yadav
5. "Lean Hospitals: Improving Quality, Patient Safety, and Employee Engagement" – Mark Grab

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: - **Blooms level**

Remember✓	Understand	Apply✓	Analyze✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM64	Digital Transformation in Healthcare	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE	MSE		ESE	Total		
					Min	Max			
		Theory	20	30	20	30	100		

Pre-requisite Course Codes	
After the successful completion students should be able to:	
Course Outcomes	CO1 Understand the basic concepts of digital health and its importance
	CO2 Understand the beneficiaries of digital health
	CO3 Role of an engineer in development and utilization of digital health record
	CO4 Key application of digital health record
	CO5 Technology tools requirement for the development, analysis and utilization of digital health record
	CO6 Ethical, Legal and policy issues

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Health care ecosystem		8
	1.1	Overview of health care ecosystem Introduction to health care system, doctor, nurses, hospital, paramedic staff, pharmacy and important definitions.	1, 2	2
	1.2	Understand the human body, diseases and disorder classifications Brief introduction of human body system and classification of diseases/ disorder	3	3
	1.3	Digital health parameters Digital health parameters for data collection, devices and technology for data collections and data analysis/ interpretation	4	1
	1.4	Digital health future Pros and cons of digital health. Clinical decision support system (CDSS), types of diseases need digital health support.	4	2
2		Understand digital health		5
	2.1	Introduction to digital health Definition, scope, evolution and need of digital health	5	1
	2.2	Healthcare and digital technology Relationship of healthcare and digital technology, need and importance	5	1
	2.3	Health information system Electronic health record, electronic medical record, health data	6	2



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		storage, data management		
	2.4	Health data and its utilization Health data user, health data utilization and health data security	6	1
3		Remote health monitoring		3
	3.1	Telehealth, Telemedicine & mHealth Concept of telehealth and telemedicine, remote patient monitoring	7,8	2
	3.2	Pros and cons of remote health monitoring Benefits and challenges of virtual consultation	7,8	1
4		Data analytics and data handling		3
	4.1	Data collection Biomedical data collection and analytics	6	1
	4.2	Data utility Data usage in public health and health research, geographic health database	6	2
5		Role of an engineer		4
	5.1	Artificial Intelligence and Machine Learning AI/ ML fundamentals in healthcare, Clinical decision support system (CDSS), Predictive analytics, disease progression, AI based diagnostic tool	9	2
	5.2	Introduction to emerging technologies Wearable devices, IoT in healthcare, personalized digital tool and continuous health monitoring, virtual care platforms	9	2
6		AI case studies, sustainability and Future Trends		3
	6.1	Ethical legal and policies		
		Data privacy and data security guidelines, HIPPA compliance, legal and regulatory framework, ethical consideration, governance and compliance in health tech	10	3
			Total	26

Self-Learning:

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2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

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Resources:



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1. The healthcare system in India, [DOI <https://doi.org/10.26092/elib/3705>]
2. Health care delivery system in India (<https://api.upums.ac.in/pdfs/doc-1718779598951-702825219.pdf>)
3. Ross and Wilson ANATOMY and PHYSIOLOGY in Health and Illness (<https://pharmabookbank.wordpress.com/wp-content/uploads/2019/03/1.2.ross-wilson-anatomy-and-physiology.pdf>)
4. WHO strategy for digital health (<https://www.who.int/publications/i/item/9789240020924>)
5. Defining the Scope of Digital Public Health and Its Implications for Policy, Practice, and Research: Protocol for a Scoping Review (<https://pubmed.ncbi.nlm.nih.gov/34255717/>)
6. WHO Health information system (https://cdn.who.int/media/docs/default-source/service-availability-and-readinessassessment%28sara%29/related-links-%28sara%29/who_mbhss_2010_section3_web.pdf)
7. Role of e-health, m-health, and telemedicine or telehealth during the COVID-19 pandemic (DOI: <https://dx.doi.org/10.18203/2394-6040.ijcmph20250651>)
8. Telemedicine, Telehealth, and Health Information Technology, The American Telemedicine Association (https://cdn.who.int/media/docs/default-source/digital-health-documents/global-observatory-on-digital-health/usa_support_tele.pdf?sfvrsn=1c0a523b_3)
9. Machine Learning and AI for Healthcare, Arjun Panesar, ISBN-13 (pbk): 978-1-4842-3798-4 ISBN-13 (electronic): 978-1-4842-3799-1 <https://doi.org/10.1007/978-1-4842-3799-1>
10. Legal and Ethical Issues Associated With Challenges in the Implementation of the Electronic Medical Record System and Its Current Laws in India (DOI 10.7759/cureus.56518)
11. Helath information system, technological and management perspective (<https://library.oapen.org/bitstream/id/5f31db6d-5945-49ad-ac3a-78cb2037af5b/978-3-031-12310-8.pdf>)

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	-	-	2	1	2	-	1	-	2
CO2	2	2	-	1	2	1	-	-	-	-	2
CO3	2	3	1	1	3	-	-	-	-	-	2
CO4	2	3	2	1	2	2	-	-	-	-	2
CO5	2	2	1	-	3	-	-	-	-	-	2
CO6	1	2	-	-	2	3	2	-	2	-	3

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate ✓	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM65	Bioinformatics and Computational Biology	2	--	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
Theory		20	30	20	30	100			

Pre-requisite Course Codes	25MDM61, 62	
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain advanced molecular biotechnology techniques including genome editing and omics technologies.
	CO2	Retrieve and analyze biological sequence data using computational tools and databases
	CO3	Perform sequence alignment, phylogenetic analysis, and structural visualization using bioinformatics software.
	CO4	Apply statistical and machine learning techniques to biological datasets.
	CO5	Evaluate computational drug discovery workflows including molecular docking.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Fundamentals of Biotechnology	5	5
	1.1	Recombinant DNA technology (advanced cloning strategies), CRISPR-Cas systems and genome editing, Next Generation Sequencing (NGS) technologies		
	1.2	RNA-seq and transcriptomics, Metagenomics and microbiome analysis, Synthetic biology and gene circuit design		
2		Biological Databases & Data Mining	2	6
	2.1	Public biological databases: National Center for Biotechnology Information (NCBI), European Bioinformatics Institute, Sequence formats (FASTA, GenBank, PDB), Data retrieval using APIs		
	2.2	Biological data mining techniques, Introduction to Biopython / R-Bioconductor. Cloud computing in bioinformatics		
3		Computational Genomics & Sequence Analysis	3	5
	3.1	Pairwise and multiple sequence alignment algorithms: Needleman–Wunsch, Smith–Waterman		



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	3.2	BLAST algorithm concept, Hidden Markov Models (HMMs), Gene prediction algorithms, Phylogenetic tree construction (UPGMA, Neighbor-Joining), Comparative genomics		
4		Structural Bioinformatics & Molecular Modelling	1	5
	4.1	Protein structure levels and folding, Structure prediction methods, Homology modeling		
	4.2	Molecular docking principles, Molecular dynamics basics, Visualization tools (PyMOL/Chimera concept)		
5		AI & Machine Learning in Biotechnology	6	5
	5.1	Introduction to bio-data statistics, Feature extraction from biological sequences, Supervised & unsupervised learning, AI-driven drug discovery		
	5.2	Neural networks in genomics, Deep learning in protein structure prediction		
Total			26	

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Principles of Gene Manipulation and Genomics – Primrose & Twyman
2. Introduction to Bioinformatics – Arthur M. Lesk
3. Bioinformatics: Sequence and Genome Analysis – David W. Mount



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4. Molecular Biotechnology – Glick, Pasternak & Patten
5. Biotechnology: An Introduction – T.A. Brown
6. Essential Bioinformatics – Jin Xiong

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)												(PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3			2									
CO2		3			2									
CO3		3			2									
CO4		3			2									
CO5		3			2									

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply✓	Analyze	Evaluate	Create
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MULTIDISCIPLINARY MINOR (EMBEDDED WITH BASIC DEGREE)

Minor in Design: (Offered to ME, CE, CSE and ECS)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMDE1	Industrial and Product Design	2	-	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes		--
Course Outcomes	CO1	Use creative problem-solving skills and apply user-centric design thinking
	CO2	Select material, use ergonomics and apply sustainability in design
	CO3	Use industry-standard software and demonstrate skills in prototyping
	CO4	Integrate design with manufacturing processes and market needs

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Industrial & Product Design	1, 2	4
	1.1	Definition and scope of industrial design		
	1.2	Design thinking process & problem-solving strategies		
	1.3	Role of industrial designers in the industry		
	1.4	Case studies of successful product designs		
2		Design Methodology & User-Centered Design	1,2	4
	2.1	Understanding user needs and market research		
	2.2	Human factors & ergonomics in product design		
	2.3	Ideation techniques (Brainstorming, Sketching, Storyboarding)		
	2.4	Creating user personas and journey maps		
3		Materials and Manufacturing Processes	3,4	5
	3.1	Selection of materials: Polymers, Metals, Composites, and Smart Materials		
	3.2	Industrial manufacturing techniques (CNC, Injection Molding, 3D Printing)		
	3.3	Sustainable materials and eco-friendly design		
	3.4	Prototyping methods and rapid manufacturing		
4		Aesthetics & Form Development	5	4
	4.1	Visual elements of design (Shape, Color, Texture, Proportion)		
	4.2	Principles of form and function		
	4.3	Emotional and psychological aspects of design		
	4.4	Digital tools for form exploration (Sketching, CAD)		
5		CAD Modeling and Prototyping	5	4
	5.1	Introduction to CAD software (SolidWorks, Rhino, Fusion 360)		
	5.2	3D modeling and rendering techniques		
	5.3	Digital vs. physical prototyping		
6		Design for Manufacturing & Assembly	6	5
	6.1	Design considerations for large-scale manufacturing		



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	6.2	Cost estimation and design optimization		
	6.3	Material waste reduction and circular economy		
Total				26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. "The Design of Everyday Things" – Don Norman
2. "Product Design and Development" – Karl T. Ulrich, Steven D. Eppinger
3. "Industrial Design: Materials and Manufacturing Guide" – Jim Lesko
4. "Manufacturing Processes for Design Professionals" – Rob Thompson
5. "Universal Principles of Design" – William Lidwell, Kritina Holden, Jill Butler
6. "Ergonomics in Product Design" – Helander Martin

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMDE2	Communication Design	2	-	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
		Theory		20	30	Min	Max		100

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explain fundamental principles of visual communication
	CO2	Use modern tools for the given exercises for branding and digital storytelling
	CO3	Demonstrate creative skills in solving given exercises for branding, digital marketing, UI/UX design, and advertising
	CO4	Draw insights from case studies and industry applications related to communication design

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Fundamentals of Communication Design	1,2	4
	1.1	Definition and Scope of Communication Design Principles of Visual Communication		
	1.2	Semiotics and Symbolism in Design		
	1.3	Psychology of Perception and Color Theory		
	1.4	Industry Applications: Branding, Packaging Design		
2		Typography & Layout Design	1,2	4
	2.1	History and Evolution of Typography Typefaces, Fonts, and Legibility		
	2.2	Hierarchy and Composition in Design		
	2.3	Grid Systems and Layout Techniques		
	2.4	Industry Applications: Editorial Design, UI/UX Design		
3		Image, Motion, and Digital Media	3,4	5
	3.1	Role of Images in Communication Photography and Illustration in Branding		
	3.2	Introduction to Motion Graphics and Animation		
	3.3	Basics of Video Editing & Storyboarding		
	3.4	Industry Applications: Digital Advertising, Social Media Marketing		
4		Branding & Identity Design	3,4	4
	4.1	Elements of Branding (Logo, Color Palette, Typography)		
	4.2	Creating Brand Identity and Guidelines		
	4.3	Case Studies of Successful Branding Campaigns		
	4.4	Industry Applications: Corporate Identity, Advertising Agencies		
5		Interactive & Digital Communication	5,6	4
	5.1	Basics of UI/UX Design, User-Centered Design & Accessibility		
	5.2	Introduction to Web and Mobile App Interfaces		



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	5.3	Interactive Prototyping Tools (Adobe XD, Figma)		
	5.4	Industry Applications: Web Design, App Development, HCI		
6		Design Thinking, Portfolio Development & Industry Integration	5,6	5
	6.1	Design Thinking Methodology, Ideation, Wireframing, and Prototyping, Human-Centered Approach in Communication Design, Industry Applications: Product Design, User Experience Research		
	6.2	Building a Strong Communication Design Portfolio		
	6.3	Industry Trends and Emerging Technologies, Ethics & Sustainability in Communication Design		
			Total	26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. “The Elements of Graphic Design” – Alex W. White
2. “Thinking with Type” – Ellen Lupton
3. “Graphic Design: The New Basics” – Ellen Lupton & Jennifer Cole Phillips
4. “Making and Breaking the Grid” – Timothy Samara
5. “Don't Make Me Think” – Steve Krug (for UI/UX principles)
6. “Logo Design Love” – David Airey

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDMDE3	Graphic Design and Animation	2	-	--	2	2	--	--	2
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
	Theory	20	30	20	50	100			

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explain fundamental principles of graphics design and animation
	CO2	Demonstrate creativity in designing interfaces, digital illustrations and making animations
	CO3	Use tools for graphic design, modelling and animation
	CO4	Design immersive digital experiences for industries like advertising, film, gaming and UI/UX applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Fundamentals of Graphic Design	1,2	4
	1.1	Introduction to Graphic Design and Visual Communication Color Theory, Typography, Layout, and Branding		
	1.2	Introduction to AI-Assisted Design Tools (Adobe Firefly, DALL·E, MidJourney)		
	1.3	Ethics of AI in Design		
	1.4	Industry Applications: Branding, Advertising, AI-Generated Art		
2		Digital Illustration & AI-Driven Creativity	1,2	4
	2.1	Introduction to Vector-Based Design (Adobe Illustrator, CorelDRAW), Digital Painting & Concept Art,		
	2.2	Iconography and Symbolism in Design Character & Environment Design Basics, Creating Digital Illustrations for Web & Print		
	2.3	AI-Powered Image Generation and Enhancement Generative Design & AI-Driven Illustrations		
	2.4	Industry Applications: Logo Design, Infographics, Editorial Illustration, Digital Art, AI-Powered Marketing Content		
3		Motion Graphics & Animation Principles	3,4	5
	3.1	Basics of Motion Graphics and Visual Storytelling		
	3.2	Principles of Animation (Squash & Stretch, Timing, Anticipation)		
	3.3	Kinetic Typography & Animated Infographics Introduction to Adobe After Effects & Blender		
	3.4	Industry Applications: Digital Marketing, Explainer Videos, Advertisements		
4		2D Animation & Frame-by-Frame Techniques	3,4	



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	4.1	Storyboarding & Scripting for Animation 2D Character Animation Basics		4
	4.2	Cel Animation & Frame-by-Frame Animation Animation in Photoshop & Toon Boom Harmony		
	4.3	AI-Enhanced Motion Design (Runway ML, Deep Motion AI)		
	4.4	Industry Applications: Cartoon Animation, Advertising, Short Films		
5		3D Animation & Motion Design	5,8,9	4
	5.1	Introduction to 3D Animation Software (Blender, Autodesk Maya), Modeling, Texturing, and Lighting Basics Camera Movements & Rendering Techniques, Rigging & Character Animation		
	5.2	Introduction to AI-Driven 3D Content Creation Basics of Virtual Reality (VR) Animation & Asset Design Immersive Storytelling with VR & 360° Animation		
	5.3	AR-Based Interactive Graphics Creating Interactive AR for Mobile & Web		
	5.4	Industry Applications: Game Design, Virtual Reality (VR), Film & Entertain		
6		UI/UX & AI-Powered Interfaces	6,7	5
	6.1	Designing for Digital Interfaces (Web & Mobile) Motion UI & Micro-Interactions Interactive Animations in Web Design		
	6.2	AI in UX Design & Personalization Interactive Prototyping with AI (Uizard, Framer AI)		
	6.3	Industry Applications: Digital Products, Smart Interfaces, Conversational UX		
	6.4	Creating a Digital Portfolio & Showreel Ethics and Copyright in Design & Animation		
Total				26

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. “Graphic Design: The New Basics” – Ellen Lupton & Jennifer Cole Phillips
2. “The Animation Survival Kit” – Richard Williams
3. “Making and Breaking the Grid” – Timothy Samara
4. “Motion Graphics: Principles and Practices” – Angie Taylor
5. “The Art of 3D Computer Animation and Effects” – Isaac V. Kerlow



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6. “The Animation Survival Kit” – Richard Williams
7. “AI in Design: Creating with Artificial Intelligence” – Craig Rodger
8. “Understanding Augmented Reality” – Alan B. Craig
9. “Designing Immersive 3D Experiences” – Kim Pallister

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -
Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM74	Interactive Design	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE	MSE	ESE		Total		
		Theory	20	30	Min	Max	20	50	100

Pre-requisite Course Codes	25MDM74	
Course Outcomes	CO1	Explain principles of Human–Computer Interaction (HCI) and user-centered design.
	CO2	Understand user research methods to define user needs and design problems
	CO3	Interpret interactive interfaces using wireframing and prototyping tools
	CO4	Understand emerging interaction technologies such as AR/VR, IoT, and voice interfaces.
	CO5	Conduct usability testing and evaluate interactive systems using standard metrics
	CO6	Understand ethical, accessible, and inclusive design principles in interactive systems.

Module No.	Unit No.	Topics	Ref	Hrs.
1	1.1	Foundations of Interactive Design Introduction to Interactive Design, Evolution of Human–Computer Interaction, Interaction paradigms (CLI, GUI, Touch, Voice, Gesture). User-Centered Design (UCD) process. Principles of good design (visibility, feedback, constraints). Mental models and affordances (concepts by Don Norman).	1-2	4
2	2.1	User Research & Experience Design UX vs UI design, User research methods (interviews, surveys, contextual inquiry), Persona development.	1-2	2
	2.2	Experience Design Empathy mapping, Customer journey mapping, Information architecture basics, Case study: UX strategy used by Airbnb Inc.	1-2	2
3	3.1	Interface Design Principles of visual hierarchy, Layout systems and grid structures, Typography and color in UI. Wireframing (Low fidelity & High-fidelity)	1-2	3
	3.2	Prototyping Interactive prototyping, Design systems and style guides, Tools: Figma, Adobe XD, Case review: Interface patterns in Instagram	1-2	2



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4	4.1	Interaction Technologies Gesture-based interaction, Voice User Interfaces (VUI) – e.g., Amazon Alexa, AR/VR interaction systems (example: Apple Vision Pro), IoT-based interface design (Smart home systems), Multi-modal interaction design, Basics of AI-driven conversational interfaces	3-4	5
5	5.1	Usability Testing & Evaluation Usability principles and heuristics (Jakob Nielsen), Usability testing methods (moderated/unmoderated), A/B Testing, Quantitative vs qualitative evaluation, Accessibility standards (WCAG guidelines), Metrics: SUS (System Usability Scale), task completion rate	3-4	4
6	6.1	Ethical and Inclusive design Inclusive design & accessibility, Ethical UX & dark patterns, Data privacy in digital platforms (example: Facebook)	3-4	2
	6.2	Future Interaction Design Sustainable digital design, AI-based interfaces & generative interaction, Future trends in immersive interaction	3-4	2
Total				26

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Recommended Books:

1. Interaction Design: Beyond Human–Computer Interaction, Helen Sharp, Yvonne Rogers, Jenny Preece, Publisher: Wiley.
2. The Design of Everyday Things, Don Norman, Publisher: Basic Books.
3. About Face: The Essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin, Publisher: Wiley.
4. Don't Make Me Think, Steve Krug, Publisher: New Riders.
5. Designing Interfaces: Patterns for Effective Interaction Design, Jenifer Tidwell, Publisher: O'Reilly Media.



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6. Universal Principles of Design, William Lidwell, Kritina Holden, Jill Butler, Publisher: Rockport Publishers.

Suggested CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes* (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	-	3	-	-	2	-	-	-	-	-	-	-	-

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand✓	Apply	Analyze	Evaluate	Create
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25DM



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM75	Mobility and Vehicle Design	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
	Theory	20	30	20	50	100			

Pre-requisite Course Codes	25MDM75	
Course Outcomes	CO1	Understand various mobility systems, urban mobility challenges, and sustainable transportation concepts.
	CO2	Understand vehicle configurations, chassis types, and packaging principles.
	CO3	Interpret systematic vehicle design methodology from concept development to prototyping
	CO4	Compare conventional and electric powertrain systems and evaluate emerging mobility technologies.
	CO5	Explain fundamentals of vehicle dynamics, safety systems, and regulatory frameworks.
	CO6	Understand future trends including autonomous vehicles, smart mobility, and sustainable design practices

Module No.	Unit No.	Topics	Ref	Hrs.
1	1.1	Introduction to Mobility Systems Evolution of mobility: From conventional to smart mobility, Types of mobility systems: Personal, public, shared, and autonomous	1-2	2
	1.2	Sustainable and Intelligent Transportation Systems Urban vs rural mobility challenges, Sustainable mobility concepts, Introduction to Intelligent Transport Systems (ITS).	1-2	2
2	2.1	Fundamentals of Vehicle Architecture Vehicle classifications (2W, 3W, 4W, commercial vehicles), Vehicle layout configurations	1-2	2
	2.2	Chassis types Ladder frame, monocoque, space frame, Packaging and ergonomics basics, Weight distribution and centre of gravity.	2-3	2
3	3.1	Vehicle Design Process Stages of vehicle design: Concept to production, Market research and benchmarking, Styling and aesthetics in vehicle design.	2-3	3
	3.2	CAD/CAM CAD/CAE tools in vehicle design, Prototyping and validation methods.	2-3	2
4	4.1	Powertrain and Mobility Technologies	4	3



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		Conventional IC engine vehicles, Electric vehicles (BEV, HEV, PHEV), Hybrid vehicle architecture.		
	4.2	Battery systems Battery systems and energy management, Emerging technologies: Hydrogen fuel cell mobility	4	2
5	5.1	Vehicle Dynamics Basics of vehicle dynamics (longitudinal, lateral, vertical dynamics), Suspension and braking systems overview.	4	2
	5.2	Safety and Regulations Active and passive safety systems, Crashworthiness fundamentals, Emission norms and safety regulations	4	2
6	6.1	Future Trends in Mobility Autonomous vehicles and ADAS, Connected mobility and IoT in vehicles, Smart cities and integrated mobility	4	2
	6.2	Sustainable Design Lightweight materials and green manufacturing, Circular economy in vehicle design	4	2
Total			26	

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Suggested CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes* (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	-	-	-	2	-	-	-	-	-	-	-	-



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Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand✓	Apply	Analyze	Evaluate	Create
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Recommended Books:

1. Automotive Engineering: Powertrain, Chassis System and Vehicle Body, David Crolla, Publisher: Butterworth-Heinemann (Elsevier).
2. Fundamentals of Vehicle Dynamics, Thomas D. Gillespie, Publisher: SAE International
3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, Publisher: CRC Press
4. Hybrid Electric Vehicles: Principles and Applications, Chris Mi, M. Abul Masrur, David Wenzhong Gao, Publisher: Wiley.
5. Introduction to Modern Vehicle Design, Julian Happian-Smith, Publisher: Butterworth-Heinemann



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Double Minor Degree in 'Emerging Areas' (For Additional 18-20 credits)

Specialized Minor in VLSI Design and Verification

(Offered to Comp and CSE branches)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM11	VLSI Design Flow	2	2	-	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tut		50	--	--	--	50			

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explore evolution of VLSI and VLSI Design flow
	CO2	Explain MOSFET Characteristics and CMOS Technology
	CO3	Write Verilog code for Digital Circuits using Industry-Standard EDA tools
	CO4	Explore emerging trends in VLSI CAD

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to VLSI Technology	1, 2	4
	1.1	Evolution of VLSI, Moore's Law, current trends, applications, VLSI Design flow, EDA tools		
	1.2	VLSI design methodologies: Full-custom, Semi-custom, Standard-cell		
	1.3	India Semiconductor Industry and GoI policies		
2		MOS Transistor Theory	1	9
	2.1	MOSFET structure and operation, threshold voltage, Scaling		
	2.2	Concept of Inverter and types CMOS Inverter: DC characteristics, voltage transfer characteristics, CMOS NAND and NOR schematic		
	2.3	Noise margins, power dissipation in CMOS circuits		
3		Verilog HDL Basics	2	6
	3.1	Need of HDL, Types of HDL Concept of design module and testbench		
	3.2	Verilog Program Structure, Language constructs, Verilog datatypes, Operators etc.		
4		Design Modeling Styles and Emerging Trends	2	7
	4.1	Design Abstractions, Behavioral, Data flow, Gate level and Switch level modeling		
	4.1	Low-power VLSI design AI/ML-driven VLSI design automation		
Total				26



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Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial Assessment:

Simulation experiments using EDA Playground and MATLAB HDL Coder

Recommended Books:

1. Sung-Mo (Steve) Kang, Yusuf Leblebici, "*CMOS Digital Integrated Circuits Analysis & Design*", McGraw-Hill Education
2. Samir Palnitkar "*Verilog HDL: A Guide to Digital Design and Synthesis*", Pearson
3. J. Bhasker, "Verilog HDL Synthesis, A Practical Primer".
4. S. H. Gerez, "VLSI Physical Design Automation: Theory and Practice"
5. Michel D. Ciletti "*Advanced Digital Design with Verilog HDL*" ,2nd Ed., PHI, 2009
6. Douglas J. Smith, "Verilog Designer's Library"
7. Some useful websites: AMD Xilinx, EDA Playground and ASIC World
8. Online Resources: NPTEL course on CAD for VLSI-
<https://archive.nptel.ac.in/courses/106/106/106106088/>
<https://www.coursera.org/learn/vlsi-cad-logic>
<http://www.facweb.iitkgp.ac.in/~isg/CAD/>

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM12	FPGA Programming	2	2	-	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tut		50	--	--	--	50			

Pre-requisite Course Codes	--	
Course Outcomes	CO1	Explain FPGA and SoC AMD Architecture
	CO2	Write Verilog HDL code for the given FSM
	CO3	Apply logic synthesis, optimization techniques and perform timing analysis
	CO4	Develop Real-World FPGA Applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to FPGA Technology	1, 6	6
	1.1	Overview of FPGA design flow Comparison with ASIC, FPGA and SoC		
	1.2	FPGA architecture: 7-Series and UltraScale AMD FPGA		
	1.3	Introduction to Zynq and Zybo SoC		
	1.4	Applications of FPGA and SoC		
2		Verilog HDL for FSM	3-5	7
	2.1	Blocking vs. Non-blocking assignments, Latch inference and unintended issues, Timing constraints, setup & hold time, clock skew, Synthesis-friendly coding practices		
	2.2	Designing finite state machines (FSMs)		
3		Logic Synthesis, Optimization and Physical Design Automation	3-5	8
	3.1	Introduction to logic Synthesis, Logic synthesis of Verilog Construct, Examples of synthesis.		
	3.2	Design constraints: Area, Delay and Power, Optimization in synthesis. Post Synthesis verification		
	3.3	Physical Design Automation: Partitioning, Placement, and Floorplanning. Routing algorithms, Clock tree synthesis (CTS), Power planning and optimization		
4		Case Studies	1-2	
	4.1	Use of FPGA in real world applications for various sectors e.g. product design, healthcare, automotive, test and measurement etc.		5
Total				26



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Self-learning:

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2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial Assessment:

1. Experiment-1: FPGA Implementation of FSM (10 Marks)
2. Experiment-2: On contents of Chapter-3 (10 Marks)
3. Experiment-3: On contents of Chapter-3 (10 Marks)
4. Mini-Project (20 Marks)

Recommended Books:

1. Wayne Wolf, “*FPGA-Based System Design*” Prentice Hall
2. David Romano, “*Make: FPGA: Programming and Interfacing*”.
3. Samir Palnitkar “*Verilog HDL: A Guide to Digital Design and Synthesis*”, Pearson
4. J. Bhasker, “*Verilog HDL Synthesis, A Practical Primer*”.
5. Michel D. Ciletti “*Advanced Digital Design with Verilog HDL*”, 2nd Ed., PHI, 2009
6. Some useful websites: AMD Xilinx, EDA Playground and ASIC World

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM13	Verification using System Verilog	2	2	--	2	2	2	--	4
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
		Theory	20	30	20	50	100		
Tutorial	50	--	--	--	50				

Pre-requisite Course Codes	25DM11,12	
Course Outcomes	CO1	Develop a verification plan and create self-checking test cases for digital designs.
	CO2	Apply System Verilog data types, procedural constructs, and interfaces to build modular testbenches.
	CO3	Apply object-oriented programming and constrained randomization techniques for verification.
	CO4	Design and implement layered testbench architecture incorporating drivers, monitors, scoreboards, assertions, and functional coverage.
	CO5	Perform functional verification of digital designs using simulators and analyse coverage and assertion results.

Module No.	Unit No.	Topics	Ref.	Hrs
1. Programmable Devices and Verification Basics	1.1	Verification Basics: Introduction, Verification Process, Verification Plan, Verification Methodology options, Basic Testbench Functionality, Directed Testing, Constrained-Random Stimulus, Functional Coverage, Testbench Components, Layered Testbench, Technology challenges test, Verification IP reuse, Verification approaches.	[1], [2]	02
2. Data types, Procedural statements, Connecting the Test bench and Design	2.1	Data Types: Built-in Data Types, Logic Data type, Fixed-Size Arrays (Packed and Unpacked arrays), Dynamic Arrays, Queues, associative array, array methods – Reduction, Locator & ordering, Creating New Types with typedef, Creating User-Defined Structures, Enumerated Types, Constants, Strings, Expression width	[1], [2]	07
	2.2	Procedural statements: Procedural Statements, Tasks, Functions, and Void Functions, routine arguments, returning from a routine, Time values.	[1], [2]	



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	2.3	Connecting the Test bench and Design: Separating the testbench and design, The Interface construct, Grouping Signals in an Interface using Modports, Creating Interface Monitor, Stimulus timing with Clocking Block.	[1], [2]	
3 Basic Object - Oriented Pro- gramming	3.1	OOP: Class, Creating new objects, Where to Define a Class, OOP Terminology, Understanding Dynamic objects, Object Deallocation, using objects, Static vs Global 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	[1], [2]	04
4. Randomiza- tion and Inter- process Com- munication	4.1	Randomization: Randomization in system Verilog, Constraint details, Solution probabilities, Controlling multiple constraint blocks, Valid constraints, In-line constraints, The pre-randomize and post-randomize functions, Random number functions, Constraints tips and techniques.	[1], [2]	03
	4.2	Threads and Inter-process Communication: Working with threads, disabling threads, inter-process communication, Events, Semaphores, Mailboxes, building a testbench with threads and IPC.	[1], [2]	03
5. System Veri- log Assertions and Func- tional Cover- age	5.1	SystemVerilog Assertions: Types of Assertions and examples, Immediate Assertions, Concurrent Assertions, SVA Property and Sequences, Implication (Overlapped & Non-Overlapped) Operator and Repetition Operator, SystemVerilog Assertion built-in methods (\$rose, \$fell, \$stable, \$past)	[1], [2]	03
	5.2	Functional Coverage: Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example, anatomy of a cover group, triggering a cover group, data sampling, cross coverage, generic cover groups, Coverage Options, Parameterized Cover Groups, Analysing Coverage Data, Measuring Coverage Statistics During Simulation.	[1], [2]	04
Total				26



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Suggested Tutorials:

Tutorial No.	Title	Ref.
1	Write Verilog code for 4:1 MUX using all Verilog modeling styles and simulate the same.	1,2
2	Write Verilog code and testbench for D flip flop and 4 bit counter and simulate the same.	1,2
3	Create a test plan and self-checking test-bench for the ALU.	1,2
4	Create dynamic arrays, associative arrays, and queues using System Verilog.	1,2
5	Write test bench using dynamic arrays, associative arrays with System Verilog to test a synchronous 8-bit x64K (512kBit) RAM.	1,2
6	Create an Interface for a Memory Design. Use Modport to assign direction to signal.	1,2
7	Create class and its objects and perform deep copy and shallow copy.	1,2
8	Create an Interface for a Memory Design. (without modport)	1,2
9	To understand and create Virtual interface and use it in a class.	1,2
10	Given design specifications, draw waveform and write SVA expressions.	1,2
11	Given design specifications, draw waveform and write clock based Sequences	1,2
12	Create IPCs like events, mailbox and semaphores to interact between threads.	1,2
13	Find coverage by writing cover groups for a design.	1,2
14	Implementation of parallel processes using Fork Join/ join_any/ join_none statement.	1,2
15	Create a layered testbench for a simple design like Adder.	1,2

Recommended Books:

1. Chris Spear, "System Verilog for Verification: A guide to learning the testbench language features", Springer, 3rd Edition
2. Janick Bergeron, "Writing Testbenches Using SystemVerilog", Springer 2006.
3. Stuart Sutherland, Simon Davidmann, and Peter Flake, "System Verilog for Design: A guide to using system verilog for hardware design and modeling", Springer, 2nd Edition.
4. Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper, "SystemVerilog Assertions Handbook", Vhdl Cohen Publishing, 3rd edition
5. S Prakash Rashinkar, Peter Paterson and Leena Singh, "System on Chip Verification Methodologies and Techniques", Kluwer Academic, 1st Edition
6. System Verilog Language Reference manual
7. Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis" second edition, Pearson – IEEE 1364-2001 compliant
8. Spartan and Virtex family user manuals from Xilinx
9. Verilog Language Reference manual



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Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											(PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	2	–	–	–	–	–	–	1	–	–
CO2	2	2	1	2	–	–	–	–	–	–	1	–	–
CO3	3	2	2	3	–	–	–	–	–	–	1	–	–
CO4	3	2	2	3	–	–	–	–	–	–	1	–	–
CO5	3	2	3	3	–	–	–	–	–	–	1	–	–

Blooms Level

Remember	Understand	Apply✓	Analyse	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM14	AI and ML for VLSI	2	2	--	4	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
		Tut		50	--	--	--	50	

Pre-requisite Course Codes		25DM13
After the successful completion students should be able to:		
Course Outcomes	CO1	Understand fundamentals of AI/ML and their applications in VLSI design
	CO2	Apply machine learning algorithms for VLSI design optimization
	CO3	Implement deep learning techniques for chip design automation
	CO4	Analyze and optimize VLSI designs using AI-based tools
	CO5	Design AI-accelerator architectures for ML workloads
	CO6	Evaluate performance of AI/ML models in VLSI applications

Module No.	Unit No.	Topics	Ref.	Hrs.
1.		Introduction to AI/ML in VLSI	1,2	5
	1.1	Overview of AI and ML fundamentals, Applications of AI/ML in the VLSI design flow.		
	1.2	Machine learning basics: supervised, unsupervised, and reinforcement learning paradigms relevant to hardware design.		
2		ML for VLSI Design Optimization	1,3	5
	2.1	Design space exploration using Machine Learning. Optimization of Power, Performance, and Area (PPA).		
	2.2	Predictive models for estimating design metrics and identifying bottlenecks early in the design cycle.		
3		Deep Learning in EDA	2,4	6
	3.1	Neural networks for circuit design and modeling. Convolutional Neural Networks (CNN) for layout pattern recognition and DRC hotspot detection.		
	3.2	Generative Adversarial Networks (GAN) for synthetic design generation. Reinforcement learning applications for floorplanning.		
4		AI Accelerator Architectures		
	4.1	Introduction to hardware architectures for AI: TPUs, NPUs, and GP-GPUs. Systolic arrays and dataflow architectures.	3,5	5
	4.2	Memory hierarchy optimization for ML workloads. Techniques for Quantization, Pruning, and Model Compression.		



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		AI-driven Verification, Testing and Emerging Trends	1,5	5
5	5.1	AI for pre-silicon verification and post-silicon testing. ML-based fault detection and yield enhancement		
	5.2	Review of industry case studies (e.g., Google TPU, NVIDIA styles). Future trends in AI-driven chip design.		
Total				26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Module No.	Sr. No.	Suggested List of Tutorials	Ref.
1	1	Setup ML environment (TensorFlow/PyTorch) for VLSI	1,2
	2	Data preprocessing: Feature extraction from Netlists	
	3	Basic regression models for circuit parameter estimation	
2	4	Design Space Exploration using regression	1,3
	5	Power estimation using ML models	
	6	Predictive modeling for delay analysis	
3	7	CNN implementation for layout pattern recognition	2,3
	8	Reinforcement Learning for simple placement	
	9	DRC Hotspot detection using neural networks	
4	10	Quantization effects on model accuracy	3,5
	11	Memory bandwidth analysis for AI accelerators	
	12	Simulation of Systolic Array architecture	
5	13	ML-based fault detection simulation	1,5
	14	Yield prediction case study	
	15	Mini-Project: End-to-end ML-EDA flow	

Course Assessment: - (Tut)

- a. Lab Performance/Journal: Based on predefined rubrics carrying 10 Marks.
- b. Skill Test/Activity: Mini-project/Activity carrying 10 Marks.



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- a. Lab Performance/Journal: Based on predefined rubrics carrying 10 Marks.
- b. End Semester Lab Examination: Oral and/or Practical Examination carrying 20 Marks

Recommended Books:

1. B. Khailany et al., "Machine Learning in VLSI Computer-Aided Design", Springer.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning", MIT Press.
3. Vivienne Sze, "Efficient Processing of Deep Neural Networks", Morgan & Claypool Publishers.
4. H. Ren et al., "ML-EDA: Electronic Design Automation using Machine Learning", IEEE Press.
5. N. P. Jouppi et al., "In-Datacenter Performance Analysis of a Tensor Processing Unit", ISCA.

SUGGESTED CO - PO Articulation Matrix

Course Outcomes	Program Outcomes (POs)											(PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1		2	-	-	1	-	-	-	-	-	1	3	2
CO2		3	2	2	3	-	-	-	-	-	-	3	3
CO3		3	3	2	3	-	-	-	-	-	-	3	3
CO4		3	2	3	3	-	-	-	-	-	-	2	3
CO5		2	3	2	2	-	-	-	-	-	1	3	2

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Remember	Understand	Apply	Analyze	✓Evaluate	Create
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Double Minor Degree in 'Emerging Areas' (For Additional 18-20 credits)

Specialized Minor in Internet of Things

(Offered to CE, ME and CSE branches)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM21	Sensors and Actuators	2	2	-	2	2	2	--	4
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
		Theory	20	30	20	50	100		
Tut.	50	--	--	--	50				
Pre-requisite Course Codes		Electronic Devices, Analog Electronics, VLSI Design							
After the successful completion of the course, students should be able to:									
Course Outcomes		CO1	Understand the concept of sensors and actuators and their characteristics						
		CO2	Understand the practical approach in design of technology based on different sensors and actuators						
		CO3	Learn various sensor materials and technology used in designing sensors and actuators						
		CO4	Implement a prototype for demonstrating the application of the sensors						
		CO5	Demonstrate problem solving & troubleshooting skills in sensor and actuator applications						
Module No.	Unit No.	Topics						Ref.	Hrs.
1 Fundamentals Sensors and Actuators	1.1	Sensor Classification – Physicals, Mechanical, Electrical, Chemical, electrochemical						1,2	5
	1.2	Functional unit of sensor: receptor and transducer; Units of						1,2	
	1.3	Sensor and actuator Characteristics, Physical Principles of Sensing Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light						1,2	
2 Interface Electronic Circuits	2.1	Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits						1,2	5
	2.2	Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries						1,2	
	2.3	Analog and digital filtering						1,2	



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3 Sensors and actuators in Different Application	3.1	Area Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors	1,2,3	6
	3.2	Temperature Sensors; Biosensors, Gas sensors, proximity sensor. (Correlation of output with the parameter being measured in engineering terms): Only Working principle of each type of sensors and transduction action (for example: detection of change in temperature and conversion to electrical	1,2,3	
	3.3	Case study of Applications of sensors and actuators in automotive, manufacturing plants, digital devices such as	1,2,3	
		(name of various sensors and their usability in each of these		
4 Sensor and Actuators: Materials and Technologies	4.1	MEMS-cantilever based sensors and their types such as, accelerometer, gyroscopes: Structure, material	2,3	5
	4.2	Metal oxide semiconductor (nano-particles) based sensors such as gas sensors, biomedical sensors, chemical sensors (Structure, material used, working principle, applications)	2,3	
	4.3	MEMS-cantilever based sensors and their types such as, accelerometer, gyroscopes: Structure, material used working	2,3	
5 Smart Sensors Industrial standards for the sensors /actuator s and its	5.1	4-20 mA Current Loop, Types of smart Sensors, Limitations of single sensor and applicability of Array-based	2,4	5
	5.2	HART, Industrial buses such as Profibus, CAN bus, etc. ISA S82.01, NEMA standards, The International Electro-Technical Commission (IEC)	2,4	
	5.3	Different Standards, Calibration and compatibility. Knowledge of terms such as accuracy, full scale, hysteresis, resolution, gain error, offset error, SNR etc.	2,4	
			Total	26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

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MSE:

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Recommended Books:

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer
2. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi
3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).
4. Metal Oxide Nanostructures as Gas Sensing Devices (Series in Sensors Book 7), G. Eranna (Author), Publisher: CRC Press

Online Resources:

1. Website link: www.nptel.ac.in

Tutorial

1. Experiment no.1. Classification of different sensors (Analog / Digital)
2. Experiment no. 2. Actuators and drivers required
3. Experiment no.3. Design of KRC filters (Active 1st and 2nd order)
4. Experiment no.4. Design of 4-20mA Current loop.
5. Experiment no.3. Design of Instrumentation Amplifier for a given gain
6. Activity based on Standards and Calibration.

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Co urse	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM22	Fundamentals of IoT	2	2	-	2	2	2	-	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tut		50	--	--	--	50			

Pre-requisite Course Codes		
Course Outcomes	CO1	Explain the IoT architecture, protocols, and communication technologies. (<i>Understand</i>)
	CO2	Identify and interface sensors, actuators, and microcontrollers for IoT applications. (<i>Apply</i>)
	CO3	Develop IoT-based systems using ESP32/Raspberry Pi with cloud integration. (<i>Create</i>)
	CO4	Analyze IoT security challenges and propose suitable solutions. (<i>Analyze</i>)
	CO5	Design and test an end-to-end IoT project for a real-world application. (<i>Evaluate, Create</i>)

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Module 1: Introduction to IoT and Industry 4.0	1,2,5	4
	1.1	Concepts of IoT: Architecture, protocols, and standards..		
	1.2	IoT Communication Technologies (Wi-Fi, Bluetooth, Zigbee, LoRa, NB-IoT)		
	1.3	MQTT, CoAP, HTTP		
2		Module 2: Sensors, Actuators, and Microcontrollers (6 Hours)	1,2	6
	2.1	Types of Sensors (Temperature, Humidity, Pressure, Motion, etc.)		
	2.2	Actuators: DC Motors, Relays, Servo Motors		
	2.3	Microcontrollers: ESP32, Raspberry Pi, Arduino		
	2.4	Data Acquisition and Processing		
3		Module 3 IoT Protocols and Communication	1,2,5	6
	3.1	Introduction to MQTT, CoAP, HTTP, and WebSockets		
	3.2	Message Queue Telemetry Transport (MQTT) and Publish-Subscribe Model		
	3.3	Data Transmission using HTTP and REST APIs		
		Module 4: IoT Cloud Platforms ,Data Analytics Security ,Privacy in IoT	1,3,5	4
4	4.1	IoT Cloud Platforms: Thingspeak, Firebase, AWS IoT		



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		Data Analytics: Role of big data and machine learning in IoT. Visualization Tools: Grafana, Tableau, and Power BI.		
	4.2	IoT Data Lifecycle: Acquisition, transmission, storage, and visualization		
	4.3	IoT Databases: Time-series databases and NoSQL		
	4.4	IoT Security Challenges and Threats, Encryption Techniques: AES, RSA, TLS, Secure Authentication & Data Protection in IoT		
		Module5:IoT Applications, Future Trends and Emerging Technologies	4,5	6
5	5.1	Smart Manufacturing: Automation, predictive maintenance, and robotics.		
	5.2	IoT in Logistics and Supply Chain: RFID, smart tracking, and inventory management.		
	5.3	IoT in Renewable Energy: Smart grids, monitoring, and optimization		
	5.4	AI in IoT: Role of machine learning and deep learning. 5G and IoT: Opportunities and challenges. Edge AI: Combining IoT devices with AI at the edge. Sustainability in IoT: Energy-efficient frameworks and green IoT.		
	5.5	Smart Manufacturing: Automation, predictive maintenance, and robotics.		
			Total	26

Module No.	Sr.no	Suggested List of Tutorials	Ref.	Hrs.
1	1	Sending ESP32 Sensor Data to Thingspeak Visualization (Use Tinkercad Simulation Platform) <ul style="list-style-type: none"> • Upload temperature & humidity data to Thingspeak • View real-time plots on Thingspeak dashboard 		2
2	2	Setup and Configuration of an IoT Development Board Objective: Install and configure ESP32 or Raspberry Pi for IoT projects. Tools: Arduino IDE, Python.		2
3	3	Implement MQTT for Sensor Data Communication Objective: Transmit real-time sensor data to a cloud platform using MQTT. Tools: MQTT.fx, HiveMQ.		2
4	4	Compare IoT Protocols (CoAP vs. MQTT) Objective: Analyze energy consumption and latency differences between protocols. Tools: Python, Wireshark.		2
5	5	LoRa Communication Setup Objective: Establish communication between two LoRa nodes and measure range. Tools: LoRa modules, Arduino IDE.		2



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6	6	Interfacing Sensors and Actuators	2
		Objective: Interface temperature, humidity, and motion sensors with ESP32 to trigger an actuator. Tools: Arduino IDE, Blynk App.	
7	7	Build a Smart Home Automation System	4
		Objective: Control appliances using voice commands via Google Assistant. Tools: ESP32, Node-RED, Google API.	
8	8	IoT-Based Energy Monitoring	4
		Objective: Monitor and analyze household energy consumption in real-time. Tools: ESP32, Current Sensor, ThingSpeak.	
9	9	Integrating ESP32 with Google Firebase: Send & retrieve sensor data from Firebase Realtime Database Logging IoT Data to Google Sheets using ESP32 & IFTTT Automate data logging to Google Sheets via IFTTT IoT Data Visualization Using Grafana	4
		Objective: Collect sensor data and visualize it in Grafana dashboards. Tools: InfluxDB, Grafana.	
10	10	Real-Time IoT Data Analytics	2
		Objective: Perform basic analytics on IoT data (e.g., finding temperature trends). Tools: Python, Pandas, Matplotlib.	
Total			26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Arshdeep Bahga, Vijay Madisetti "Internet of Things: A Hands-On Approach"
Publisher: Orient Blackswan Private Limited - New Delhi
2. Peter Waher, "Mastering Internet of Things: Design and Create Your Own IoT"



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- Applications", Packt Publishing (March 28, 2018); eBook (Free Edition)
3. Perry Lea," "IoT and Edge Computing for Architects: Implementing Edge and IoT Systems from Sensors to Clouds with Azure IoT and AWS IoT Core", Publisher(s): Packt Publishing ISBN: 9781839214806
 4. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Publisher New York, NY : Apress
 5. David Hanes, Gonzalo Salgueiro, Rob Barton," IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" Released June 2017Publisher(s): Cisco Press ISBN: 978013430709

Online Resources:

6. <https://onlinelibrary.wiley.com/doi/book/10.1002/9781119740780?msocid=0d711fd0b87062382ca90a8bb9c26374>(Print ISBN:9781119740759 |Online ISBN:9781119740780 |DOI:10.1002/9781119740780)

Further Reading:

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things"
2. Klaus Schwab, "The Fourth Industrial Revolution"

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM23	Embedded Systems and RTOS	2	2	--	4	2	2	--	4
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
		Theory	20	30	20	50	100		
		Tutorial	50	--	--	--	50		

Pre-requisite Course Codes	25DM22	
After the successful completion of the course, students should be able to:		
Course Outcomes	CO1	Describe the architecture of a microcontroller and its programming for different applications.
	CO2	Identify the characteristics and hardware components for any given embedded system.
	CO3	Compare GPOS and RTOS, and apply RTOS concepts to develop multi-tasking embedded applications.
	CO4	Design Embedded system applications using different embedded cores based on system life-cycle requirements, considering ethical and environmental issues.

Module No.	Unit No.	Topics	Ref.	Hrs
1		Review of Microcontrollers		06
	1.1	Comparison of Microprocessors and Microcontrollers, Concept of Buses, Read/write operations, T-state, Machine cycle and Instruction cycle.	1,2	
	1.2	8051 Architecture, 8051 Memory organization, I/O ports, Timers, Serial port, Interrupts, Low power modes of 8051.	1,2	
	1.3	CISC and RISC Concepts, Harvard and Von Neumann Architectures, Overview of various available Microcontrollers.	1,2	
2		Embedded System Hardware		06
	2.1	Definition, Characteristics, Classification, Applications, Design metrics of Embedded systems and Challenges in optimization of metrics	3,6	
	2.2	Low power design: Need and techniques, Case study of Low Power modes in ARM Cortex-M3.	5,7	



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	2.3	Communication Interfaces: Wired- I2C, CAN, USB (v2.0), Wireless- Bluetooth, Zigbee [Frame formats of above protocols are not expected]	3,6	
3		Embedded Software		
	3.1	Real-time Operating system: Need of RTOS in Embedded system software, Comparison with GPOS, Concept of a Task, Task states, Multi-tasking, Interrupt Latency	3,4,8,9	10
	3.2	Task scheduling -Pre-emptive Shortest Job First (SJF), Round-Robin, Priority, Rate Monotonic Scheduling, Earliest Deadline First (EDF), Inter-Process communication: Message queues, Mailbox	3,4,8,9	
	3.3	Task synchronization: Need, Issues - Deadlock, Race condition, live Lock, Solutions using Mutex, Semaphores. Shared Data problem, Priority Inversion.	3,4,8,9	
	3.4	FreeRTOS Task Management features, Resource Management features, Task Synchronization features, Event Management features, Calculation of the CPU Utilization of an RTOS, Interrupt Management features, Time Management features.	4,10	
4	System Integration		04	
	4.1	Embedded Product Design Life-Cycle (EDLC)- Waterfall Model, Hardware-Software Co-design	3	
	4.2	Testing & Debugging: Hardware testing tools, Boundary scan /JTAG interface concepts, Emulator.	3	
	4.3	Software Testing tools, Simulator, Debugger. White-Box and Black-Box testing.	3	
			Total	26

	Suggested List of Practicals /Tutorials	Ref.
1.	Interfacing of LEDs /switches with any embedded core. (8051/ARM/STM32, etc)	1,2,7
2.	Interfacing of LCD/ Seven segment display with any embedded core. (8051/ARM/STM32,etc)	1,2,7
3.	Interfacing of a DC motor (speed and Direction control) with any embedded core. (8051/ARM/STM32,etc)	1,2,7
4.	Implement power management in any embedded core of your choice	1,2,4
5.	Implement the I2C communication to connect to DS1307 RTC	1,2,4
6.	Porting of FreeRTOS to Arduino/STM32.	2,10
7.	Write a Program to Create multiple Tasks and understand the Multitasking capabilities of RTOS (FreeRTOS).	2,10,4
8.	Write a Program to illustrate the Queue Management Features of Free	2,10



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	RTOS.	
9.	Write a Program to illustrate the Event Management Features of Free RTOS.	2,10
10.	Design a embedded system application and perform the testing and debugging	4

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Reference books:

1. M.A.Mazidi, J.C.Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, Second Edition, 2007.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, Third Edition, 2005.
3. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
4. Sriram Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company Ltd., 2003.
5. Joseph Yiu, "The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.
6. Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 Edition 3rd.
7. Andrew Sloss, Dominic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimizing System Software", Elsevier, 2004
8. Frank Vahid, Tony Givargis, "Embedded System Design – A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002.
9. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi, 2009.
10. www.freertos.org
11. <https://www.keil.com>
12. <https://www.arduino.cc>
13. Situnayake, D., & Plunkett, J. AI at the Edge: Solving Real-World Problems with Embedded Machine Learning O'Reilly Media.2023
14. Patterson, D. A., & Hennessy, J. L. Computer Organization and Design RISC-V Edition: The Hardware Software Interface (2nd ed.). Morgan Kaufmann.2021
15. Harris, S. L., & Harris, D. *Digital Design and Computer Architecture: RISC-V Edition*. Morgan Kaufmann.2022.
16. Harris, D., Stine, J., Harris, S., & Thompson, R. *RISC-V System-on-Chip Design* (1st ed.). Morgan Kaufmann. ISBN-13: 978-0323994989.2025
17. Kleidermacher, D., & Kleidermacher, M. *Embedded systems security: Practical methods for safe and secure software and systems development*. Elsevier/Morgan Kaufmann 2012.
18. Merli, D. *Engineering secure devices: A practical guide for embedded system architects and developers 2024*.



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Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial/Laboratory Assessment:

- a. Assessment should be conducted for the first four experiments based on predefined rubrics, with a total weightage of 20 marks
- b. Assessment should be conducted for the four experiments based on predefined rubrics, with a total weightage of 20 marks.
- c. Mini-project/Activity carrying-10 Marks

SUGGESTED CO - PO Articulation Matrix

Course Outcomes	Program Outcomes (POs)										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	-	2	3	-	-	-	-	1	1
CO2	3	3	2	1	-	-	-	-	-	1	1
CO3	2	2	3	1	3	-	-	-	1	1	1
CO4	2	2	2	2	3	1	1	1	2	1	1

Blooms Level

Remember✓	Understand✓	Apply ✓	Analyse ✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM24	System Design	2	2		4	2	2	-	4
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
		Theory	20	30	20	50	100		
Lab	50	--	--	--	50				

Pre-requisite Course Codes		25DM23
After the successful completion students should be able to:		
Course Outcomes	CO1	Formulate customer requirements into measurable system specifications.
	CO2	Design complete electronic system architecture including hardware and software blocks.
	CO3	Select appropriate electronic components and justify design decisions using datasheets.
	CO4	Develop RTOS-based firmware integrated with IoT communication
	CO5	Plan PCB layout, mechanical integration, and system-level testing.
	CO6	Validate and deploy a complete electronic product considering reliability and scalability

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Product Requirements & System Specification		
	1.1	Product lifecycle in electronic system design. Customer requirement capture, stakeholder analysis, Functional and Non-functional requirements.	1,2,3	2
	1.2	System specification: Power budget estimation, performance metrics, environmental constraints, regulatory considerations.	1,2,3	2
	1.3	Feasibility study, Risk analysis, Preliminary BOM estimation, Documentation standards.	1,2,3	2
		System Architecture & Component Selection		
2	2.1	System block diagram: Sensing unit, Processing unit, Power unit, Communication unit, Protection circuits.	1,2,3	2
	2.2	Component trade-offs: MCU selection (MCU fallback strategy, stock risks). (Flash, RAM, peripherals, RTOS compatibility), Sensor selection, Communication module selection (WiFi/LoRa/BLE) Architecture impact of switching communication (WiFi vs LoRa vs BLE), Migration planning (e.g., ESP32 to ESP32-S3 / RISC-V).	1,2,3	2
	2.3	Power design decisions: LDO vs Buck, Battery chemistry, Charging ICs. EMI/EMC basics and grounding strategy. Power budget estimation(- Power budget vs cost trade-offs.) , performance metrics, environmental constraints, regulatory considerations. - Battery fuel gauges and peak current	6,9	2



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		considerations.		
3		PCB & Mechanical Design		
	3.1	Schematic design, Footprint selection, PCB layout fundamentals, Trace width calculation, Ground plane design.	7	2
	3.2	Advanced PCB considerations: Signal integrity basics, DFM, DFT, Protection circuits (ESD, TVS).	7,12, 13	1
	3.3	2-layer vs 4-layer PCB decisions,DFM and enclosure impact on PCB layout,Thermal pads, screw boss design and IP rating basics.	7,12, 13	2
	3.4	Thermal derating and heat dissipation planning,Peak current and brownout debugging, EMI failures and grounding strategies.	7,12, 13	1
		RTOS & IoT Software Architecture		
4	4.1	RTOS task design: Task partitioning, Scheduling, Inter-task communication, Watchdog and fail-safe mechanisms. Memory fragmentation and RTOS stability issues	1,2, 14	2
	4.2	IoT communication design: MQTT/HTTP/CoAP selection, Topic design, Payload schema, QoS strategy.	8	2
	4.3	Secure communication, Device identity, OTA updates, Backend architecture overview, Data flow design. Fail-safe OTA with dual-bank firmware rollback.	8	1
	4.4	- Cloud cost awareness (AWS IoT cost implications).	15	1
5		Integration, Testing & Deployment		
	5.1	Hardware-software integration, Debugging strategies, Communication validation. Battery stress testing and hot/cold testing. Building testing jigs.	1,4	2
	5.2	System testing: Functional testing, Power testing, Environmental testing, Traceability matrix.	6,9	1
	5.3	Deployment planning: Pilot deployment, Version control, Maintenance strategy, Cost optimization for mass production.	11	1
	5.4	Certification in India (BIS, WPC, EPR, EMI/EMC).	6	1
		Total		26

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.



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MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

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Tutorial Assignments			
	Topics	Ref.	Hrs.
1	Requirement documentation and SRS drafting for selected product	1,3	3
2	Block diagram creation and component selection using datasheets	1,3	3
3	Power budget and BOM preparation	1,3	3
4	RTOS task implementation prototype	14	4
5	MQTT communication integration prototype	8	2
6	Integration testing and validation demo	11	4
Activities (Mini Project Based)			
A1	Product Requirement Document submission	-	1
A2	System Block Diagram & Component Selection Report	-	1
A3	RTOS-based firmware demo	-	1
A4	IoT Data Transmission demonstration	-	1
A5	Final Product Design Dossier Submission	-	1
A6	Product Requirement Document submission	-	1
A7	System Block Diagram & Component Selection Report	-	1
Total			26

Course Assessment: - (Lab)

ISE: Activity A1,A2,A3,A3,A4,A5,A7 to be assessed

Recommended Books:

- [1] S. V. S. Murthy, *8051 Microcontroller Fundamentals and Programming: Project Based Learning Approach*. New Delhi, India: McGraw Hill Education, 2022.
- [2] B. P. Douglass, *Real-Time UML Workshop for Embedded Systems*. Burlington, MA, USA: Elsevier/Newnes, Oct. 19, 2006.
- [3] H. Scott, *Designing Electronics That Work: Real-World Hardware Development*. Sebastopol, CA, USA: O'Reilly Media, 2025.
- [4] A. Huang, *The Hardware Hacking Handbook: Breaking Embedded Security with Hardware Attacks*. San Francisco, CA, USA: No Starch Press, 2023.
- [5] M. A. Mazidi, J. G. Mazidi, and R. D. McKinlay, *The 8051 Microcontroller and Embedded Systems: Using Assembly and C*, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2006.
- [6] H. W. Ott, "Electromagnetic Compatibility Engineering". Hoboken, NJ, USA: John Wiley & Sons", 2009.
- [7] R. Hu, "PCB Design and Layout Fundamentals for EMC"5. Independently Published, Jul. 22, 2019, ISBN: 978-1082079252.
- [8] S. Dutt, A. Ray, and S. S. Sarma, *Industry 4.0: Industrial Internet of Things (IIoT), Additive Manufacturing, Robotics, Cloud Computing and Digital Twin, Supported by Extended Reality and Transformation of Lean and Agile into Lean 4.0 and Agile 4.0*. New Delhi, India: BPB Publications, 2025.



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[9] E. Bogatin, *Signal and Power Integrity – Simplified*, 3rd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2018.

[10] Y. Sato and J. J. Kaufman, *Value Analysis Tear-Down: A New Process for Product Development and Innovation*. New York, NY, USA: Industrial Press Inc., 2005.

[11] S. G. Blank and B. Dorf, *The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company*. Pescadero, CA, USA: K&S Ranch Press, 2012. [12] High Speed PCB Design Guide :<https://s3vi.ndc.nasa.gov/ssri-kb/static/resources/High-Speed%20PCB%20Design%20Guide.pdf>

[13] Secrets of High speed PCB <https://s3-us-west-2.amazonaws.com/pcb007/books/secrets1/TPCDG2secrets-1.pdf>

[14] J. J. Labrosse, *MicroC/OS-II: The Real-Time Kernel*, 2nd ed. Boca Raton, FL, USA: CRC Press, 2002.

[15] Q. Luo and E. R. Sanchez, *Cloud Cost Optimization Handbook for AWS: Collection of Ideas and Best Practices for Saving on Cost in AWS*. Birmingham, UK: Packt Publishing, 2023.

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											(PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	2	1	–	2	–	1	2	1	2		
CO2	3	3	3	2	2	2	–	2	2	2	2	2	1
CO3	3	2	3	1	3	2	–	1	1	3	2		
CO4	2	2	3	2	3	2	–	2	2	2	2	2	1
CO5	2	2	3	3	3	2	–	2	2	2	2		
CO6	2	2	3	2	2	3	2	2	3	3	3	2	2

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply	Analyze	Evaluate	Create
		✓			✓



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Double Minor Degree in 'Emerging Areas' (For Additional 18-20 credits)

Specialized Minor in Automation and Robotics

(Offered to CE, ECS and CSE branches)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM31	Introduction to CAD/CAM	2	2	-	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tutorial		50	--	--	--	50			

Pre-requisite Course Codes	Basics of Mathematics.	
Course Outcomes	CO1	Use of computer graphics in design.
	CO2	Understand Fundamental Concepts geometric transformation.
	CO3	Apply parametric equations for curve and surface generation.
	CO4	Understand the fundamental principles, components, and working of CNC machines.
	CO5	Apply the appropriate code for performing particular tasks in a CNC.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to CAD: Need and Utility of CAD systems in industry, Fundamentals of computer graphics, Types of Geometric Modelling, Raster Graphics: line and circle algorithm.	1-8	6
		Geometric Transformation: Homogenous Transformation (2D Translation, scaling, Reflection, Rotation)		
2	2.1	Window Viewport and Clipping.	1-8	6
	2.2			
3	3.1	Curves And Surfaces: Cubic spines Bezier curves & B- spines (No Numerical).	1-8	4
	3.2	CAD Application software's, Product data exchanges formats (STEP, IGES)		



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4	4.1	CNC Machines: Fundamental elements of CNC, Benefits of CNC, Computer control concepts, Data processing units. Basics of control systems: Motion controller, Interpolation-Linear & Circular, Positioning & contouring control loops, Incremental & Absolute system, DNC & CNC systems and Adaptive control system. CNC Hardware Basics:	1-8	4
5	5.1	CNC Programming and simulation: G & M code, Tool length, nose radius & Diameter compensation, Canned cycles, Turning & Machining centre programming. CAM simulation software.	1-8	6
Total				26

Tutorial:

Sr. No.	Tutorial Details	Hours
1	Line DDA algorithm numerical.	01
2	Bresenham's Line Algorithm.	01
3	Circle Algorithm.	01
4	2 D transformation using translation and Rotation matrix.	01
5	Compound 2 D transformation.	01
6	Bezier Curve.	01
7	Turning Centre (Sinumerik) Programming.	01
8	Machining Centre (Fanuc) Programming.	01
Total Hours		08

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.



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Tutorial:

1. ISE

First Four tutorials (20 marks) Continuous pre-defined rubrics-based evaluation for 20 marks. Next four tutorials (30 marks) Continuous pre-defined rubrics-based evaluation for 30 marks

Recommended Books:

1. CAD/CAM by Groover and Zimmers
2. CAD Principles and Applications by Barr, Krimger and Lazaer
3. William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, Mc Graw Hill Book Co. Singapore, 1989.
4. Donald Hearn and M. Pauline Baker “Computer Graphics”, Prentice Hall, Inc., 1992.
5. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.
6. CAD / CAM by P.N. Rao (Tata-Mcgraw- Hill) 2
7. Computer Graphics by Hearn and Baker (PHI)
8. Mastering CAD – CAM by Ibarahim Zeid (Tata-Mcgraw-Hill) 4

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/112/102/112102101/>
2. <https://nptel.ac.in/courses/106/102/106102065/>
3. <https://nptel.ac.in/courses/106/102/106102065/>
4. <https://nptel.ac.in/courses/112/102/112102103/>
5. <https://nptel.ac.in/courses/112/105/112105211/>
6. <https://nptel.ac.in/courses/112/104/112104265/>
7. <https://www.youtube.com/watch?v=2cCMty9v3Tg>
8. <https://www.youtube.com/watch?v=2zPh26Q1BT8>

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM32	3D Printing	2	2	-	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ISE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tutorial		50	--	--	--	50			

Pre-requisite Course Codes	Basic Engineering Drawing & Design.	
Course Outcomes	CO1	Illustrate understanding of various cost-effective alternatives for manufacturing products and select the feasible 3D Printing for specific technical application
	CO2	Understand and apply the principles of liquid-based rapid prototyping and tooling processes to build and generate data for
	CO3	Understand and apply the principles of solid-based rapid prototyping systems for efficient 3D printing and product development.
	CO4	Understand and apply the principles of powder-based additive manufacturing systems for efficient prototyping and production of complex geometries.
	CO5	Understand and apply reverse engineering techniques in 3D printing to reconstruct, modify, and optimize existing designs for manufacturing and prototyping.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to 3D printing, its historical development, advantages. Classification of 3D printing process, Advantages & Disadvantages, Applications to various fields, Rapid Tooling, Design Consideration.	1-8	6
2	2.1	Liquid-Based Systems: Stereolithography (SLA): Photopolymerization process, Working Principle, Advantages and limitation, Application	1-8	6
	2.2	Solid ground curing: Working Principle, Advantages and limitation, Application.		
3	3.1	Solid Based Rapid Prototyping Systems: LOM (Laminated Object Manufacturing) System: Working Principle, Advantages and limitation, Application.	1-8	4
	3.2	FDM (Fused Deposition Modelling) System: Working Principle, Advantages and limitation, Application.		
	4.1	Powder Based Systems:		



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4		SLS (Selective Laser Sintering): Working Principle, Advantages and limitation, Application.	1-8	6
	4.2	(3DP) Three-Dimensional Printing: Working Principle, Advantages and limitation, Application.		
	4.3	(EBM) Electron Beam Melting: Working Principle, Advantages and limitation, Application.		
5	5.1	Reverse Engineering: Data Extraction, Data Processing. Applications and Case Studies: Engineering Applications, Medical Applications.	1-8	4
Total				26

Tutorial:

Sr. No.	Tutorial Details	Hours
1	Preprocessing of 3d Print Component.	01
2	3D Printing of Component.	01
3	Case study on SLA.	01
4	Case study on LOM.	01
5	Case study on FDM.	01
6	Case study on SLS.	01
7	Case study on 3DP.	01
8	Case study on EBM.	01
Total Hours		08

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

- First Four tutorials (20 marks)
- Continuous pre-defined rubrics-based evaluation for 20 marks
- Next four tutorials (30 marks)
- Continuous pre-defined rubrics-based evaluation for 30 marks



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Recommended Books:

1. Chua C.K., Leong K.F., and Lim C.S., “Rapid Prototyping Principles and Applications”,
World Publishing Co. Pte. Ltd.
3. Gibson, D.W. Rosen, and B. Stucker, “Additive Manufacturing Technologies Rapid
Prototyping to Direct Digital Manufacturing”, 2010, Springer Inc.
5. Ali Kamrani, EmadAbouel Nasr, “Rapid Prototyping Theory and Practice”, 2006, Springer
6. RafiqNoorani, Rapid Prototyping: Principles and Applications, John Wiley & Sons, Inc.,
2006, ISBN 0-471-73001-7
7. James O. Hamblen, and Michael D. Furman, “Rapid Prototyping of Digital Systems”,
Kluwer
Academic Publishers.
8. Kenneth G. Cooper, “Rapid Prototyping Technology Selection and Application”, 2001,
Marcel Dekker Inc, New York.

**Links for online NPTEL/SWAYAM
courses:**

1. https://onlinecourses.nptel.ac.in/noc24_me138/preview
2. https://onlinecourses.nptel.ac.in/noc22_me74/preview
3. https://onlinecourses.nptel.ac.in/noc22_me130/preview
4. https://onlinecourses.nptel.ac.in/noc25_mm02/preview

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -
Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs. / Week)				Credit Assigned			
		L	T	P	SL	L	T	P	Total
25DM33	Mechatronics	2	2	-	4	2	2	--	4
		ISE		MSE	ESE		Total		
					Min	Max			
		Theory		20	30	20	50	100	
		Tutorial		50	--	--	--	50	

Pre-requisite Course Code	25DM32		
25DM33	CO1: Understand fundamental concepts of mechatronics design and system integration		
	CO2: Explain Architecture and Working Principles of Microcontrollers		
	CO3: Understand the application of sensors in mechatronics		
	CO4: Understand the working of several types of actuators		
	CO5: Understand the principles of Data Acquisition		
	CO6: Explain the working of control system of a mechatronic system		
Module No.	Topics	Ref.	Hrs.
1	Introduction to mechatronics: Historical Perspective, Key Elements of a Mechatronic system, Role in automation, robotics, manufacturing, Comparison with traditional engineering disciplines Examples of Mechatronic System.	1	4
2	Microcontrollers and Micro-computers: Microprocessors and Microcomputers, Microcontroller architecture (Arduino, AVR, ARM), PIC16F84 Microcontroller, programming a PIC, Interfacing common PIC peripherals, Digital I/O, timers, interrupts, Communication protocols (UART, SPI, I2C).	1,2	4
3	Sensors: Position and Speed Measurement, Stress and Strain Measurement, Temperature Measurement, Vibration and Acceleration Measurement, Pressure and Flow Measurement	1,2	5
4	Actuators: Solenoids and Relays, Electric Motors - DC Motors, Stepper Motors. Selecting a Motor, Hydraulic and Pneumatic Actuators.	1,2	4
5	Data Acquisition: Introduction, Sampling and Aliasing, Quantization Theory, Digital-to-analog conversion hardware, Analog-to-digital conversion hardware, Working of any USB Data Acquisition Card	1,2	4
6	Control System in Mechatronics: Elements of a control system, Classifications of Control system, Feedback & open/closed loop systems, PID control fundamentals, Case Study: Controlled Robotic Arm	3	5
TOTAL			26



Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

ISE: Assignments for the all 6 Modules

Recommended Books:

D. G. Alciatore, M. B. Histan, “Introduction to Mechatronics and Measurement Systems”, 4th Edition, McGraw-Hill, 2012

1. G. Onwubolu, “Mechtronics Principles and Applications”, Elsevier, 2005
2. R.K. Mittal, “Robotics and Control”, Tata McGraw Hill, 2013

Suggested CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes* (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	1	-	-	-	-	-	-	2	-	-
CO2	3	2	2	-	3	-	-	-	-	-	-	3	2	-
CO3	3	3	2	-	2	-	-	-	-	-	-	3	-	-
CO4	3	2	3	-	2	-	-	-	-	-	-	3	2	-
CO5	3	3	2	2	3	-	-	-	-	-	-	3	2	-
CO6	3	3	3	2	2	-	-	-	1	1	-	3	2	-

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand✓	Apply✓	Analyze✓	Evaluate✓	Create
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Course Code	Course Name	Teaching Scheme (Hrs. / Week)				Credit Assigned			
		L	T	P	S L	L	T	P	Total
25DM34	Industrial Robotics and Automation	2	2	--	4	2	2	--	4
		ISE		MSE	ESE		Total		
					Min	Max			
		Theory	20	30	20	50	100		
		Tutorial	50	--	--	--	50		

Pre-requisite Course Code	25DM32,33
25DM34	CO1: Illustrate the basic concept of Industrial automation in different manufacturing set-ups.
	CO2: Design and Develop Pneumatic Circuits
	CO3: Design and Develop Electro-Pneumatic Circuits
	CO4: Understand basic anatomy of a robot system
	CO5: Understanding Robot Direct and Inverse Kinematics
	CO6: Demonstrate an understanding of robot Trajectory planning

Module No.	Topics	Ref.	Hrs.
1	Definitions: Automation, Robotics, Brief History & Evolution of Automation and Robotics, Automation Applications, Basic elements of an automated system; Advanced automation functions; Levels of automation; Types of automation; Benefits and Impact of Automation in Manufacturing and Process Industries. Architecture of Industrial Automation Systems.	1	4
2	Pneumatic control systems: Overview of different types of valves and Actuators in Pneumatics, their applications and their ISO symbols. Working of DCV, Flow control Valves, time delay Valve, Pressure Sequence Valve and Pneumatic Counter. Design of Pneumatic circuits of single cylinder.	2	5
3	Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves of single cylinder Design of Pneumatic circuits using PLC Control of single cylinder	3	5
4	Robotics: Brief History & Evolution of Robotics, Classification of Robots: By motion, application, control system, degrees of freedom (DOF) Applications: Industrial, Service, Medical, Space, Military, Robots and its Peripherals- > End Effectors and Tools	5,6	4
5	Robot Kinematics: Coordinate systems & transformations, Homogeneous transformation matrix, Forward Kinematics: Denavit-Hartenberg (DH) method, Introduction to Inverse Kinematics	5,6	4
6	Trajectory Planning: Definitions, Steps in Trajectory Planning, Joint space Techniques vs Cartesian Space techniques, Use of p Degree Polynomial as Interpolation function, Cubic Polynomial Trajectories.	5,6	4
TOTAL			26



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Self-Learning

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Suggested CO - PO articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	1	-	-	-	-	-	-	2	-	-
CO2	2	3	3	1	2	-	-	-	-	-	-	3	-	-
CO3	2	3	3	2	2	-	-	-	-	-	-	3	-	-
CO4	3	2	1	-	1	-	-	-	-	-	-	2	-	-
CO5	3	3	2	2	2	-	-	-	-	-	-	2	-	-
CO6	2	3	3	2	2	-	-	-	-	-	-	3	-	-

Blooms level

Remember✓	Understand✓	Apply✓	Analyze✓	Evaluate✓	Create
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Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

ISE: Assignments from 6 Modules

Recommended Books:

1. Groover, M.P. "Automation, Production Systems, and Computer-Integrated Manufacturing", 4th Edition, Pearson, 2015.
2. Festo Didactic, "Fundamentals of Pneumatics", Festo Training Manual.
3. Festo Didactic, "Electro-Pneumatics Basic Level", Festo Training Manual.
4. Joji P., "Pneumatic Controls", Wiley, 2008
5. R.K. Mittal, I.J. Nagrath, "Robotics and Control", 22nd Edition, Tata McGraw-Hill,
6. Industrial Robotics, Technology, Programming & Applications, Grover, Weiss, Nagel, Rodey, McGraw Hill.
7. Robotics: Control, Sensing, Vision & Intelligence, Fu, Gonzalez, Lee, McGraw Hill.



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Double Minor Degree in 'Emerging Areas' (For Additional 18-20 credits)

Specialized Minor in Sustainability

(Offered to all branches)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM41	Design Thinking for Sustainability	2	2	-	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tut		50	--	--	--	50			

This course explores how Design Thinking methodologies can drive sustainable innovation across various

sectors. By integrating human-centered design, systems thinking, and circular economy principles, students will learn to develop solutions that address environmental, social, and economic challenges while fostering long-term sustainability.

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explain the principles of Design Thinking and their application to sustainable innovation
	CO2	Apply problem-solving techniques to address sustainability challenges
	CO3	Apply systems thinking and circular economy principles to sustainable product and service design
	CO4	Develop prototypes and iterative solutions to sustainability challenges.
	CO5	Use collaborative, interdisciplinary approaches to problem-solving

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Ancient Indian Sustainable Practices in Engineering and Management Overview of insights into sustainable solutions in construction, energy, materials, water management, transportation, and financial management	1	2
	1.2	Introduction to Design Thinking for Sustainability Overview of Design Thinking principles (Empathize, Define, Ideate, Prototype, Test). Fundamentals of sustainability in design. Importance of sustainability in innovation and problem-solving. Case studies of successful sustainable design projects. UN SDGs and their role in design.	2-3	3
2	2.1	Human-Centered & Systems Thinking for Sustainability Understanding user needs and behavior for sustainable solutions. Empathy in sustainable design – Ethical considerations and inclusivity. Systems thinking approach – How different systems interact in sustainable development. Tools for mapping stakeholder impact and environmental consequences.	2-3	3



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	2.2	Problem Framing & Identifying Sustainability Challenges Defining real-world sustainability challenges. Conducting sustainability-focused design research.	2-3	5
		Life Cycle Thinking (LCT) – Cradle-to-cradle design and environmental impact analysis. Problem framing techniques – How to ask the right sustainability questions. Integrating biodiversity into design – Living walls, urban forests, pollinator-friendly spaces Passive design strategies– Natural ventilation, daylighting, thermal mass. Green buildings and materials– LEED, BREEAM, IGBC certification. Net-zero and energy-efficient buildings – Smart homes, solar panels, green roofs. Sustainable urban planning– Smart cities, transit-oriented development, walkable communities.		
3	3.1	Ideation for Sustainable Innovation Brainstorming for green solutions– Ideation techniques for sustainability. Biomimicry in sustainable design– Learning from nature’s solutions. Regenerative and resilient design principles. Case studies – Sharkskin-inspired materials, termite-inspired ventilation, lotus-effect coatings.	4	4
	3.2	Prototyping & Testing for Sustainability Creating low-impact prototypes using sustainable materials. Digital prototyping and simulation tools for eco-friendly design. Evaluating sustainability impact and feasibility in prototypes. Rapid testing and iteration for scalable, sustainable solutions.	2-4	3
4	4.1	Circular Economy & Sustainable Business Models Principles of the circular economy and zero-waste design. Business models for sustainability– Social enterprises, green start- ups, and impact investing. Sustainable product-service systems (PSS)	5	2
	4.2	Sustainable Innovation in Different Sectors Sustainable architecture & urban planning – Green buildings, smart cities. Eco-friendly product design – Sustainable packaging, furniture, and technology. Sustainable fashion and textiles – Ethical sourcing, upcycling, slow fashion. Green transportation and mobility solutions – EVs, bike-sharing, public transport innovations.	2-5	2



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4.3	Digital Technologies & Sustainability		2
	Sustainable UX/UI design – Reducing digital carbon footprint. AI and IoT in smart sustainability solutions. Blockchain for supply chain transparency and sustainability tracking. 3D printing and additive manufacturing for zero-waste production.		
Total			26

Recommended Books:

1. B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R. N., “*Introduction to Indian Knowledge System: Concepts and Applications*” PHI, 2022
2. Idris Mootee *Design Thinking for Strategic Innovation*
3. William McDonough & Michael Braungart *Cradle to Cradle: Remaking the Way We Make Things*
4. Janine Benyus *Biomimicry: Innovation Inspired by Nature*
5. Peter Lacy, Jessica Long, Wesley Spindler *The Circular Economy Handbook*
6. IDEO’s *Design Thinking Toolkit for Sustainability*

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial Assessment:

Activity-1: Complex Problem Solving using Design Thinking principles **(20 Marks)**

Activity-2: Create a campaign to promote sustainability **30 Marks**

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM42	Green Computing	2	2	-	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tut		50	--	--	--	50			

Green computing focuses on environmentally sustainable computing practices. This course covers energy-efficient hardware, software, and system designs, as well as strategies for reducing IT's environmental footprint.

Pre-requisite Course Codes		--
Course Outcomes	CO1	Explain the fundamentals of green computing and sustainability
	CO2	Explain energy-efficient computing technologies
	CO3	Explore designs and energy management techniques for green data center and sustainable materials in Electronics
	CO4	Explain strategies for development of green hardware and software
	CO5	Explain policies, standards and regulations for sustainability
	CO6	Identify future trends in green computing

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to Green Computing Definition and scope of green computing Environmental impact of computing and IT systems The need for sustainable computing practices Life cycle assessment of computing devices	1,2	3
	1.2	Energy-Efficient Computing Energy consumption in computing devices Power management techniques in hardware and software Energy-efficient processors and architectures Low-power computing techniques (e.g., Dynamic Voltage and Frequency Scaling - DVFS) Virtualization and cloud computing for energy optimization	1,2	3
2	2.1	Green Data Centers and Cloud Computing Energy-efficient data center architectures Energy-efficient cooling and thermal management Renewable energy integration in data centers Sustainable cloud computing practices	1,2	3



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	2.2	Sustainable Materials in Electronics Environmental impact of traditional materials in electronics Biodegradable and recyclable materials for hardware components Alternative materials to reduce toxic waste (e.g., lead-free soldering, bio-plastics) Sustainable circuit board manufacturing (e.g., bio-resin PCBs)	1,2	4
		E-waste management and recycling Reducing E-Waste Through Material Innovation		
3	3.1	Sustainable Hardware Design and manufacturing of eco-friendly hardware Upgradeability and modular design Energy-efficient storage and networking devices Recycling and refurbishing computing devices Green supply chain and procurement strategies	1,2	4
	3.2	Green Software Development Energy-efficient programming techniques Optimized algorithms for power-aware computing Power-aware computing in mobile and embedded systems	1,2	3
4	4.1	Policies, Regulations, and Industry Standards Global sustainability standards (e.g., Energy Star, EPEAT, ISO 14001) WEEE (Waste Electrical and Electronic Equipment) directive Government regulations on IT sustainability Corporate sustainability initiatives Green IT frameworks and assessment tools	1,2	3
	4.2	Future Trends and Research in Green Computing AI and machine learning for energy-efficient computing Blockchain and green IT solutions IoT and smart grids for sustainable computing Future of green technology	3,4,5	3
			Total	26

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus



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(20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial Assessment:

Activity-1: Case Study (20 Marks) on one of following topic (not limited to)-

1. Sustainable data centers
2. Sustainable software solutions
3. Best practices from major IT manufacturers
4. Companies adopting sustainable materials (e.g., Dell, HP)
5. Energy-efficient hardware initiatives from companies (e.g., Apple, Google, Microsoft)
6. Innovations in reducing toxic waste in electronics
7. Success stories in reducing hardware-related carbon footprints

Activity-2: Green Digital Certificate:30 Marks

Complete Online Certificate Course (and submit certificate) from INCO Academy: This Self- paced online Free Course equips learners with the knowledge and skills to build sustainable digital solutions.

(<https://greendigitalcertificate.inco-group.co/course>)

Recommended Books:

1. Bud E. Smith *Green Computing: Tools and Techniques for Saving Energy, Money, and Resources*, 1st Edition, CRC Press
2. Toby J. Velte, Anthony T. Velte, Robert Elsenpeter *Green IT: Reduce Your Information System's Environmental Impact While Adding to the Bottom Line*, 1st Edition, McGraw Hill Osborne Media
3. Wu-chun Feng *Green Computing Book*, 1st Edition, CRC Press
4. Sourav Banerjee, Chinmay Chakraborty, Kousik Dasgupta *Green Computing and Predictive Analytics for Healthcare*, 1st Edition, Chapman & Hall
5. Stephen Peake *Renewable Energy: Power for a Sustainable Future*, Oxford University Press, 3rd Edition
6. Research papers and case studies from IEEE, ACM, and sustainability journals



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM43	Emerging Technologies for Sustainability	2	2	--	4	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	30	100	
Tutorial		20	--	30	--	50			

Pre-requisite Course Codes **25DM41, 25DM42**

After the successful completion students should be able to:

Course Outcomes	CO1	Explain the principles and applications of emerging sustainability technologies in engineering systems.
	CO2	Explain renewable energy and smart energy technologies for sustainable development.
	CO3	Describe digital and smart manufacturing technologies used in sustainability applications.
	CO4	Explain sustainable transportation technologies and intelligent mobility systems.
	CO5	Explain emerging materials and resource-efficient technologies for sustainability.
	CO6	Identify modern technologies and future trends in sustainable engineering.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Technology-Driven Sustainability: Foundations and Innovation Pathways			
	1.1	Introduction to Emerging Sustainability Technologies: Overview of emerging sustainability technologies. Technology-driven resource efficiency. Technology solutions in energy, transportation, and manufacturing.	1,2	2
	1.2	Technology Innovation for Sustainability: Technology innovation trends. Modern engineering solutions for sustainability. Case studies of sustainability technologies.	1,3	2
2	Renewable Energy Systems and Smart Energy Infrastructure			
	2.1	Renewable Energy Technologies: Solar energy systems. Wind energy systems. Bioenergy technologies. Hybrid renewable energy systems.	2,4	3
	2.2	Energy Storage and Smart Energy Systems: Battery technologies. Hydrogen energy and fuel cells. Smart grids and energy management systems. Energy monitoring technologies.	2,4	2
3	Digitalization and Smart Manufacturing for Sustainable Systems			
	3.1	Digital Technologies for Sustainability: Internet of Things applications. Smart sensors and monitoring systems. Artificial intelligence applications. Data-driven sustainability management.	3,5	2
	3.2	Smart Manufacturing Technologies: Automation for resource	3,5	2



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		efficiency. Digital twins in manufacturing. Additive manufacturing. Sustainable production monitoring.		
4	Sustainable Mobility and Intelligent Transportation Technologies			
	4.1	Sustainable Transportation Technologies: Electric vehicles. Hybrid vehicles. Hydrogen fuel cell vehicles. Charging infrastructure.	2,4	2
	4.2	Intelligent Transportation Systems: Smart traffic systems. Shared mobility technologies. Public transportation innovations. Transportation monitoring technologies.	4,6	2
5	Emerging Sustainable Materials and Resource Recovery Technologies			
	5.1	Emerging Sustainable Materials: Green materials. Biodegradable materials. Recyclable materials. Sustainable material selection.	1,5	3
	5.2	Resource Efficient Technologies: Water purification technologies. Waste-to-energy technologies. Recycling technologies. Resource recovery technologies.	1,5	2
6	Sustainable Infrastructure and Future Engineering Technologies			
	6.1	Sustainable Infrastructure Technologies: Smart cities technologies. Green building technologies. Energy-efficient buildings. Sustainable construction technologies.	1,6	2
	6.2	Future Sustainability Technologies: Carbon capture technologies. Precision agriculture technologies. Environmental monitoring technologies. Future sustainability trends.	1,6	2
Total			26	

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:



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1. Mini Study Report on a selected sustainability technology, such as a renewable energy system, electric vehicle technology, smart manufacturing, or sustainable materials. (20 Marks)
2. Technical survey and presentation on an emerging sustainability technology, including working principle, applications, and sustainability benefits (30 Marks)

Recommended Books:

1. Sustainable Design: Green Engineering and Sustainability, Daniel A. Vallerio – Wiley
2. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford
3. The Circular Economy Handbook, Peter Lacy , Palgrave
4. Alternative Fuels and Advanced Vehicle Technologies, Richard Folkson , Woodhead
5. Sustainable Industrial Design and Waste Management, Salah El-Haggar , Academic Press
6. The Principles of Green Urbanism, Steffen Lehmann , Earthscan

Suggested CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes* (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1		1	–	–	–	3	–	–	–	–	2	–	–	
CO2		1	–	–	1	3	–	–	–	–	2	–	–	
CO3		1	–	–	2	2	–	–	–	–	2	2	1	
CO4		1	–	–	1	3	–	–	–	–	2	–	–	
CO5		1	1	–	1	3	–	–	–	–	2	1	2	
CO6		–	–	–	–	2	–	–	–	–	3	–	–	

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand✓	Apply	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM44	Sustainable Product Design	2	2	--	4	2	2	--	4
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
		Theory	20	30	20	50	100		
Tutorial	50	--	--	--	50				

Pre-requisite Course Codes **25DM41, 25DM42, 25DM43**

After the successful completion students should be able to:

Course Outcomes	CO1	Explain the principles and concepts of sustainable product design.
	CO2	Select appropriate sustainable materials using basic material selection criteria.
	CO3	Apply eco-design principles and life cycle assessment methods to engineering products.
	CO4	Describe sustainable manufacturing methods and resource-efficient production practices.
	CO5	Analyse environmental performance of products using sustainability indicators.
	CO6	Identify modern trends and innovations in sustainable product designs

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Fundamentals of Sustainable Product Design			
	1.1	Introduction to Sustainable Product Design: Principles of sustainable product design. Environmental impact of products. Product life cycle concept. Sustainability considerations in product design.	1,2	2
	1.2	Product Sustainability Considerations: Environmental considerations in product design. Energy consumption during product use. Product durability and service life. Repairability and upgradeability in products. End-of-life considerations in product design.	1,2	2
2	Sustainable Material Selection			
	2.1	Sustainable Material Selection for Product Design: Material selection considerations in sustainable product design. Environmental properties of engineering materials. Material substitution strategies.	2,4	3
	2.2	Lightweight materials for product sustainability. Recyclability and durability considerations in product design. Material databases and selection charts. Case studies of material substitution in products.	2,4	2
3	Eco-Design and Life Cycle Assessment			
	3.1	Eco-Design Methods: Design for environment. Design for recycling. Design for disassembly. Design for durability.	1,4	2
	3.2	Life Cycle Assessment Methods: Life cycle assessment concept. Environmental impact indicators. Basic LCA methodology.	1,4	2



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		Product carbon footprint.		
4	Sustainable Manufacturing Practices			
	4.1	Sustainable Manufacturing: Energy-efficient manufacturing. Green manufacturing methods. Waste reduction methods. Cleaner production.	3,5	2
	4.2	Resource Efficient Production: Material efficiency. Energy efficiency. Water efficiency. Sustainable production practices.	3,5	2
5	Product Sustainability and Circular Design			
	5.1	Product Sustainability Evaluations: Environmental performance indicators. Product carbon footprint. Energy consumption of products. Sustainability assessment methods.	1,5	3
	5.2	Circular Product Design: Product reuse concepts. Product remanufacturing. Product recycling. Circular product strategies.	1,5	2
6	Sustainable Product Innovations and Trends			
	6.1	Sustainable Product Case Studies: Sustainable packaging products. Sustainable electronics products. Sustainable household products.	2,5	2
	6.2	Future Trends in Sustainable Product Design: Smart sustainable products. Lightweight products. Bio-based products. Future product design trends.	1,6	2
Total			26	

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:



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1. Product sustainability analysis report for a selected engineering product (20 Marks)
2. Product redesign project incorporating sustainable design principles (30 Marks)

Recommended Books:

1. Daniel A. Vallero, Sustainable Design: Green Engineering and Sustainability, Wiley Publications.
2. William McDonough and Michael Braungart, Cradle to Cradle: Remaking the Way We Make Things, North Point Press.
3. Salah El-Haggar, Sustainable Industrial Design and Waste Management, Academic Press.
4. Rob Thompson, Sustainable Materials, Processes and Production, Thames & Hudson Publications.
5. David A. Dornfeld, Green Manufacturing: Fundamentals and Applications, Springer Publications.
6. Research papers and case studies from sustainability and product design journals.

Suggested CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											(PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	–	–	3	–	–	–	–	2	–	–	
CO2	2	1	2	–	1	3	–	–	–	–	2	1	1	
CO3	2	1	3	–	1	3	–	–	–	–	2	1	1	
CO4	2	1	2	–	1	3	–	–	–	–	2	1	3	
CO5	2	2	1	–	1	3	–	–	–	–	2	–	1	
CO6	1	–	–	–	–	2	–	–	–	–	3	–	–	

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand✓	Apply✓	Analyze✓	Evaluate	Create
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Specialized Minor in Data science

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM51	Statistics for Data Science	2	2	-	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tutorial		50	--	--	--	50			

Pre-requisite Course Codes	BSC11ME01, BSC11ME03, VSE11ME02	
Course Outcomes	CO1	Apply basic statistical techniques to any given structured data base and summarize it
	CO2	Use discrete and continuous probability distribution to solve mathematical problems based on it
	CO3	Use appropriate sampling method for any real world case study
	CO4	Apply hypothesis testing techniques to real world scenarios and draw meaningful conclusions.
	CO5	Conduct analysis of variance by constructing ANOVA table for one way and two way ANOVA

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction	1,3	5
	1.1	Data and Statistics: Elements, Variables, and Observations, Scales of Measurement, Categorical and Quantitative Data, Cross-Sectional and Time Series Data, Descriptive Statistics, Tabular and Graphical Summarizing of Categorical Data, Summarizing of Quantitative Data, Cross Tabulations and Scatter Diagram.		
	1.2	Numerical Measures: Measures of Location, Measures of Variability, Measures of Distribution Shape, Relative Location, and Detecting Outliers, Box Plot, Measures of Association Between Two Variables, Scatter plot, QQ plot		
2		Probability	1,3	5
	2.1	Probability: Experiments, Counting Rules, and Assigning Probabilities, Events and Their Probabilities, Complement of an Event, Addition Law Independent Events, Multiplication Law, Baye's theorem		



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	2.2	Discrete Probability Distributions: Random Variables, Discrete Probability Distributions, Expected Value and Variance, Binomial Probability Distribution, Poisson Probability Distribution		
	2.3	Continuous Probability Distributions: Uniform Probability Distribution, Normal Curve, Standard Normal Probability Distribution, Computing Probabilities for Any Normal Probability Distribution		
3		Sampling	1,3	4
	3.1	Sampling from a Finite Population, Sampling from an Infinite Population, Other Sampling Methods, Stratified Random Sampling, Cluster Sampling, Systematic Sampling, Convenience Sampling, Judgment Sampling, parameter and statistic, standard error of statistic, sampling and non-sampling errors, Central Limit theorem		
	3.2	Interval Estimation: Point estimation, Confidence Intervals, Student's t-Distribution,		
4		Hypothesis Tests	1,3	7
	4.1	Developing Null and Alternative Hypotheses, Type I and Type II Errors, Population Mean: Known, Population Mean: Unknown, Inference About Means and Proportions with Two Populations, Inferences About Population Variances		
	4.2	Chi-Square Distribution, Tests of Goodness of Fit, Multinomial Population, Test of Independence		
5		The Analysis of Variance (ANOVA)	1,3	5
	5.1	F distribution, Variance analysis in One way classification, Variance analysis in Two way classification		
Total				26

Course Assessment:

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.



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Tutorial:

Evaluation based on all six tutorials

Topics for Tutorial
Tutorial 1: Calculate statistical measures for any real world available data using python
Tutorial 2: Show different graphs (scatter plot, box plot and QQ plot) for the given data using python
Tutorial 3: Problem solving for binomial/Poisson distribution
Tutorial 4: Problem solving for Normal Probability Distribution
Tutorial 5: Case study on sampling
Tutorial 6: Central limit theorem quiz
Tutorial 7: Hypothesis testing (one population problem solving)
Tutorial 8: Hypothesis testing(two population problem solving)
Tutorial 9: Quiz/tutorial on chi square testing
Tutorial 10: programming of ANOVA using any software

Recommended Books:

1. David R. Anderson, Dennis J. Sweeney, Thomas A. Williams “Statistics For Business And Economics”11th Edition, South-Western, Cengage Learning
2. John A. Rice , “Mathematical Statistics and Data Analysis”, University of California, Berkeley,Thomson Higher Education
3. S.C. Gupta, V.K. Kappor, “Fundamentals Of Mathematical Statistics (A Modern Approach)” Tenth Revised Edition, Sultan Chand & Sons Educational Publishers New Delhi
4. Jay L. Devore, “Probability and Statistics for Engineering and the Sciences”, Cengage Publication.
5. O'Reilly Media, Wes McKinney, “Python for Data Analysis”, 2nd Edition, O'Reilly Media, Wes McKinney.

Legends :- High: 03, Medium: 02,Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM52	Data Analytics and Visualization	2	2	0	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tutorial		50	--	--	--	50			

Pre-requisite Course Codes	BSC11ME01, BSC11ME03, DM51	
Course Outcomes	CO1	Comprehend basics of data analytics and visualization
	CO2	Perform various analysis and visualization technique using python or any other software
	CO3	Apply various regression models on given data set and perform prediction.
	CO4	Demonstrate advance understanding of Time series concepts and analysis of data using various time series models.
	CO5	Analyze Text data and gain insights.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction	1,2	4
	1.1	Data Analytics Lifecycle overview: Key Roles for a Successful Analytics, Background and Overview of Data Analytics Lifecycle Project		
	1.2	Need of exploratory data analysis, cleaning and preparing data, Feature engineering, Missing values, understand dataset through various plots and graphs (histogram, scatter plot, bar chart, pie chart, stem and leaf plot, density plot), draw conclusions, the Kinds of Data Analytics – Descriptive, Diagnostic, Predictive and Data Mining		
2		Data analytics and Visualization with Python	2	4
	2.1	Essential Data Libraries for data analytics: Pandas, NumPy, SciPy. Plotting and visualization with python: Introduction to Matplotlib, Basic Plotting with Matplotlib, Create Histogram, BarChart, Pie chart, Box Plot, violin plot using Matplotlib. Introduction to seaborn Library, MultiplePlots,		
3		Regression	2,5	6



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	3.1	Simple Linear Regression: Simple Linear Regression Model, Regression Equation, Least Squares Method, Coefficient of Determination, Correlation Coefficient, Regression coefficient, Model Assumptions, testing for Significance, Residual Analysis: Outliers and Influential Observations, explained and unexplained variation		
	3.2	Multiple Regression: Multiple Regression Model, Least Squares Method, Multiple Coefficient of Determination, Model Assumptions, Testing for Significance, Categorical Independent Variables, Residual Analysis		
4		Time Series Analysis and Prediction	1,3	6
	4.1	Overview of Time Series Analysis, Components of time series, decomposition of time series, methods of finding trend, methods of finding seasonal variation, Box-Jenkins Methodology		
	4.2	ARIMA Model, Autocorrelation Function (ACF, PACF), Autoregressive Models, Moving Average Models, ARMA and ARIMA Models, Building and Evaluating an ARIMA Model		
5		Text Analytics	1,4	6
	5.1	History of text mining, Roots of text mining overview of seven practices of text analytic, Application and use cases for Text mining: extracting meaning from unstructured text, Summarizing Text.		
	5.2	Text Analysis Steps, A Text Analysis Example, Collecting Raw Text, Representing Text, Term Frequency—Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments, Gaining Insights.		
Total			26	

Course Assessment:

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete



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syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

ISE-1: 20 Marks

Evaluation based on first four tutorials

ISE-2: 30 Marks

Evaluation based on next six tutorials

Topics for Tutorial
Tutorial 1: Case study on exploratory data analysis
Tutorial 2: Perform exploratory analysis on any real world data using python
Tutorial 3: Perform visualization task in python for the given data
Tutorial 4: Perform visualization task in Excel for the given data
Tutorial 5: Problem solving on Regression
Tutorial 6: Create a Linear Regression model for a dataset and display the error measures, Chose a dataset with categorical data and apply linear regression model (using python)
Tutorial 7: Quiz on Time series forecasting
Tutorial 8: Implement ARIMA model in python
Tutorial 9: Implement TFIDF algorithm in Python
Tutorial 10: Build interactive dashboard using Tableau

Recommended Books:

1. Wes McKinney, “Python for Data Analysis”, 3rd Edition, Publisher(s): O'Reilly Media, Inc.
2. Bharati Motwani , “Data Analytics using Python”, 2nd Edition, Wiley Publications
3. George Athanasopoulos , Rob J Hyndman, “Forecasting: Principles and Practice”, 3rd Edition, Otext Publication
4. Dipanjan Sarkar, “Text Analytics with Python: A Practitioner's Guide to Natural Language Processing”, 2ND EDITION, Apress publisher
5. David R. Anderson, Dennis J. Sweeney, Thomas A. Williams “Statistics For Business And Economics” 11th Edition, South-Western, Cengage Learning



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM53	Game Theory using AI & ML	2	2	--	4	2	2	--	4
		Examination Scheme							
		Theory	Tutorial	ISE	MSE	ESE		Total	
						Min	Max		
		20	30	20	50	100			
50	--	--	--	50					

Pre-requisite Course Codes	25DM52	
After the successful completion students should be able to:		
Course Outcomes	CO1	Understand basic concept of game theory.
	CO2	Evaluate Artificial Intelligence (AI) methods and describe their foundations
	CO3	Analyze and illustrate how search algorithms play vital role in problem solving, inference, perception, knowledge representation and learning.
	CO4	Demonstrate knowledge of reasoning and knowledge representation for solving real world problems
	CO5	Recognize the characteristics of machine learning that makes it useful to realworld problems and apply different dimensionality reduction techniques
	CO6	Apply the different supervised learning methods of support vector machine and tree based models

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Game Theory	1,2	06
	1.1	Introduction, The theory of rational choice, Games with Perfect Information, Nash Equilibrium: Theory, Prisoner's Dilemma, Stag Hunt, Matching pennies, BOS, Multi NE, Cooperative and Competitive Games, Strict and Non Strict NE, Best response functions for NE.		
	1.2	Nash Equilibrium: Illustrations, Cournot's model of oligopoly, Bertrand's model of oligopoly, Electoral competition, The War of Attrition, Auctions, Mixed Strategy Equilibrium, Strategic games in which players may randomize, Dominated actions, Extensive Games with Perfect Information		



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2		Games with Imperfect Information	1,3	04
	2.1	Bayesian Games, Introduction, Motivational examples, General definitions, two examples concerning information, Strictly Competitive Games and Max minimization, Rationalizability		
	2.2	Evolutionary Equilibrium, Monomorphic pure strategy equilibrium, Mixed strategies and polymorphic equilibrium, Repeated games: The Prisoner's Dilemma, Infinitely repeated games, Strategies, General Results.		

3		Introduction to AI & Problem Solving	2,3	06
	3.1	Definitions – Foundation and History of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment. Artificial Intelligence vs Machine learning,		
	3.2	Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Best first Search; Problem Reduction.		
	3.3	Beyond Classical Search: Local search algorithms and optimization problem, local search in continuous spaces, searching with nondeterministic action and partial observation, online search agent and unknown environments.		

4		Knowledge and Reasoning	3,4	05
	4.1	Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus. Theorem Proving in First Order Logic, Planning, partial order planning. Uncertain Knowledge and Reasoning, Probabilities.		
	4.2	Bayesian Networks. Probabilistic reasoning over time: time and uncertainty, hidden Markova models, Kalman filter, dynamic bayesian network, keeping track of many objects		

5		Introduction to ML	3,4	08
	5.1	Introduction to Machine Learning, Examples of Machine Learning Applications, Learning Types, Supervised Learning -Learning a Class from Examples, Vapnik- Chervonenkis (VC) Dimension, probably approximately Correct (PAC) Learning, Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine Learning Algorithm		
	5.2	Introduction, Linear Regression Models and Least Squares, Subset Selection, Shrinkage Methods, Logistic Regression- Fitting Logistic Regression Models, Quadratic Approximations and Inference, L1 Regularized Logistic Regression, SVM-Introduction to SVM, The Support Vector Classifier, Support Vector Machines and Kernels-		



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		Computing the SVM for Classification		
6		Unsupervised Learning	3,4	05
	6.1	Introduction, Association Rules-Market Basket Analysis, The Apriori Algorithm, Unsupervised as Supervised Learning, Generalized Association Rules, Cluster Analysis Proximity Matrices, Clustering Algorithms-K-mean, Gaussian Mixtures as Soft K-means Clustering, Example: Human Tumor Microarray Data, Vector Quantization, K- medoids, Hierarchical Clustering, Self-Organizing Maps, PCA-Spectral Clustering		
	6.2	Hidden Markov Models-Introduction, Discrete Markov Processes, Hidden Markov Models, Three Basic Problems of HMMs, Evaluation Problem, Finding the State Sequence, Learning Model Parameters, Continuous Observations, The HMM with Input, Model Selection in HMM		
		Total		26

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Theory:

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Text Books:



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1. Martin Osborne, "An Introduction to Game Theory", Oxford University Press.
2. Russell, S. and Norvig, "Artificial Intelligence - A Modern Approach", 3rd edition, Prentice Hall, 2015
3. Ethem Alpaydin, "Introduction to Machine Learning", Second Edition.

References:

1. Thomas Ferguson, Stef Tijs, "Introduction to Game Theory", Hindustan Book Agency World Scientific, 2018.
2. J. Gabriel, "Artificial Intelligence for Humans, Create Space Independent Publishing Platform, First edition, 2016.
3. Dan W Patterson, "Introduction to Artificial Intelligence & Expert Systems" Cengage Learning, First Edition, 2011.
4. Tom Mitchell, "Machine Learning" First Edition, McGraw-Hill, 1997.
5. Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -
6. **Blooms level**

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM54	Data Science- Web and Social Analysis	2	2		4	2	2		4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tutorial		50	--	--	--	50			

Pre-requisite Course Codes **25DM53**

After the successful completion students should be able to

Course Outcomes	CO1	Explain data science fundamentals for web and social media analytics.
	CO2	Apply data collection, preprocessing, and visualization techniques.
	CO3	Analyze web and social network data using machine learning.
	CO4	Build real-world web/social analytics applications.
	CO5	Apply machine learning and recommendation techniques to build, evaluate, and optimize predictive models for web and social media data analysis.
	CO6	Explain scalable big data technologies and ethical considerations in web and social analytics applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Data Science and Web Analytics	1,3	
	1.1	Introduction to Data Science and Web Analytics, Types of data: structured, semi-structured, unstructured		1
	1.2	Web data sources and web logs, Basics of Web Analytics		1
	1.3	Web metrics: Page views, Sessions, Bounce rate, CTR, Introduction to Google Analytics (conceptual)		2
2		Data Collection and Web Scraping	2	
	2.1	Web scraping fundamentals, HTML structure and DOM, APIs and RESTful services		2
	2.2	Data extraction using BeautifulSoup and Requests, Handling JSON data, Data cleaning and preprocessing, Handling missing values and noise		2
3		Social Media Analytics	2,3	
	3.1	Overview of Social Media Platforms (Twitter, Facebook, YouTube, Instagram), Social media data characteristics, Social engagement metrics (likes, shares, comments, impressions)		2
	3.2	Hashtag analysis, Trend detection, Location analytics, Sentiment analysis (basic NLP concepts) Text preprocessing: tokenization, stopwords, stemming		2
4		Social Network Analysis (SNA)	1,3	



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	4.1	Introduction to Graph Theory: Nodes, edges, degree, Centrality measures: Degree, Betweenness, Closeness		2
	4.2	Community detection, Network visualization Tools: NetworkX, Neo4J		2
5		Predictive Modeling and Intelligent Systems for Web & Social Data	4,5	
	5.1	Introduction to predictive analytics in web and social platforms, Feature engineering for web and social datasets		2
	5.2	Supervised learning techniques: Logistic Regression, Decision Trees, Naïve Bayes, Unsupervised learning techniques: K-Means Clustering, Hierarchical Clustering (conceptual overview) Recommendation systems: Content-based filtering, Collaborative filtering		2
	5.3	Model performance evaluation: Confusion matrix: Accuracy, Precision, Recall, F1-score, ROC Curve (conceptual) Overfitting and model validation techniques		2
6		Big Data Technologies and Real-Time Social Intelligence	5	
	6.1	Big Data in Web and Social Analytics, Real-time data processing (conceptual overview of Spark), Fake news detection		2
	6.2	Social media marketing analytics, Ethical issues in web and social data, Privacy and data governance		2
			Total	26

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

- [1] Avinash Kaushik, “Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity”, Wiley Publishing, 2010. Alex Holmes, “Hadoop in Practice”, Manning Press, Dreamtech Press, 2012.



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- [2] Chuck Hemann and Ken Burbary, “Digital Marketing Analytics: Making Sense of Consumer Data in a Digital World”, Que Publishing, 2013.
- [3] Matthew A. Russell and Mikhail Klassen, “Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Instagram, GitHub, and More”, O’Reilly Media, 2019.
- [4] Foster Provost and Tom Fawcett, “Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking”, O’Reilly Media, 2013.
- [5] Jiawei Han, Micheline Kamber and Jian Pei, “Data Mining: Concepts and Techniques”, Morgan Kaufmann Publishers, 2011.

Useful Links

- [1] <https://analytics.google.com/analytics/academy>
- [2] <https://developer.twitter.com/>
- [3] <https://networkx.org/>
- [4] <https://matplotlib.org/>
- [5] <https://spark.apache.org/>
- [6] <https://towardsdatascience.com/>

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											(PSOs)	
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	–	–	1	–	–	–	–	–	1		
CO2	3	3	2	2	3	–	–	–	–	–	2		
CO3	2	3	1	1	2	–	–	–	–	–	1	1	2
CO4	2	3	2	2	3	–	–	-	2	2	1	2	
CO5	2	2	2	1	2	2	1	–	–	–	2	1	2
CO6	2	2	1	3	3	–	–	–	–	–	1	1	

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand ✓	Apply ✓	Analyze ✓	Evaluate	Create
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Double Minor Degree in 'Emerging Areas' (For Additional 18-20 credits)

Specialized Minor in Artificial Intelligence and Machine Learning

(Offered to ME branch)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM61	Statistics for Data Science	2	2	-	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tutorial		50	--	--	--	50			

Pre-requisite Course Codes	BSC11ME01, BSC11ME03, VSE11ME02	
Course Outcomes	CO1	Apply basic statistical techniques to any given structured data base and summarize it
	CO2	Use discrete and continuous probability distribution to solve mathematical problems based on it
	CO3	Use appropriate sampling method for any real world case study
	CO4	Apply hypothesis testing techniques to real world scenarios and draw meaningful conclusions.
	CO5	Conduct analysis of variance by constructing ANOVA table for one way and two way ANOVA

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction	1,3	5
	1.1	Data and Statistics: Elements, Variables, and Observations, Scales of Measurement, Categorical and Quantitative Data, Cross-Sectional and Time Series Data, Descriptive Statistics, Tabular and Graphical Summarizing of Categorical Data, Summarizing of Quantitative Data, Cross Tabulations and Scatter Diagram.		
	1.2	Numerical Measures: Measures of Location, Measures of Variability, Measures of Distribution Shape, Relative Location, and Detecting Outliers, Box Plot, Measures of Association Between Two Variables, Scatter plot, QQ plot		
2		Probability	1,3	5
	2.1	Probability: Experiments, Counting Rules, and Assigning Probabilities, Events and Their Probabilities, Complement of an Event, Addition Law Independent Events, Multiplication Law, Baye's theorem		
	2.2	Discrete Probability Distributions: Random Variables, Discrete Probability Distributions, Expected Value and Variance, Binomial Probability Distribution, Poisson Probability Distribution		



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	2.3	Continuous Probability Distributions: Uniform Probability Distribution, Normal Curve, Standard Normal Probability Distribution, Computing Probabilities for Any Normal Probability Distribution		
3		Sampling	1,3	4
	3.1	Sampling from a Finite Population, Sampling from an Infinite Population, Other Sampling Methods, Stratified Random Sampling, Cluster Sampling, Systematic Sampling, Convenience Sampling, Judgment Sampling, parameter and statistic, standard error of statistic, sampling and non-sampling errors, Central Limit theorem		
	3.2	Interval Estimation: Point estimation, Confidence Intervals, Student's t-Distribution,		
4		Hypothesis Tests	1,3	7
	4.1	Developing Null and Alternative Hypotheses, Type I and Type II Errors, Population Mean: Known, Population Mean: Unknown, Inference About Means and Proportions with Two Populations, Inferences About Population Variances		
	4.2	Chi-Square Distribution, Tests of Goodness of Fit, Multinomial Population, Test of Independence		
5		The Analysis of Variance (ANOVA)	1,3	5
	5.1	F distribution, Variance analysis in One way classification, Variance analysis in Two way classification		
Total				26

Course Assessment:

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

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Tutorial: Assessment carried out based on 6 tutorials



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Topics for Tutorial
Tutorial 1: Calculate statistical measures for any real world available data using python
Tutorial 2: Show different graphs (scatter plot, box plot and QQ plot) for the given data using python
Tutorial 3: Problem solving for binomial/Poisson distribution
Tutorial 4: Problem solving for Normal Probability Distribution
Tutorial 5: Case study on sampling
Tutorial 6: Central limit theorem quiz
Tutorial 7: Hypothesis testing (one population problem solving)
Tutorial 8: Hypothesis testing(two population problem solving)
Tutorial 9: Quiz/tutorial on chi square testing
Tutorial 10: programming of ANOVA using any software

Recommended Books:

1. David R. Anderson, Dennis J. Sweeney, Thomas A. Williams “Statistics For Business And Economics” 11th Edition, South-Western, Cengage Learning
2. John A. Rice , “Mathematical Statistics and Data Analysis”, University of California, Berkeley, Thomson Higher Education
3. S.C. Gupta, V.K. Kappor, “Fundamentals Of Mathematical Statistics (A Modern Approach)” Tenth Revised Edition, Sultan Chand & Sons Educational Publishers New Delhi
4. Jay L. Devore, “Probability and Statistics for Engineering and the Sciences”, Cengage Publication.
5. O'Reilly Media, Wes McKinney, “Python for Data Analysis”, 2nd Edition, O'Reilly Media, Wes McKinney.

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM62	Fundamentals of AI & ML	2	2	-	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
TUT		50	--	--	--	50			

Pre-requisite Course Codes	Mathematics & Statistics, python Programming Skills	
Course Outcomes	CO1	To develop a basic understanding of AI building blocks presented in intelligent agents.
	CO2	To choose an appropriate problem-solving method and knowledge representation technique.
	CO3	To acquire fundamental knowledge of machine learning models.
	CO4	To Apply classification techniques to categorize given datasets
	CO5	To Apply different regression techniques to predict continuous
	CO6	To Analyze model performance using evaluation metrics like

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Title: Introduction to Artificial Intelligence		
	1.1	Introduction: History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI, Ethics, Challenges, and Future Trends in AI	1,2	3
	1.2	Intelligent Agents: Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agent.	1,2,3	1
2		Title: AI Techniques & Problem Solving		
	2.1	Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search	1,2,4	2
	2.2	Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search.	1,2,4	2
	2.3	Knowledge Representation & Reasoning: Logical Reasoning (Propositional & Predicate Logic), Expert Systems and Decision Trees	1,2,4	2
3		Title: Introduction to Machine Learning		
	3.1	Definition & Importance of ML, Differences Between AI, ML &	1,2,3	2



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		unsupervised learning, semi-supervised learning, semi supervised		
	3.2	Training Error, Generalization error, Overfitting, Underfitting, Bias Variance trade-off.	1,2	2
4		Title: Learning with Regression and Trees		
	4.1	Learning with Regression: Definition of Regression in Machine Learning , Real-World Applications of Regression (Stock Price Prediction, House Price Estimation, Sales Forecasting) Linear Regression, Multivariate Linear Regression, Logistic Regression.	1,2,6	2
	4.2	Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index (Regression)	1,2,3,7	2
5		Title: Learning with Classification		
	5.1	Definition & Importance of Classification, Difference between Classification and Regression, Real-World Applications of	1,2,4	2
	5.2	Support Vector Machine: Concept of Hyperplanes & Support Vectors, SVM for linear and nonlinear classification, Basics of Kernel trick.	1,2,3	2
	5.3	Support Vector Regression, Multiclass Classification	1,3	1
6		Title: Learning with Clustering		
	6.1	Definition & Importance of Clustering, major clustering approaches, Applications of Clustering (Customer Segmentation, Anomaly	4,5	1
	6.2	Clustering Techniques & Algorithms: K-Means Clustering, Hierarchical Clustering, Density-Based Clustering	4,5	2
Total				26

Module No.	Sr.No.	Suggested List of Tutorials	Ref.	Hrs.
1	1.1	Breadth-First Search (BFS): <ul style="list-style-type: none"> For a given a scenario where multiple paths exist between locations, how would BFS ensure finding the shortest path? Apply BFS to a transportation network, a social network, or a maze-solving problem and describe the order of exploration. Depth-First Search (DFS): <ul style="list-style-type: none"> In a game tree or file system, how would DFS be used to traverse the structure efficiently? Given a complex decision-making problem, apply DFS to find all possible solutions before making a decision. 	1,2,3	4
	1.2	Greedy Best-First Search: In a delivery routing system , how can Greedy BFS be applied to find a quick, though not necessarily optimal,	1,2,3	4



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		<ul style="list-style-type: none"> Apply Greedy BFS to a word puzzle game, where you move toward the most promising next step based on estimated success. <p>A* Search</p> <ul style="list-style-type: none"> You are designing a navigation system for a self-driving car, how would you use A* to ensure an optimal route? Apply A* to project scheduling, where tasks must be completed in an optimal sequence based on priority and dependencies. 		
	1.3	Case study on State space formulation and PEAS representation for various AI applications	1,2	2
2	2.1	<p>Linear Regression & Classification</p> <ul style="list-style-type: none"> For any given dataset, apply Linear Regression to predict a continuous outcome. For any given dataset, apply Logistic Regression for binary classification. For any given dataset, apply a Decision Tree to classify or predict outcomes. For any given dataset, determine whether a Linear or 	6,7,8	4
	2.2	<p>Consider a classification problem where the target variable has three or more categories (e.g., classifying emails as Spam, Promotions, or Primary).</p> <ul style="list-style-type: none"> How would you use algorithms like Softmax Regression, Decision Trees, or Random Forest to build a model? How do you evaluate the model using Precision, Recall, and Confusion Matrix? If new class probabilities are given, how do you decide which class a new instance belongs to? 	6,7	4
3	3.1	For any given dataset, apply K-Means Clustering to segment data into groups.	8,9	2
	3.2	<p>For any given dataset, apply Hierarchical Clustering to create a hierarchical grouping.</p> <ul style="list-style-type: none"> Consider a dataset where you want to cluster products based on their sales performance. What are the differences between Agglomerative and Divisive Clustering? How do you decide which two clusters to merge first using Single-Linkage vs. Complete-Linkage? How can you visualize the hierarchical structure using a dendrogram? 	8,9	2
	3.3	For any given dataset, apply DBSCAN to detect clusters and outliers.	8,9	2
4	4.1	Mini project/presentation/Group activity/ Simulation using modern tools on regression, classification and clustering	13,14,15	2



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	Total	26
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Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

TUT: ISE:

1. **Assessment** will be conducted for 50% of numerical problems given in the syllabus. Continuous pre-defined rubrics-based evaluation for 20 marks.
2.
 - a. Remaining 50% of numerical problems given in the syllabus. Continuous pre-defined rubrics-based evaluation for 20 marks.
 - b. Simulation using modern tools to solve the given problem statement for 10 marks/Mini project



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Recommended Books:

1. 1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition" Pearson Education, 2020
2. Saroj Kaushik, "Artificial Intelligence", Cengage Learning, First edition, 2011
3. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication
4. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
5. Peter Harrington, "Machine Learning in Action", Dream Tech Press.
6. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press.
7. Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Press.
8. Han Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann Publishers.
9. Margaret. H. Dunham, —Data Mining Introductory and Advanced Topics, Pearson Education.
10. Kevin P. Murphy, Machine Learning "A Probabilistic Perspective".
11. Samir Roy and Chakraborty, "Introduction to soft computing", Pearson Edition.
12. Richard Duda, Peter Hart, David G. Stork, "Pattern Classification", Second Edition, Wiley Publications.

Online Resources:

13. https://onlinecourses.nptel.ac.in/noc21_cs24/preview
14. https://onlinecourses.nptel.ac.in/noc25_cs50/preview?utm_source=chatgpt.com
15. https://onlinecourses.nptel.ac.in/noc21_cs85/preview

Further Reading:

1. https://onlinecourses.nptel.ac.in/noc21_cs85/preview?utm_source=chatgpt.com
3. <https://www.youtube.com/playlist?list=PLZoTAELRMXVPBTrWtJkn3wWQxZkmTXG>

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -
Blooms level

Remember✓	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned				
		L	T	P	SL	L	T	P	Total	
25DM63	Natural Language Processing	2	2	--	4	2	2	--	4	
		Examination Scheme								
			ISE	MSE	ESE		Total			
					Min	Max				
		Theory	20	30	20	50	100			
Tut	50	--	--	--	50					

Pre-requisite Course Codes		25DM62
After the successful completion students should be able to:		
	CO1	Describe the mathematical and linguistic preliminaries necessary for various processes in NLP
Course Outcomes	CO2	Analyze natural language at word-Level to extract meaningful linguistic features.
	CO3	Analyze natural language at Syntax-Level to determine sentence structure and relationships between linguistic constituents.
	CO4	Analyze the natural language at Semantic Level to understand meaning and identify relationships between words.
	CO5	Explain the role of pragmatics in NLP in interpreting meaning based on context and intent.
	CO6	Apply NLP techniques to design and develop real-world NLP applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Natural Language Processing	1,3	4
	1.1	The need of NLP, Levels of NLP		
	1.2	Stages in building a Natural Language Processing System		
	1.3	Challenges and ambiguities in NLP Design		
	1.4	Mathematical preliminaries required for NLP: Probability Theory, Conditional Probability and Independence, Bayes Rule, Probability Distributions, Statistics: Counting, Frequency, Mean and Variance.		
2		Word Level Analysis	1,3	5
	2.1	Tokenization, Segmentation, Lemmatization, Edit Distance, Collocations, Porter Stemmer.		
	2.2	N-gram Language Model, Evaluating N-gram Model: Perplexity, Smoothing.		
	2.3	Morphological Analysis, Derivational and Reflectional Morphology		
3		Syntax Analysis	3,4	5



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	3.1	Tag set for English (Penn Tree bank), Introduction to Parts of Speech Tagging (POST), Types of POS tagging: Rule –based, stochastic and Transform based		
	3.2	Markov Processes, Hidden Markov Models (HMM), Parts of Speech Tagging using Hidden Markov Models, Viterbi Algorithm.		
4		Semantic Analysis	3,4	4
	4.1	Lexical Semantics, ambiguous words, word senses, Relations between senses: synonym, antonym, reversives, hyponym, hypernym, meronym, structured polysemy, metonymy, zeugma		
	4.2	Study of Various language dictionaries: WordNet (gloss, synset, sense relations in WordNet), Babelnet.		
	4.3	Document representation methods: Bag of Words (BoW), TF-IDF Representation. Similarity Measures: Cosine Similarity, Euclidean Distance, Jaccard Similarity.		
	4.4	Word sense disambiguation: Knowledge based, Supervised, Semi-supervised method , Unsupervised Approach		
5		Pragmatics & Discourse Processing and Applications of NLP	2,4	4
	5.1	Reference resolution: Discourse model, Reference Phenomenon, Syntactic and Semantic Constraints on co reference.		
6		Applications of NLP	1,3	4
	6.1	Applications of NLP: Machine Translation, Text Summarization, Sentiment Analysis, Named Entity Recognition, Information Retrieval, Predictive Maintenance using Text Data.		
Total			26	

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Suggested List of Tutorials			
S.N.	Topics	Ref.	Hrs.



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1	NLP Tools and Library exploration (NLTK, Spacy) Text Preprocessing (Tokenization, Filtration, Lower casing, Stop Word Removal, Stemming, Lemmatization)	5,6	2
2	NLP Dataset Exploration: Select an NLP dataset, Understand real-world data characteristics and Identify imbalance issues. perform <ul style="list-style-type: none"> • Class distribution analysis • Vocabulary size calculation • Basic visualization 	5,6	2
3	Perform N-Gram Analysis of given text	5,6	2
4	Study different POS taggers and Perform POS tagging on the given text.	5,6	2
5	Compare BoW vs TF-IDF performance for a given text/document	5,6	2
7	Build a sentiment Analyzer	5,6	4
8	Build a Simple Chatbot	5,6	4
9	Mini project: Mini project implementation for real-world problems related to Mechanical Engineering (Examples: <ul style="list-style-type: none"> • Extract specifications from machine manuals • Analyze maintenance logs • Extract fault descriptions from service reports) 	5,6	8
Total			26

Course Assessment- TUT

ISE:20M Evaluation based on first four tutorials.

20M Evaluation based on Remaining three tutorials (Tut 5 to 7).

10M Evaluation based on Mini Project summarization

Recommended Books:

1. Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
2. Christopher D. Manning and Hinrich Schutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.
3. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
4. Alexander Clark, Chris Fox, Shalom Lappin — The Handbook of Computational Linguistics and Natural Language Processing, John Wiley and Sons, 2012.



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5. Steven Bird, Ewan Klein & Edward Loper,” Natural Language Processing with Python, OREILLY.
6. Rohan Chopra,” Natural Language Processing with Python, Packt Publications.

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	3	-	-	-	-	-	-	-	-
CO3	3	2	-	3	-	-	-	-	-	-	-	-
CO4	3	2	-	3	-	-	-	-	-	-	-	-
CO5	2	-	-	3	-	-	-	-	-	-	-	-
CO6	3	3	3	3	-	-	-	3	-	-	-	3

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand✓	Apply✓	Analyze✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM64	Artificial Intelligence for Mechanical Engineering	2	2	--	4	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tutorial		50	--	--	--	50			

Pre-requisite Course Codes		25DM61, 25DM62
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain the role of artificial intelligence techniques in mechanical engineering applications.
	CO2	Apply artificial intelligence concepts to solve basic mechanical engineering problems in design and thermal systems.
	CO3	Apply artificial intelligence approaches in manufacturing and quality improvement problems.
	CO4	Analyse machine performance and maintenance problems using AI-based approaches.
	CO5	Describe intelligent mechanical systems and AI-based production systems.
	CO6	Identify emerging applications of artificial intelligence in mechanical engineering.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Foundations of AI in Mechanical Engineering			
	1.1	Introduction to Artificial Intelligence in Mechanical Engineering: Overview of artificial intelligence. Applications of AI in mechanical engineering such as design improvement, manufacturing and maintenance. Examples of AI-based engineering systems.	1,2	2
	1.2	Mechanical Engineering Data for AI Applications: Sources of engineering data such as experiments and sensors. Selection of important mechanical parameters. Input and output variables in engineering prediction problems.	1,2	2
2	AI in Design and Thermal Systems			
	2.1	AI Applications in Mechanical Design: Prediction of design parameters. Design optimization concepts. Estimation of strength and weight of components. Simple design case examples.	1,3	3
	2.2	AI Applications in Thermal and Fluid Systems: Prediction of	1,3	2



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		temperature and heat transfer performance. Flow parameter estimation. Performance prediction of thermal systems.		
3	AI in Manufacturing and Quality Control			
	3.1	AI Applications in Manufacturing Processes: AI applications in machining processes. Process parameter selection. Surface roughness prediction. Tool wear prediction concepts.	1,4	2
	3.2	AI Applications in Quality Control: Defect identification concepts. Quality prediction methods. Inspection data analysis.	1,4	2
4	AI in Maintenance and Performance Monitoring			
	4.1	AI Applications in Maintenance Engineering: Condition monitoring concepts. Vibration and temperature monitoring. Machine fault identification concepts.	1,5	2
	4.2	Machine Performance Monitoring: Monitoring of rotating machines. Performance trend analysis. Maintenance planning concepts.	1,5	2
5	Intelligent Mechanical and Production Systems			
	5.1	Intelligent Mechanical Systems: Smart machines and sensor-based systems. Automated mechanical systems. Robotics applications in mechanical engineering.	1,5	3
	5.2	AI in Production Systems: Smart manufacturing concepts. Machine monitoring systems. AI-based production improvement examples.	1,5	2
6	Industrial and Emerging AI Applications			
	6.1	Industrial Applications of AI: AI applications in automotive systems. AI in energy systems. AI applications in rotating machinery.	2,5	2
	6.2	Emerging AI Applications in Mechanical Engineering: Digital engineering concepts. AI-assisted design tools. Future applications of AI in mechanical engineering.	2,6	2
Total				26

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.



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Recommended Books/References:

1. Jay Lee, *Industrial AI: Applications with Sustainable Performance*, Springer Publications.
2. Janapati Venkata Rao, Desai and Fernandes, *Applied Artificial Intelligence and Machine Learning Techniques for Engineering Applications*, Routledge Publications.
3. S. Rajasekaran and G.A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic and Genetic Algorithms*, PHI Publications.
4. Adedeji B. Badiru and Vhance V. Valencia, *Artificial Intelligence and Neural Network Applications in Engineering*, CRC Press.
5. K. Erickson, N. V. Chawla and C. Shin, *Big Data Analytics in Smart Manufacturing*, CRC Press.
6. Research papers and case studies on Artificial Intelligence in Mechanical Engineering.

Suggested CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											(PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1		1	–	–	–	1	–	–	–	–	2	–	–	–
CO2		2	2	–	2	1	–	–	–	–	2	3	1	–
CO3		2	2	–	2	1	–	–	–	–	2	2	3	–
CO4		3	1	–	2	1	–	–	–	–	2	2	2	
CO5		1	2	–	2	1	–	1	–	–	2	2	3	
CO6		–	–	–	–	–	–	–	–	–	3	1	–	

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply	Analyze	Evaluate	Create
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Double Minor Degree in 'Emerging Areas' (For Additional 18-20 credits)

Specialized Minor in Blockchain Technology

(Offered to ECS branch)



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM71	Blockchain Basics	2	2	--	2	2	2	--	4
		Examination Scheme							
		ISE		MSE		ESE		Total	
						Min	Max		
		TH	20	30	20	50	100		
TU	50	--	--	--	50				

Pre-requisite Course Codes	PCC13CE11	
Course Outcomes	CO1	Explain Blockchain concepts in the context of distributed ledger.
	CO2	Associate concepts of cryptocurrencies, consensus algorithms and mining with security of blockchain.
	CO3	Explain basic working principles of Ethereum.
	CO4	Apply the concepts of smart contract using Solidity programming for a given application.
	CO5	Explore Hyperledger Fabric and its working as a private blockchain.
	CO6	Demonstrate the components of blockchain and the processes used in blockchain for a given problem as well as in real world applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Introduction to Blockchain Technology: What is a blockchain, Origin of blockchain, Foundation of blockchain: Genesis block, Merkle trees, limitations and applications of blockchain	1,3	3
	1.2	Components of blockchain, Block in blockchain, Types of blockchain: Public, Private, and Consortium, Consensus protocols: Proof-of-Work (PoW), Proof-of-Burn (PoB), Proof-of-Stake (PoS), and Proof-of-Elapsed Time (PoET), mining in	1,3	4
2	2.1	Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture	1,3	03
	2.2	Exploring etherscan.io and the block structure Ethereum test networks Decentralized file system: IPFS	1,2	03



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3	3.1	Programming for Blockchain: Introduction to Smart Contracts, Types of Smart Contracts, Limitations of Smart Contracts	1	1
	3.2	Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling, events, If-Then-	Useful Link 5	4
4		Need of Private Blockchain, Consensus Algorithms for Private Blockchain - PAXOS, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT	1, Ref.3	4
5		Introduction to Hyperledger, Tools and Frameworks Hyperledger Fabric: Hyperledger Fabric Architecture, Components of Hyperledger Fabric, Transaction Flow, application for	1, Ref. 3	4
Total				26

Suggested list of tutorials: (Minimum 10)

Sr. no.	Suggested Tutorials	Hrs.
1	Explore various blockchain platforms other than Bitcoin and	2
2	Case study: blockchain security threats with real life incidents of the attacks	2
3	Case study of application of blockchain in Fintech	2
4	Case study of supply chain management using blockchain	2
5	Case study: Blockchain integrated with AI/Cloud computing/IoT	2
6	Block mining and reward transfer to the account	2
7	Solidity program: voting application	2
8	Solidity program: crowd funding	2
9	Solidity program: Transactions using Remix IDE and MetaMask	2
10	Storing and retrieving file from IPFS	2
11	Smart contract execution using Ganache	2

Recommended Books:

1. Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and Meena Karthikeyan, Universities Press.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing.
4. Blockchain for Beginners, Yathish R and Tejaswini N, SPD
5. Blockchain Basics, A non-Technical Introduction in 25 Steps, Daniel Drescher, Apress
6. Blockchain with Hyperledger Fabric, Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing



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Useful Links:
1. https://www.blockchain.com/explorer/assets/btc
2. https://etherscan.io/
3. https://bitcoin.org/bitcoin.pdf
4. https://ethereum.org/en/whitepaper/
5. https://docs.soliditylang.org/
6. Research paper on integration of blockchain and Cloud computing: https://ieeexplore.ieee.org/document/9252909 DOI: 10.1109/ACCESS.2020.3036812
7. https://www.researchgate.net/publication/333639731 Blockchain Technologies for IoT
8. Research paper on integration of blockchain and AI: https://ieeexplore.ieee.org/iel7/6287639/10380310/10379100.pdf DOI: 10.1109/ACCESS.2023.3349019
9. https://www.infosys.com/industries/financial-services/white-papers/documents/blockchain-adoption-

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM72	Bitcoin and Cryptocurrency	2	2	--	2	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		TOTAL	
						Min	Max		
		Theory	20	30	20	50	100		
TUT	50	-	-	-	50				

Pre-requisite Course Codes	Introduction to Cryptography: Hash functions, Public key cryptography, Digital Signature
Course Outcomes	CO1 Describe the basic concept of Block chain.
	CO2 Associate knowledge of consensus and mining in Block chain
	CO3 Summarize the bit coin crypto currency at an abstract level
	CO4 Apply the concepts of keys, wallets and transactions to the Bit coin network
	CO5 Interpret the knowledge of Bit coin network, nodes and their
	CO6 Illustrate the applications of Block chain and analyze case

Sr. No.	Module	Topics	Ref	Hours
0	Prerequisite	Introduction to Cryptography: Symmetric Key Cryptography, Public key cryptography, Hash functions, Digital Signature (ECDSA)		3
1	Introduction to Block chain	Structure of a Block, Block Header, Block Identifiers: Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Block chain.	1, 4	2
2	Consensus and Mining	Decentralized Consensus, Byzantine General's Problem, Independent Verification of Transactions, Mining Nodes, Aggregating Transactions into Blocks, Constructing the Block header, Mining the Block, Successfully Mining the Block, Validating a New Block, Assembling and Selecting Chains of Blocks, Block chain Forks	1,3	6
3	Introduction to Bit coin	What is Bit coin and the history of Bit coin, Bit coin Transactions, Altcoins, Tokens (Utility and Security), UTXO and double spending. Self-learning Topics: Study the	1,3	4



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4	Concepts of Bit coin	Keys and addresses, Wallets and Transactions: Public Key Cryptography and Crypto currency, Private and Public Keys, Bit coin Addresses, Base58 and Base58Check Encoding, Nondeterministic (Random) Wallets, Deterministic (Seeded) Wallets, HD Wallets (BIP-32/BIP-44), Transaction Outputs and Inputs, Transaction Fees, Transaction Scripts and Script Language, Turing Incompleteness, Stateless Verification, Script Construction (Lock + Unlock), Pay-to-Public-Key- Hash (P2PKH). Self-learning Topics: Visit and use	1,3	6
5	Bit coin Networks	Peer-to-Peer Network Architecture, Node Types and Roles, Incentive based Engineering The Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes, Exchanging “Inventory”, Simplified Payment Verification (SPV) Nodes, Bloom Filters, SPV Nodes and Privacy, Encrypted and Authenticated Connections, Transaction Pools Self-learning	1,3	3
6	Cryptocurrency Applications & Case Studies	Domain-Specific Applications: FinTech, Records & Identities, cross-border payments, Gaming and NFTs Self-learning Topics: Read Technical papers on bitcoin applications	2,4,6	2

Suggested list of tutorials: (Minimum 10)

Module No	Sr. no.	Suggested List of Tutorials	Ref	Hrs.
1	1	Introduction to Blockchain Objective: Understand the basic structure of blockchain and how blocks are linked. Topics: Block structure, Block header and identifiers, The Genesis Block, Linking Blocks in Blockchain Activity: Visualize the blockchain structure using a block explorer.	1,4	2
2	2	Consensus and Mining Basics Objective: Learn about decentralized consensus and the mining process. Activity: Research and compare different consensus algorithms of Polygon. RCorda, Litecoin	1,3	2
4	3	Bitcoin Transactions and Fees	1,3	2



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		<p>Objective: Learn how Bitcoin transactions work and how fees are determined.</p> <p>Topics : Transaction inputs and outputs, Pay-to-Public-Key-Hash (P2PKH), Transaction scripts and Bitcoin script language, Transaction fees and balance calculations</p> <p>Hands-on Activity: Use a Bitcoin block explorer to analyze a real transaction.</p>		
4	4	<p>Blockchain Forks and Network Disruptions</p> <p>Objective: Understand blockchain forks and their impact.</p> <p>Topics : Soft forks vs hard forks, Chain reorganizations, Famous forks (e.g., Bitcoin Cash)</p> <p>Activity: Research a famous Bitcoin fork and discuss its impact.</p>	1,3	2
3	5	<p>Creating and Sharing Tokens</p> <p>Topics: Token standards (ERC-20, ERC-721), Smart contracts for tokens,</p> <p>Hands-on Activity: Use an online platform (Ethereum Remix) to create a simple token.</p>	1,3	2
5	6	<p>Bitcoin Security and Privacy</p> <p>Objective: Understand security risks and privacy concerns in Bitcoin</p> <p>Topics: Private key security, Bitcoin transaction anonymity, Common attack vectors (51% attack, Sybil attack)</p> <p>Activity: Read a technical paper on Bitcoin security and summarize key findings.</p>	1,3	2
6	7	<p>DeFi and Future of Cryptocurrency</p> <p>Objective: Understand Decentralized Finance (DeFi) and upcoming blockchain trends.</p> <p>Topics: DeFi platforms, Staking and yield farming, The future of Bitcoin and Layer 2 solutions</p> <p>Activity: Research and present an upcoming DeFi project.</p>	2,4, 6	2
6	8	<p>Cross-Chain Transactions and Atomic Swaps</p> <p>Objective: Learn how Bitcoin interacts with other blockchains.</p> <p>Topics : Introduction to atomic swaps, Hashed Time-Locked Contracts (HTLC) ,Cross-chain trading using Lightning Network , Role of decentralized exchanges (DEXs)</p> <p>Hands-on Activity: Use a testnet atomic swap simulator to swap Bitcoin with another cryptocurrency.</p>	2,4, 6	2
6	9	<p>Regulatory Challenges and Legal Considerations in Bitcoin</p> <p>Objective: Understand the legal aspects and global regulations of Bitcoin. Topics : Bitcoin's legal status in different countries, Taxation and reporting for Bitcoin transactions, Anti-Money Laundering (AML) and Know Your Customer (KYC) laws, Impact</p>	2,4, 6	2



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		of Central Bank Digital Currencies (CBDCs) on Bitcoin Activity: Research Bitcoin regulations in our country and prepare a summary. Analyze a case study of Bitcoin-related legal action (e.g., Silk Road, Mt. Gox).		
6	10	Stablecoins - Bridging Crypto and Traditional Finance Objective: Understand the role of stablecoins in the cryptocurrency ecosystem. Topics : Definition and types of stablecoins (Fiat-backed, Crypto-backed, Algorithmic) , Use cases and advantages of stablecoins, Risks and regulatory challenges, Popular stablecoins (USDT, USDC, DAI) Activity: Research and compare different stablecoins based on their stability mechanism and adoption.	2,4,6	2

Recommended Books:

1. “Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN”, 2nd Edition by Andreas M. Antonopoulos, June 2017, O'Reilly Media, Inc. ISBN: 9781491954386.
2. “Blockchain Applications: A Hands-On Approach”, by Arshdeep Bahga, Vijay Madiseti, Paperback – 31 January 2017.
3. “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction”, July 19, 2016, by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Princeton University Press.
4. Mastering Blockchain”, by Imran Bashir, Third Edition, Packt Publishing
5. “Mastering Ethereum: Building Smart Contracts and Dapps Paperback” by Andreas Antonopoulos, Gavin Wood, Publisher(s): O'Reilly Media
6. “Blockchain revolution: how the technology behind bitcoin is changing money, business and the world \$ don tapscott and alex tapscot, portfolio penguin, 856157449

Online References:

Sr. No.	Website Name
1	https://andersbrownworth.com/blockchain/
2	https://andersbrownworth.com/blockchain/public-private-keys/
3	https://www.coursera.org/learn/cryptocurrency
4	https://coinmarketcap.com/

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.



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2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

TUT:

ISE:

ISE- will be conducted for four or 50% of tutorials. Continuous pre-defined rubrics- based evaluation for 20 marks. Remaining Four experiments or 50% of experiments. Continuous pre-defined rubrics- based evaluation for 20 marks. Simulation using modern tools to solve the given problem statement/ Debate/ research paper analysis/ case studies for 10 marks/Mini project



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM73	Blockchain Security	2	2	--	4	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tut		50	--	--	--	50			

Pre-requisite Course Codes		25DM71, 25DM72		
After the successful completion students should be able to:				
Course Outcomes	CO1	Explain the architectural layers, cryptographic foundations, and security properties of blockchain systems.		
	CO2	Analyze blockchain network attacks and application-level vulnerabilities.		
	CO3	Design secure smart contracts and decentralized applications using secure coding practices.		
	CO4	Evaluate blockchain security solutions including privacy-preserving mechanisms and Layer-2 security enhancements.		
Module No.	Unit No.	Topics	Ref.	Hrs.
1		Foundations of Blockchain Security	1,3	5
	1.1	Introduction to Blockchain Security : Evolution from centralized systems to decentralized systems, Layers of blockchain: Application Layer, Contract Layer, Network Layer, Data Layer, Threat Model & Attack Surface, What is a threat model.		
	1.2	Security properties: Immutability, Transparency, Decentralization		
		Wallet security and key management, Zero Knowledge Proofs (ZKP) and zk-SNARKs, Privacy – enhancing mechanisms		
2		Blockchain Application Exploitation	3	6
	2.1	Introduction to Blockchain Application Layer, Smart contract execution environment, Attack surface in blockchain applications, Compare and Contrast Front End and Back End risks, Overview of MFA, MFA And Blockchain, Mining Pool Vulnerabilities, Comprehensive Security Strategies in Web3		
	2.2	DeFi Exploits - Flash Loan Attacks - No-collateral borrowing, Price manipulation, Oracle Manipulation - Tampering price feeds, Liquidity Pool Exploits, Automated Market Maker vulnerabilities		
	2.3	Wallet & Key Exploitation Private key theft, Phishing attacks, Seed phrase leakage,		



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		Malware attacks, Exchange hacks		
3		Blockchain Network Security	1	5
	3.1	Peer-to-peer network architecture, Common blockchain attacks: 51% Attack, Sybil Attack, Eclipse Attack, Double Spending Attack, Selfish Mining, P2P and DHT Attacks, Partition Attacks		
	3.3	Secure propagation and validation of blocks –Secure Block Propagation -Propagation delay attacks, Latency and fork probability, Secure Block Validation- rejection of invalid or malicious blocks,		
	3.4	Security in permissioned blockchain (Hyperledger)		
4		Smart Contract Security	4	5
	4.1	Introduction to Smart Contracts (Solidity basics)		
	4.2	Common vulnerabilities: Reentrancy Attack Integer Overflow/Underflow Front-running Timestamp dependency		
	4.3	Secure coding practices in Solidity		
5		Advanced Blockchain Security	1,3	5
	5.1	Layer-2 security (Lightning Network, Rollups) Cross-chain security risks Regulatory and compliance challenges		
	5.2	Blockchain Application Audit Future trends: Quantum threats to blockchain, Blockchain security solutions		
Total				26

Self-Learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Module No.	Sr. No.	Suggested List of Tutorials
1	1	Consensus Mechanisms & Security



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		<p>Explain how PoW prevents double spending in Bitcoin. Calculate block mining probability given hash power distribution. Compare PoW vs PoS in terms of security risks. Discuss how PBFT ensures safety in permissioned blockchains like Hyperledger Fabric.</p>
2	2	<p>Blockchain Network Attacks If an attacker controls 40% hash power, analyse success probability of double spending. Draw architecture of Sybil attack. Explain how Eclipse attack isolates a node. Case study: 51% attack on Ethereum Classic.</p>
3	3	<p>Smart Contract Vulnerabilities Explain Identify vulnerability in given Solidity snippet. Reentrancy attack with reference to The DAO hack. Suggest mitigation strategies using OpenZeppelin libraries. Explain checks-effects-interactions pattern.</p>
4	5	<p>Wallet & Key Management Security Design a 2-of-3 multisig wallet. Explain risks of storing private keys on exchanges. Compare hardware wallets and software wallets. Discuss seed phrase recovery attacks.</p>
	6	<p>Zero Knowledge Proofs & Privacy Explain Zero Knowledge using “Ali Baba cave” example. Compare privacy in Bitcoin vs Zcash. Explain how zk-Rollups improve security and scalability. Analyze trade-offs between transparency and privacy.</p>
	7	<p>Layer-2 & DeFi Security Explain security risks in DeFi flash loans. Compare Optimistic Rollups vs zk-Rollups. Analyze a real-world DeFi exploit case. Discuss MEV (Miner Extractable Value).</p>
5	8	<p>Case Study & Research Discussion Analysis of DAO Hack Discussion on recent blockchain exploit Research paper review Threat modeling exercise Assignment: Students prepare security audit report of a simple smart contract.</p>

Recommended Books:

- [1] “Blockchain Security from the Bottom Up”, John Wiley & Sons Inc.
- [2] “Blockchain and the Law”, Primavera De Filippi, Aaron wright
- [3] “Ultimate Blockchain security handbook”, Taha Sajid, AVA publication
- [4] “Fundamentals of Smart Contract Security”, Richard Ma, Momentum Press
- [5] “Real-World Cryptography for Ethereum Developers” – Richard Moore (Apress)
- [6] “Layer 2 Scaling for Ethereum Developers” – by DApp University / Packt
- [7] “Cryptocurrency Forensics “,by Nick Furneaux , John Wiley & Sons Inc
- [8] “Mastering Ethereum” – Andreas M. Antonopoulos & Gavin Wood.
- [9] “Blockchain Economics” – Chris Burniske / Packt

Video Lectures

NPTEL - <https://youtu.be/UAKfY33SMFo?si=OpVONIqwDe56JltS>



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25DM74	Industrial Blockchain	L	T	P	SL	L	T	P	Total	
		2	2	-	4	2	2	-	4	
		Examination Scheme								
			ISE	MSE	ESE		Total			
					Min	Max				
		Theory	20	30	20	50	100			
		Tu	50	--	--	--	50			

<https://www.youtube.com/watch?v=L83K2e8s4A>

<https://youtu.be/Hqqcq-KhBho?si=a49RsNzUOn83loqA>

Legends: - High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply	Analyze	Evaluate	Create
		✓			

Pre-requisite Course Codes	25DM71, 25DM72, 25DM73	
After the successful completion students should be able to:		
Course Outcomes	CO1	Describe enterprise blockchain architecture.
	CO2	Apply enterprise blockchain platforms and smart contract concepts to design blockchain solutions.
	CO3	Analyze decentralized finance systems, consensus mechanisms, and enterprise blockchain frameworks.
	CO4	Analyze blockchain security mechanisms.
	CO5	Design enterprise blockchain solutions

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Enterprise Blockchain Fundamentals	1,2	5
	1.1	Review of Blockchain Fundamentals, Types of Blockchain		
	1.2	Enterprise Blockchain Concept, Enterprise vs Public blockchain, Features		
	1.3	Enterprise Blockchain Architecture		
2		Enterprise Blockchain Platforms and Framework	1,2	6
	2.1	Introduction to Hyperledger, Hyperledger frameworks: Fabric, Sawtooth, Hyperledger Fabric Architecture, Membership Service Provider (MSP)		
	2.2	Introduction to R3 Corda: Corda architecture, Nodes, transactions, Notary		



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	2.3	Introducing Quorum: Key Features, Consensus Mechanisms: RAFT, IBFT, Enterprise Applications: Digital payments, Asset tokenization		
3		Decentralized Finance (DeFi) in Enterprise Blockchain	1,2	5
	3.1	Introduction to Decentralized Finance (DeFi), DeFi Architecture and Components, Working principle of Automated Market Makers (AMM), Example platforms: Uniswap, Aave		
	3.2	Core DeFi Services: Decentralized Lending and Borrowing, Decentralized Exchanges, Stable coins, Yield Farming and Staking		
4		Enterprise Blockchain Security and Consensus	1,2,3,6	5
	4.1	Blockchain Security Concepts, Identity Management		
	4.2	Security and Risks in DeFi: Smart contract vulnerabilities, Flash loan attacks (concept), Private key security, Risks in DeFi adoption		
	4.3	Crash Fault Tolerant Consensus, RAFT Consensus		
	4.4	Secure Multi-Party Computation (SMPC) in Enterprise Blockchain: Concept and architecture, Distributed trust model, Secure data sharing without revealing actual data		
	4.5	Blockchain Interoperability and Cross-Chain Security: Need for interoperability in enterprise systems, Cross-chain communication architecture, Security challenges in cross-chain communication, Atomic swaps – concept		
5		Enterprise Blockchain Adoption, Stakeholders and Sales Cycle	1,2,8	5
	5.1	Enterprise Blockchain Sales Cycle, Phases of blockchain sales cycle, Challenges in enterprise blockchain adoption		
	5.2	Blockchain Roles and Stakeholders Technical roles, Business roles, Organizational stakeholders, Responsibilities and interactions among stakeholders.		
	5.3	IT-Based Sales Cycle and Enterprise Integration, Overview of traditional IT solution sales cycle, Comparison with blockchain sales cycle.		
			Total	26

Self-Learning: -

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment:

ISE:



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ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Activities to be Completed in Tutorial			
1	Consensus Mechanism Analysis Study and Explain: RAFT, PBFT, PoA, IBFT consensus Working , Advantages, Comparison Analysis	13	2
2	Case Study : TradeLens: Improving global trade	12	4
3	DeFi application case study : IBM World Wire - Global Payments	11	2
4	Case study discussion of enterprise blockchain adoption. Study enterprise blockchain of: <ul style="list-style-type: none"> • JPMorgan Chase Onyx • Adoption lifecycle • Benefits 	10	2
5	Interbank Information Network (IIN) Case study and analysis of Interbank Information Network (Liink) focusing on architecture, stakeholders, and benefits in enterprise banking.	7	2
6	Case study: Onyx and JPM Coin Case study and analysis of Onyx and JPM Coin focusing on enterprise blockchain architecture, digital payment mechanism, and enterprise applications.	7, 10	2
7	Explore Chain link (Oracles): Comparative analysis of blockchain oracle mechanisms and Chain link architecture, focusing on working, security, and enterprise applications.	9	2
8	Enterprise blockchain solution design Design blockchain solution for certificate verification or Supply chain involve <ul style="list-style-type: none"> • Stakeholders • Platform 	13	2
			26

Course Assessment: -

Tutorial:

ISE

- a. Based on predefined rubrics carrying 10 Marks.
- b. Mini-project/Activity carrying-10 Marks
- a. Based on predefined rubrics carrying 10 Marks
- b. Oral and/or Practical Examination-20 Marks

Recommended Books

1. J. Holbrook, “Architecting Enterprise Blockchain Solutions”, Wiley Sybex, 2020.
2. Oracle, “Enterprise Blockchain For Dummies®,” Oracle Special Edition, 2019.
3. J. Holbrook, “Architecting Enterprise Blockchain Solutions”, 1st ed. Indianapolis, IN.
4. Tormen, Romain. Blockchain for decision makers: A systematic guide to using blockchain for improving your business. Packt Publishing Ltd, 2019.
5. Swan, Melanie. Blockchain: Blueprint for a new economy. " O'Reilly Media, Inc.", 2015.



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6. IBM Research SMPC Tutorials
7. Whitepapers on JPM Coin and JPMorgan documentation
8. Deloitte & PwC Blockchain Reports
9. Chainlink Oracle Official Documentation, Chainlink whitepaper
10. JPMorgan Onyx official website, Onyx Digital Assets whitepapers, PwC Global Blockchain Survey
11. IBM Blockchain World Wire whitepaper, Stellar network documentation (World Wire uses Stellar), Stablecoin mechanism documentation
12. IBM TradeLens whitepapers, Maersk & IBM joint announcements, IBM Blockchain case study archives
13. Blockchain with Hyperledger Fabric, Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing

Online Recourses:

1. <https://www.oreilly.com/library/view/architecting-enterprise-blockchain/9781119557692/c05.xhtml>
2. Coursera course on “Blockchain Revolution specialization”
<https://www.coursera.org/specializations/blockchain-revolution-enterprise>

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											(PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2												
CO2	2				1			1	2	2			
CO3	2	2	1					1	2	2			1
CO4	2	1			1			2	2	2			2
CO5	2	1	1		1	1		2	2	2			2

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -0

Blooms level

Remember	Understand	Apply ✓	Analyze ✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM81	Cyber Security Essentials	2	2	-	2	2	--	2	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Tutorial		50	--	--	--	50			

Pre-requisite Course Codes		
Course Outcomes	CO1	Identify cybersecurity threats, vulnerabilities, and risks in digital systems.
	CO2	Analyze the theoretical principles behind common attack vectors and defense mechanisms
	CO3	Evaluate security policies, risk management strategies, and regulatory frameworks.
	CO4	Discuss the theoretical foundations of cryptography and data protection.
	CO5	Critique theoretical models of secure network architectures and propose enhancements.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Cybersecurity Threats and Vulnerabilities		
	1.1	Overview & Importance of Cybersecurity <ul style="list-style-type: none"> Role and significance of cybersecurity in the digital age Overview of key cybersecurity domains Historical milestones and evolution of cyber threats Impact of past incidents on current cybersecurity paradigms 	1, 2, 4	2
	1.2	Fundamental Terminologies & Concepts <ul style="list-style-type: none"> Definitions of threat, vulnerability, risk, and mitigation Overview of cybersecurity frameworks and theoretical models Classification of cyber threats and threat actors Threat intelligence 	1, 2, 4	2



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	1.3	Malware: Viruses, Worms, Trojans, and Ransomware <ul style="list-style-type: none"> • Characteristics and behaviors of various malware types • Theoretical discussion of propagation methods and impact 	1, 2, 4	1
	1.4	Vulnerability Fundamentals <ul style="list-style-type: none"> • Examination of vulnerabilities in software, hardware, and human factors • Common security weaknesses (e.g., unpatched systems) 	1, 2, 4	2
2	Cyber Attack Vectors and Defense Mechanisms			



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	2.1	Introduction to Attack Vectors <ul style="list-style-type: none"> • Definition and significance of attack vectors • Overview of classification 	1, 2, 4	1
	2.2	Network-Based Attacks <ul style="list-style-type: none"> • DoS/DDoS, Man-in-the-Middle attacks • Network vulnerabilities 	1, 2, 4	1
	2.3	Application-Based Attacks <ul style="list-style-type: none"> • SQL Injection, XSS, CSRF • Underlying exploitation principles 	1, 2, 4	1
	2.4	Social Engineering & Insider Threats <ul style="list-style-type: none"> • Phishing, spear phishing, pretexting • Theoretical analysis of insider risks 	1, 2, 4	1
	2.5	Advanced Persistent Threats (APTs) <ul style="list-style-type: none"> • Multi-vector, long-term infiltration strategies • Theoretical models of APTs 	1, 2, 4	1
	2.6	Defense Mechanisms <ul style="list-style-type: none"> • Conceptual frameworks for mitigating attacks • Comparative analysis of defense strategies 	1, 2, 4	1
3	Security Policies and Risk Management Strategies			
	3.1	Introduction to Risk Management <ul style="list-style-type: none"> • Theoretical concepts of risk, impact, and likelihood • Overview of risk management processes • Risk Assessment Models: NIST SP 800-30, OCTAVE, DREAD, ISO/IEC 27005 	1, 2, 4	2
	3.2	Security Policies/Standards, Regulatory & Legal Frameworks <ul style="list-style-type: none"> • Analysis of key standards (ISO, NIST, CIS) • Components and rationale behind effective policies • Overview of major regulations (e.g., GDPR, HIPAA) • Impact on cybersecurity practices. 	1, 2, 4	2
	3.3	Incident Response & Disaster Recovery <ul style="list-style-type: none"> • Conceptual models of incident response planning • Best practices from a theoretical standpoint 	1, 2, 4	1
	3.4	Evaluating and Updating Security Policies <ul style="list-style-type: none"> • Critical assessment techniques for policy effectiveness • Theoretical case studies on policy evolution 	1, 2, 4	1
4	Foundations of Cryptography and Data Protection			
	4.1	Introduction to Cryptography <ul style="list-style-type: none"> • Basic principles and history of cryptography • Theoretical importance of confidentiality, integrity, and authenticity • Symmetric and asymmetric encryption • Discussion of use cases and underlying mathematical concepts 	1, 2, 4	2
	4.2	Hashing Algorithms, Digital Signatures & Certificates	1, 2, 4	1



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		<ul style="list-style-type: none"> Overview of hashing techniques and their theoretical applications Analysis of digital signatures and certificate frameworks 		
	4.3	Key Management and Cryptographic Protocols <ul style="list-style-type: none"> Theoretical approaches to secure key generation, distribution, and storage Discussion on cryptographic protocols and their underlying principles 	1, 2, 4	1
	4.4	Data Protection Techniques Encryption Methods: Advanced Encryption Standard (AES) for data at rest, TLS/SSL for securing data in transit. Data Masking Techniques, Tokenization Approaches, Full disk and file-level encryption strategies, Data Loss Prevention (DLP) conceptual models	1, 2, 4	2
5	Secure Network Architectures			
	5.1	Network Security & Frameworks Secure network architecture theories, defense-in-depth strategies, Firewall models and their theoretical foundations, Intrusion Detection & Prevention, Virtual Private Networks (VPNs) & Remote Access Security, VPN technologies and secure tunneling, challenges in ensuring secure remote access.	1, 3, 4	4
	5.2	Wireless Network Security WEP, WPA, WPA2, WPA3, comparative analysis of Secure Network Architectures Authentication Methods: 802.1X Framework, EAP Methods: Attack Vectors: Evil Twin Attacks, Deauthentication Attacks, Man-in-the-Middle (MitM)	1, 3, 4	2
			Total	26

Suggested Tutorials	
Sr. No.	Tutorial
1	Threat Identification Workshop (CO1): An in-class activity where students work in small groups on simulated scenarios to identify potential cybersecurity threats, vulnerabilities, and risks. They document their findings on a shared digital whiteboard or paper. A group report (2–3 pages) summarizing identified threats with justifications, submitted at the end of the session.
2	Historical Cyber Incident Analysis (CO1): A case study in which groups review documented historical cybersecurity incidents to examine the sequence of events, exploited vulnerabilities, and overall impact. A 10-minute group presentation accompanied by a one-page summary report detailing lessons learned.
3	Attack Vector Simulation Discussion (CO2): A group discussion/simulation where students map out theoretical attack vectors (network-based, application-based, etc.) on paper and discuss possible defense mechanisms.



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	A flowchart and a one-page commentary explaining the simulated attack vectors and defenses.
4	Network Attack Case Study (CO2): A case study focusing on a specific network attack (e.g., DDoS or Man-in-the-Middle). Students dissect the case to understand how the attack was executed and evaluate theoretical defense strategies. A detailed case study report (3–4 pages) along with a brief 5-minute summary presentation.
5	Policy Evaluation Assignment (CO3): A written assignment where students are provided with sample security policies to evaluate their strengths and weaknesses using theoretical frameworks, then propose improvements. An analytical essay (4–5 pages) with an annotated copy of the policy document.
6	Risk Management Comparative Analysis (CO3): A written assignment in which students compare various risk assessment models (NIST SP 800-30, OCTAVE, DREAD, ISO/IEC 27005) through research and theoretical analysis. A comparative analysis report (4–5 pages) supported by tables and diagrams as needed.
7	Cryptography Theory Seminar (CO4): A seminar/presentation where students research and present on the theoretical foundations of cryptography—including symmetric vs. asymmetric encryption, hashing, and digital signatures—with emphasis on underlying mathematics and conceptual frameworks. A 15-minute presentation with supporting slides and a brief summary handout (1–2 pages).
8	Data Protection Techniques Debate (CO4): A debate/discussion activity that divides the class into teams to debate the merits and drawbacks of various data protection techniques (e.g., AES vs. TLS/SSL, tokenization, data masking) using theoretical evidence. Each team submits a position paper (2–3 pages) outlining their arguments and supporting evidence.
9	Network Architecture Critique Workshop (CO5): A workshop where groups review several secure network architecture models, analyzing defense-in-depth strategies, firewall models, and VPN configurations, then critique their theoretical effectiveness. A critique report (around 3 pages) and a group discussion presentation of key findings.
10	Secure Architecture Enhancement Project (CO5): A group project where teams select an existing network architecture model and propose theoretical enhancements based on current literature and best practices. A comprehensive project report (5–6 pages) along with a 15-minute group presentation outlining proposed improvements.
11	Integrated Threat Analysis Exercise (CO1 & CO2): An in-class activity/simulation where students are given a comprehensive scenario that includes multiple threat elements; they identify threats (CO1) and then analyze associated attack vectors (CO2). A combined analysis report (2–3 pages) and a visual diagram or mind map illustrating the relationship between threats and attack vectors.
12	Attack Response Simulation and Demonstration (CO2 & CO3): A simulation exercise where students role-play an attack scenario in a simulated environment and develop a theoretical incident response plan incorporating risk management and policy-based mitigation strategies. Additionally, the instructor demonstrates a live or recorded attack (e.g., simulated phishing or network intrusion) to illustrate key concepts. A written incident response plan (3 pages) and a brief in-class demonstration analysis with active participation in a discussion.
13	Security Policy and Cryptography Integration (CO3 & CO4): An assignment/discussion where students evaluate how cryptographic techniques (e.g., encryption, key management, digital signatures) support and reinforce security policies and risk management strategies. An integrated analytical report (4 pages) and active participation in an in-class discussion.



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14	Cryptography and Network Architecture Synergy (CO4 & CO5): A group project where students investigate the interplay between cryptographic protocols and secure network design by analyzing case studies and proposing a cohesive integrated model. A project report (5 pages) accompanied by a 15-minute group presentation detailing the proposed integrated model.
15	Comprehensive Security Analysis and Strategic Recommendations (CO1, CO2, CO3, CO4, CO5): In this capstone project, teams are provided with a detailed fictional scenario of a medium-sized organization facing diverse cybersecurity challenges. Students must perform a thorough analysis by identifying potential threats and vulnerabilities (CO1); examining and analyzing relevant attack vectors (CO2); evaluating risk management strategies and security policies (CO3); recommending appropriate cryptographic and data protection measures (CO4); and designing a secure network architecture to mitigate the identified risks (CO5). A comprehensive strategic report (8–10 pages) detailing the analysis, recommendations, and proposed security architecture, along with a final presentation (20 minutes) summarizing the findings and strategic recommendations.

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

ISE-: Activity/ Quizzes/ Assignments (20 Marks)

ISE-: Activity: Case studies, Article Discussion/ Quiz/ Assignments (20 Marks), Seminar on Recent Research paper/ real life Cyber security incident analysis(10Marks)

Recommended Books:

1. William Stallings and Lawrie Brown authored "Computer Security: Principles and Practice" (5th edition), published by Pearson Education in 2023.
2. Charles P. Pfleeger, Shari Lawrence Pfleeger, and Lizzie Coles-Kemp authored "Security in Computing" (6th edition), published by Addison-Wesley Professional in 2023.
3. Bernard Menezes and Ravinder Kumar authored "Cryptography, Network Security, and Cyber Laws" (assumed 3rd edition), published by Cengage Learning in 2021.
4. Matt Bishop authored "Computer Security: Art and Science" (1st edition), published by Addison-Wesley Professional in 2003.



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Online Resources:

1. ITACT 2000: <https://www.meity.gov.in/content/information-technology-act-2000-0>
2. [bgubfugbububjxcgfvvsbdihbfgGhdfgFHtyyhRtMTk4NzY=](https://www.meity.gov.in/content/information-technology-act-2000-0)
3. NIST Cybersecurity Framework: <https://www.nist.gov/cyberframework>
4. MITRE ATT&CK Framework: <https://attack.mitre.org/>
5. OWASP Top Ten: <https://owasp.org/www-project-top-ten/>
6. US-CERT: <https://www.us-cert.gov/>
7. Center for Internet Security (CIS): <https://www.cisecurity.org/>
8. SANS Institute Whitepapers: <https://www.sans.org/white-papers/>
9. Cybrary – Free Cyber Security Training: <https://www.cybrary.it/>
10. Cybersecurity & Infrastructure Security Agency (CISA): <https://www.cisa.gov/>
11. Krebs on Security: <https://krebsonsecurity.com/>
12. Google Security Blog: <https://security.googleblog.com/>
13. Microsoft Security Blog: <https://www.microsoft.com/security/blog/>

NPTEL:

1. <https://nptel.ac.in/courses/128106006>
2. <https://archive.nptel.ac.in/courses/106/106/106106129/>

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -0

Remember	Understand	Apply✓	Analyze ✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned				
		L	T	P	SL	L	T	P	Total	
25DM82	Web application penetration testing and Ethical hacking	2	2	-	2	2	2	--	4	
		Examination Scheme								
			ISE	MSE	ESE		Total			
					Min	Max				
		Theory	20	30	20	50	100			
		Tutorial	50	--	--	--	50			

Pre-requisite Course Codes	Basics of networking and web technologies.	
Course Outcomes	CO1	Integrate foundational cybersecurity concepts with ethical hacking methodologies into a cohesive theoretical framework.
	CO2	Synthesize advanced penetration testing methodologies and stages as applied to web applications.
	CO3	Critique prevalent web application vulnerabilities and the conceptual techniques for their exploitation.
	CO4	Evaluate legal, ethical, and regulatory dimensions that govern ethical hacking practices.
	CO5	Formulate comprehensive strategies for vulnerability assessment and incident response.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	Cybersecurity and Ethical Hacking			
	1.1	Cybersecurity Foundations: Importance of cybersecurity in today's digital landscape. The CIA Triad: Confidentiality, Integrity, Availability. Overview of common cyber threats (malware, phishing, ransomware, DDoS). Types of security controls: Preventive, Detective, Corrective	1, 2	2
	1.2	Ethical Hacking Foundations: Definition, scope, and objectives of ethical hacking. Classification of hackers: White Hat, Black Hat, Grey Hat. Phases of ethical hacking: Reconnaissance, Scanning, Exploitation, Maintaining Access, Covering Tracks	2, 4	2
	1.3	Technical Underpinnings: Basic networking concepts: TCP/IP, DNS, DHCP, OSI Model. Introduction to Linux fundamentals: File permissions, processes, and basic commands	3	2
2	Web Application Security and Vulnerabilities			
	2.1	Web Technologies and Architecture: Overview of web application architecture. Core web protocols: HTTP/HTTPS. Role of front-end technologies: HTML, CSS, JavaScript	5	2
	2.2	Common Web Vulnerabilities:	4, 5	3



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		OWASP TOP10, SQL Injection, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), File Inclusion Vulnerabilities (Local/Remote), Additional vulnerabilities (e.g., XML External Entity attacks)		
	2.3	Vulnerability Assessment: Methods for vulnerability identification. Principles of risk assessment and vulnerability prioritization	1	1
3	Reconnaissance and Information Gathering			
	3.1	Reconnaissance Strategies: Passive reconnaissance techniques (OSINT): WHOIS, DNS enumeration, social media profiling, Active reconnaissance techniques: Port scanning, banner grabbing, network mapping	2, 4	2
	3.2	Tools and Methodologies: Overview of OSINT tools (e.g., conceptual insights into Maltego, Recon-ng, Google Dorks). Review of active scanning tools (e.g., Nmap, Netcat)	4	2
	3.3	Web Application Reconnaissance: Directory enumeration and hidden URL identification. Theoretical exploration of web reconnaissance tools (e.g., Burp Suite, DirBuster)	5	2
4	Penetration Testing Methodologies			
	4.1	Penetration Testing Process: Penetration testing stages: Pre-Engagement, Reconnaissance, Scanning, Exploitation, Post-Engagement. Analysis of theoretical testing approaches.	4	2
	4.2	Testing Methodologies and Approaches: Understanding and Comparative study of Black Box, White Box, and Grey Box testing, Exploitation techniques. Red Teaming, Blue Teaming, Purple Teaming, Social Engineering Testing, Risk-Based Testing.	4, 5	3
	4.3	Frameworks and Guidelines: Overview frameworks: NIST Penetration Testing Guide, OWASP Testing Guide. Differentiation between vulnerability assessment and penetration testing approaches	1	1
5	Legal, Ethical, and Defensive Perspectives			
	5.1	Legal and Regulatory Context: Overview of cyber laws and regulations (e.g., IT Act, GDPR, HIPAA, CCPA), ethical considerations, compliance, and the importance of permissions	2	2
	5.2	Incident Response and Defensive Mechanisms: Incident Response Lifecycle: Preparation, Detection, Containment, Recovery. Defensive strategies: System hardening, firewalls, IDS/IPS, patch management.	1	2
	5.3	Case Studies and Governance: Analysis of significant cybersecurity breaches, Overview of governance frameworks and compliance standards (ISO 27001, PCI DSS, SOC 2) and strategic defense best practices	2	2



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Total	26
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Suggested Tutorials	
Sr. No.	Tutorial
1	<p>Network Traffic Analysis with Wireshark</p> <p>Objective: Use Wireshark to analyze packet captures and identify potential threats.</p> <p>Activity:</p> <ol style="list-style-type: none"> 1. Open provided .pcap files in Wireshark. 2. Identify protocols, IP addresses, and suspicious traffic patterns. 3. Detect threats like DNS anomalies, SQL injection, or SYN floods. 4. Answer analysis questions, e.g., attacker IP or unauthorized access details. <p>Tools: Wireshark and pre-captured .pcap files(sample captures).</p>
2	<p>Exploiting and Mitigating Advanced Buffer Overflow Attacks</p> <ul style="list-style-type: none"> • Objective: Analyze and exploit a buffer overflow vulnerability, then implement mitigation techniques. <p>Activity:</p> <ul style="list-style-type: none"> • Use a vulnerable program to: <ul style="list-style-type: none"> o Craft a payload using Python and exploit the vulnerability. o Investigate the memory layout using tools like GDB and Radare2. o Apply modern mitigation techniques (ASLR, stack canaries) to secure the program.
3	<p>Deconstructing Cyber Attacks from Real-World Incidents</p> <ul style="list-style-type: none"> • Objective: Analyze the stages of a real-world cyber attack and propose a response strategy. <p>Activity:</p> <ul style="list-style-type: none"> • Provide learners with anonymized data from a famous cyber attack (e.g., SolarWinds breach). <ul style="list-style-type: none"> o Use log files, network traffic, and timelines to reconstruct the attacker's steps. o Propose immediate actions, long-term defensive strategies, and policy improvements.
4	<p>Designing a Cybersecurity Framework for a Smart City</p> <ul style="list-style-type: none"> • Objective: Create a scalable cybersecurity framework for interconnected IoT systems in a smart city. <p>Activity:</p> <ul style="list-style-type: none"> • Provide a scenario with IoT devices (traffic lights, surveillance cameras, etc.). <ul style="list-style-type: none"> o Identify potential vulnerabilities and map them to threats. o Propose a secure architecture using tools like Zero Trust and IDS/IPS for IoT.
5	<p>Simulating an Advanced Persistent Threat (APT)</p> <ul style="list-style-type: none"> • Objective: Simulate an APT attack on a controlled network and analyze the indicators of compromise (IOCs). <p>Activity:</p>



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	<ul style="list-style-type: none"> • Learners simulate an APT using tools like Metasploit and Cobalt Strike alternatives (e.g., Covenant). <ul style="list-style-type: none"> o Perform reconnaissance, exploit vulnerabilities, and maintain persistence. o Analyze IOCs using Splunk or ELK stack for detection and reporting.
6	<p>Reconnaissance Competition: Defend vs. Attack</p> <ul style="list-style-type: none"> • Objective: Perform reconnaissance to identify vulnerabilities while defending your own system. <p>Activity:</p> <ul style="list-style-type: none"> • Split students into two teams: <ul style="list-style-type: none"> o Team A: Conduct passive and active reconnaissance on Team B's mock network. o Team B: Implement monitoring tools (e.g., Wireshark, Suricata) to detect Team A's activities. o Swap roles after analyzing each round's performance.
7	<p>Exploiting Multi-Stage Web Vulnerabilities</p> <ul style="list-style-type: none"> • Objective: Chain multiple vulnerabilities to compromise a web application entirely. <p>Activity:</p> <ul style="list-style-type: none"> • Set up a vulnerable application with: <ul style="list-style-type: none"> o Weak authentication (SQL injection). o Improper session management (Session ID theft). o File upload vulnerability (Remote code execution). o Learners must exploit all three in sequence to gain full system access.
8	<p>Redesigning a Penetration Testing Report</p> <ul style="list-style-type: none"> • Objective: Create a business-focused penetration testing report from technical findings. <p>Activity:</p> <ul style="list-style-type: none"> • Provide raw penetration test data, including vulnerabilities and exploited systems. <ul style="list-style-type: none"> o Convert technical findings into an executive summary for non-technical stakeholders. o Include risk prioritization, cost implications, and remediation recommendations.
9	<p>Analyzing Compliance Gaps in a Healthcare System</p> <ul style="list-style-type: none"> • Objective: Evaluate a healthcare network for compliance with HIPAA regulations. <p>Activity:</p> <ul style="list-style-type: none"> • Provide a virtualized healthcare setup. <ul style="list-style-type: none"> o Identify gaps in data encryption, access controls, and audit logs. o Propose solutions to meet compliance standards and create an audit report.



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10

Incident Response Drill with Live Attack Simulation

- **Objective:** Develop and execute an incident response plan for a simulated security incident.

Activity:

- Simulate an attack (e.g., ransomware outbreak) in a controlled lab environment.
 - o Detect and contain the attack.
 - o Perform forensic analysis to determine the root cause.
 - o Report findings and execute a recovery plan.



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Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

ISE-1: Activity, Quizzes, Assignments (20 Marks)

ISE-2: Activity: Case studies, Article Discussion, Quiz and Assignments (20 Marks), Attack simulations/ Penetration testing Project(10Marks)

Recommended Books:

1. William Stallings, *Computer Security Principles and Practice*, Seventh Edition, Pearson Education,
2. Charles P. Pfleeger, *Security in Computing*, Fifth Edition, Pearson Education,
3. Bernard Menezes, *Network Security and Cryptography*, Cengage Learning.
4. Ummed Meel, *Advanced Penetration Testing with Kali Linux: Unlocking Industry-Oriented VAPT Tactics*, BPB Publications,
5. Prakhar Prasad, *Mastering Modern Web Penetration Testing*, Packt Publishing

Online Resources:

1. <https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-53r5.pdf>
2. <https://www.csoonline.com/article/571697/penetration-testing-explained-how-ethical-hackers-simulate-attacks.html>
3. <https://link.springer.com/article/10.1365/s43439-023-00100-2>
4. <https://owasp.org/www-project-web-security-testing-guide/>
5. <https://amigocyber.com/ethical-hacking-in-practice-real-world-case-studies/>

Legends:- High: 03, Medium: 02,Low: 01, No Mapping: -0

Remember	Understand✓	Apply✓	Analyze ✓	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM83	Digital Forensics	2	2	-	4	2	2	--	4
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
		Theory	20	30	20	50	100		
Tutorial	50	--	--	--	50				

Pre-requisite Course Codes	25DM81, 25DM82	
Course Outcomes	CO1	Discuss the scope of digital forensics, cybercrime investigation flow, and discipline-specific challenges.
	CO2	Differentiate digital evidence types and crime/incident scene handling requirements across private-sector and law-enforcement contexts.
	CO3	Interpret evidence lifecycle principles including integrity, chain of custody, documentation, reporting, and testimony expectations.
	CO4	Evaluate computer and network forensic artifact sources and reconstruction approaches used in investigations.
	CO5	Examine mobile and cloud forensic challenges alongside legal and privacy considerations (incl. IT Act 2000/2008 context).

Module No.	Unit No.	Topics	Ref.	CO.
1		Foundations of Digital Forensics Science & Computer Crime		1
	1.1	Computer forensics and investigations as a profession; Understanding computer forensics; Preparing for computer investigations; Maintaining professional conduct.	1	
	1.2	Navigating the Ethical Landscape of Digital Investigations	2	
	1.3	What is forensic science; What is digital forensics; Uses of digital forensics; The digital forensics process; Locard's exchange principle; Scientific method; Role of the forensic examiner in the judicial system.	5	
	1.4	Bits, bytes, and numbering schemes; File extensions and file signatures; Storage and memory; Computing environments; Data types; File systems; Allocated and unallocated space; How magnetic hard drives store data.	5	
2		Cyber Crime Scene Analysis & Evidence Acquisition		2
	2.1	Processing crime and incident scenes; Identifying digital evidence; Collecting evidence in private-sector incident scenes; Processing law enforcement crime scenes; Preparing for a search; Securing a computer incident or crime scene; Seizing digital evidence at the scene; Storing digital evidence; Obtaining a digital hash.	1	



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	2.2	Data acquisition; Understanding storage formats for digital evidence; Determining the best acquisition method; Validating data acquisitions; Performing RAID data acquisitions; Using remote network acquisition tools.	1	
	2.3	Acquisition of Live Analysis and Volatile Data.	2	
	2.4	Crime scenes and collecting evidence; Documenting the scene; Chain of custody; Cloning; Live system versus dead system; Hashing.	5	
3		Evidence Management, Reporting, and Presentation		3
	3.1	Report writing for high-tech investigations; Understanding the importance of reports; Guidelines for writing reports.	1	
	3.2	Expert testimony in high-tech investigations; Preparing for testimony; Testifying in court; Preparing for a deposition or hearing; Preparing forensics evidence for testimony.	1	
	3.3	Ethics for the expert witness; Applying ethics and codes to expert witnesses; Ethical difficulties in expert testimony.	1	
	3.4	Forensics Investigation Reporting.	2	
	3.5	Novel Cryptographic Hashing Technique for Preserving Integrity in Forensic Samples; Authentication and Admissibility of Forensic Evidence under Indian Criminal Justice Delivery System: An Analysis.	3	
	3.6	Final report themes within evidence collection and presentation.	5	
4		Computer Forensics and Network Forensics		4
	4.1	File System Forensics; Windows Forensics and Registry Analysis; Network Forensics; Unmasking Web Browser Artifacts; Anti-forensics Techniques.	2	
	4.2	Working with Windows and DOS systems; Understanding file systems; Exploring Microsoft file structures; Examining NTFS disks; Understanding whole disk encryption; Understanding the Windows registry; Understanding Microsoft startup tasks; Understanding virtual machines.	1	
	4.3	Macintosh and Linux boot processes and file systems; Examining UNIX and Linux disk structures and boot processes.	1	
	4.4	Computer forensics analysis and validation; Validating forensic data; Addressing data-hiding techniques; Performing remote acquisitions.	1	
	4.5	Virtual machines, network forensics, and live acquisitions; Network forensics overview; Developing standard procedures for network forensics; Using network tools.	1	
	4.6	Windows system artifacts; Network forensics; Internet and E-mail.	5	
5		Mobile Forensics, Cloud Forensics, and Legal Aspects		5
	5.1	Cell phone and mobile device forensics; Understanding acquisition procedures for cell phones and mobile devices.	1	
	5.2	Mobile device forensics; Looking ahead: challenges and concerns, including cloud forensics and solid state drives.	5	
	5.3	Introduction to the Cloud; Trends in Cyber and Privacy Laws and Their Impact on DFIR; DFIR Investigations – Logs in AWS; DFIR Investigations – Logs in Azure; DFIR Investigations – Logs in GCP; Cloud Productivity Suites; Cloud Evidence Acquisition; Analyzing Compromised Containers.	4	
	5.4	Challenges in Digital Forensics and Future Aspects; International Cyberspace Laws: A Review; Unraveling the Dark Web; Deepfakes;	3	



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		Authentication and Admissibility of Forensic Evidence under Indian Criminal Justice Delivery System: An Analysis.		
Total				26

Course Assessment:

ISE:

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MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Suggested list of Tutorials:

Sr. No.	Tutorial	Ref.	CO
1	Investigation scoping and role-boundary matrix: A suspected data-theft incident involves an office workstation, a shared folder, and a personal laptop. The brief contains partial timeline hints, unclear authority, and competing priorities (business continuity vs investigation). Create an investigation scope matrix that states objectives, boundaries, stakeholders, constraints, and assumptions. Separate facts from unknowns, produce at least 15 clarifying questions, and draft a concise initial plan that explains what should be examined first and why (process-level only). Tools: scope matrix template, RACI sheet, NIST IR lifecycle handout, timeline worksheet (Sheets/Excel). Activity format: small-group tabletop (4–5) with a short class debrief on scope creep and authority.	1, 5	CO1
2	Hypothesis tree for cybercriminalistics reasoning: A case shows intermittent network spikes, a privileged login at an unusual hour, and a missing archive file, but also mentions planned maintenance. Construct a hypothesis tree with at least three competing explanations. For each hypothesis, list supporting indicators, disconfirming indicators, and what additional evidence would confirm or refute it. Rank hypotheses using confidence levels and explicitly state uncertainty and alternative interpretations.	2, 5	CO1
3	Evidence reliability and limits of conclusions: Artifact summaries include missing logs, time drift between systems, and partial records during key windows. Create a defensibility matrix that rates potential claims about timeline, user action, attribution, and data access as strong, moderate, or weak. Write a limitations section that clearly states what cannot be concluded and why, while preserving defensible conclusions.	1, 5	CO1
4	Digital evidence identification and volatility ranking: A workplace scene includes a laptop, phone, USB drive, Wi-Fi router, CCTV recorder, email account, and shared folder. Tampering risk is present and	1, 5	CO2



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	documentation is incomplete. Prepare an evidence inventory and order-of-volatility ranking. For each evidence source, state contamination risks and the essential documentation needed to preserve context and integrity.		
5	Corporate versus law-enforcement scene handling decision tree: The same incident must be handled as (a) a corporate internal investigation and (b) a law-enforcement crime scene. Create a decision tree showing authorizations, documentation expectations, notification triggers, and handover points. Identify process differences that could affect admissibility and credibility, and propose controls that reduce those risks. Tools: decision-tree template (diagrams.net), chain-of-custody form, policy/authorization checklist. Activity format: structured debate (two groups represent corporate IR vs law enforcement) followed by a consensus checklist.	1	CO2
6	Acquisition strategy selection under constraints with validation logic: An investigation involves an encrypted laptop, a RAID-based server, remote endpoints, and limited time. Choose a high-level acquisition approach per asset and justify tradeoffs. Design validation checkpoints using integrity concepts such as hashing, repeatability, and documentation checkpoints. Propose a prioritization order and justify it under time pressure. Tools: acquisition decision matrix, integrity checkpoint template, tool-context list (FTK Imager, Guymager, dd) for naming only.	1, 2	CO2
7	Chain-of-custody defect detection and correction: A chain-of-custody record contains missing signatures, inconsistent timestamps, unclear transfer reasons, and ambiguous storage controls. Identify all defects, classify severity (critical, major, minor), propose realistic corrective actions, and rewrite the custody record into a corrected, court-ready format with clear handoffs and storage entries. Tools: chain-of-custody template, evidence label template, custody audit checklist.	1, 5	CO3
8	Report writing from raw notes to structured findings: Raw investigator notes and artifact summaries mix observations, assumptions, and varying confidence. Convert the material into a structured report excerpt with background, scope, methodology summary, findings, and limitations. Ensure each finding is evidence-linked, interpretations are separated, and uncertainty is stated using disciplined language (observed, indicates, consistent with). Tools: report template, findings-to-evidence mapping table, wording checklist. Activity format: peer-review circle (each report reviewed by 2 peers using a checklist) and a short revision round.	1, 2	CO3
9	Expert testimony preparation with exhibits: A mock cross-examination challenges integrity, bias, tool reliability, and alternative explanations. Prepare 15 questions with best-possible responses, select at least 8 exhibits, and map each exhibit to a specific claim it supports. Add an ethics boundary statement explaining what cannot be concluded from the available evidence and where expert opinion must stop. Tools: mock testimony question bank, exhibit register template, objection/credibility checklist.	1, 3	CO3
10	Windows artifact correlation and timeline reconstruction: Summaries of Windows artifacts include logon activity, USB usage, program	2, 5	CO4



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	execution traces, browser activity, and file access hints across multiple days. Build a detailed timeline with confidence tags per event and identify gaps. Propose additional artifact sources that would reduce uncertainty and write a short narrative that explains the sequence while acknowledging plausible alternative interpretations. Tools: timeline worksheet, confidence-tag rubric, tool-context list (Plaso, Timesketch, KAPE, RegRipper) for naming only.		
11	Linux and macOS boot and persistence reasoning: Evidence summaries include authentication logs, scheduled task entries (cron or launchd/systemd), shell history, and package changes. Classify each activity as benign administration, suspicious persistence, or ambiguous. For each suspicious indicator, provide at least two benign alternative explanations and state what evidence would disprove those alternatives, ending with a balanced conclusion. Tools: classification rubric, log interpretation worksheet, tool-context list (journalctl concepts, osquery concepts) for naming only.	1	CO4
12	Network forensics reconstruction from multi-log evidence: Firewall events, DNS queries, proxy logs, and endpoint alerts suggest suspicious activity but do not show payloads. Reconstruct an intrusion sequence across stages such as initial access, internal discovery, command and control, and data exfiltration. Identify the weakest-evidence stage, justify why it is weak, and propose additional evidence sources that would strengthen reconstruction. Tools: correlation matrix sheet, kill-chain mapping sheet, tool-context list (Wireshark, Zeek, Suricata, ELK/Splunk) for naming only. Activity format: group case conference where one group presents a reconstruction and another group challenges weak links.	1, 2, 5	CO4
13	Anti-forensics impact assessment and survivability: A suspect system shows indicators of log clearing, timestomping, wiping, and encrypted containers. Identify which artifact categories are likely impacted and which commonly survive. Produce a defensibility table listing which conclusions remain supportable and which become speculative. Propose a minimal corroboration plan using independent evidence sources to restore confidence. Tools : survivability checklist, defensibility matrix template, tool-context list (shadow copies concepts, USN Journal concepts, memory forensics concepts) for naming only.	1, 2	CO4
14	Mobile forensics interpretation with alternative hypotheses: A logical extraction summary includes app installation history, permission changes, backup timestamps, location toggles, and chat metadata counts. Infer a plausible timeline, distinguish user-driven actions from automated system behavior, generate alternative explanations for suspicious patterns, and write limitations emphasizing what logical extraction cannot prove due to encryption, app design, and cloud sync effects. Tools: mobile artifact worksheet, timeline sheet, tool-context list (ALEAPP, iLEAPP, AXIOM, UFED) for naming only.	1, 5	CO5
15	Cloud forensics triage from log patterns with legal boundaries: A cloud compromise narrative includes summarized API activity such as unusual sign-ins, key creation, anomalous storage access, and container configuration changes. Identify suspicious patterns and likely attacker objectives, map evidence sources by layer (identity, storage, network, compute, SaaS), and draft an authorization and notification checklist	3, 4	CO5



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reflecting legal and privacy boundaries in the Indian context. Tools : cloud log mapping sheet, tool-context list (AWS CloudTrail/CloudWatch/GuardDuty, Azure Activity Logs, GCP Cloud Logging, Prowler/ScoutSuite) for naming only. Activity format: tabletop incident review (groups produce a one-page executive brief plus a technical annex outline).		
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Course Assessment:

Tutorial:

ISE

Activities will be conducted for 50% of tutorials. Continuous pre-defined rubrics-based evaluation for 20 marks.

- a. This is based on activities based on remaining tutorials. Continuous pre-defined rubrics-based evaluation for 20 marks.
- b. Simulation using modern tools to solve the given problem statement for 10 marks OR 3 research papers analysis presentation.

Recommended Books:

1. H. William (Bill) Nelson; Amelia Phillips; Christopher Steuart. *Guide to Computer Forensics and Investigations*. 4th ed. Course Technology (Cengage Learning), 2010.
2. Akashdeep Bhardwaj; Pradeep Singh; Ajay Prasad. *Practical Digital Forensics: A Guide for Windows and Linux Users*. 1st ed. Bentham Science Publishers, 2024.
3. Keshav Kaushik; Rohit Tanwar; Susheela Dahiya; Komal Kumar Bhatia; Yulei Wu (eds.). *Unleashing the Art of Digital Forensics*. 1st ed. Chapman & Hall/CRC (Taylor & Francis), 2023
4. Ganesh Ramakrishnan; Mansoor Haqanee. *Cloud Forensics Demystified: Decoding Cloud Investigation Complexities for Digital Forensic Professionals*. 1st ed. Packt Publishing, 2024.
5. John Sammons. *The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics*. 2nd ed. Syngress (Elsevier), 2014

Online Resources

1. <https://tools.kali.org/>
2. <https://www.sleuthkit.org/autopsy/>
3. <https://accessdata.com/product-download/ftk-imager-version-4-3-0>
4. <https://www.pearsonitcertification.com/articles/article.aspx?p=462199&seqNum=2>
5. <https://www.cfreds.nist.gov/>
6. <https://www.sleuthkit.org/autopsy/docs/user-docs/4.15/>
7. <https://github.com/keydet89/RegRipper3.0>



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8. https://forensicswiki.xyz/wiki/Linux_Forensics
9. <https://volatilityfoundation.org/>
10. https://www.wireshark.org/docs/wsug_html_chunked/
11. <https://github.com/abrignoni/ALEAPP>
12. <https://dfir.training/resources-and-tools>
13. <https://resources.infosecinstitute.com/category/computer-forensics/network-forensics/web-browser-forensics/>
14. <https://practicalmalwareanalysis.com/>

Remember	Understand	Apply	Analyze	Evaluate	Create
		✓	✓		



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25DM84	Cloud and IOT security	2	2	--	4	2	2	--	4
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
		Tutorial		50	--	--	--	50	

Pre-requisite Course Codes	25DM81, 25DM82, 25DM83	
Course Outcomes	CO1	Differentiate cloud service/deployment models and their security responsibility allocation.
	CO2	Assess cloud security controls for access, protection, visibility, and governance.
	CO3	Analyze IoT threats and vulnerabilities across devices, networks, and application layers.
	CO4	Evaluate IoT security and privacy mitigations for connected systems and their cloud backends.

Module No.	Unit No.	Topic	Reference	Hours
1	Cloud Security Foundations and Data Protection		1,2	8
	1.1	Principles and concepts of cloud security		
	1.2	Cloud service models, deployment models, shared responsibility model		
	1.3	Threat surface, trust boundaries, basic risk terminology		
	1.4	Data identification and classification		
	1.5	Protecting data in the cloud: encryption and key management concepts		
	1.6	Data leakage risks and baseline mitigations		
	Self-study: Shared responsibility mapping examples (IaaS, PaaS, SaaS); Cloud asset inventory and tagging concepts; Data classification examples and control rationale; Key management models comparison			
2	Cloud IAM, Network and Application Security, Monitoring and Governance		1,2,3	7
	2.1	Identity and access management: identity lifecycle, authentication, authorization concepts		
	2.2	Cloud network security: segmentation, filtering controls, secure connectivity concepts		
	2.3	Cloud application security: secure APIs, common misconfiguration patterns, secure SDLC concepts		
	2.4	Cloud security monitoring: logs, metrics, alerting, detection strategy concepts		
	2.5	Incident response in cloud: evidence, containment, recovery		



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	planning Concepts		
	2.6 Compliance and governance: control evidence, audit readiness, zero trust as a governance principle		
	Self-study: IAM failure patterns and privilege misuse scenarios; Network segmentation patterns and control placement; Logging strategy and detection use-cases overview; Compliance evidence artifacts checklist		
3	IoT Communication Foundations and Protocol Security	4,5	6
	3.1 Intro to IoT paradigm and enabling technologies		
	3.2 Cryptography and networking essentials for IoT (conceptual focus)		
	3.3 IoT communication models and modes of connectivity		
	3.4 MQTT security concepts: broker model, TLS, authentication and authorization concepts		
	3.5 HTTP, HTTPS, WebSockets for IoT application flows and security concepts		
	3.6 IoT privacy and security challenges in connected environments		
	Self-study: case studies - Non-IP Based Communication in IoT: Handling Security Challenges; Security Challenges to IoT and Cloud-Based Systems in the Era of Quantum Attacks; Security Challenges of IoT-Enabled Vehicular Communications and Their Countermeasures; Communication Technologies and Security		
4	IoT Attacks, Smart Home and IIoT, Secure Onboarding and Platform Security	4,5	5
	4.1 Attacks against IoT systems: device, firmware, and network protocol attacks		
	4.2 Smart home security: home network vulnerabilities, impact, basic risk analysis		
	4.3 Raspberry Pi and edge device security concepts: interfaces, hardening basics, update integrity		
	4.4 Cloud IoT platforms overview using AWS IoT as a reference architecture: device identity, policies, messaging security		
	4.5 Secure bootstrapping concepts: trusted boot, secure boot, TPM concepts, remote attestation		
	4.6 IoT system security concepts: isolation, TrustZone overview, trust assumptions		
	Total		26

Sr. No.	Suggested Tutorials	Ref.	CO
1	Objective: Shared responsibility mapping for cloud service models. Create a responsibility matrix for IaaS, PaaS, and SaaS using a given scenario set. For each model, assign ownership for identity, host and OS patching, middleware, application security, network controls, logging, and data protection. Add one “common misconception” per model and correct it. Submit a 1 page matrix plus short justification notes for each row.	CO1	1, 2
2	Objective: Cloud threat surface and trust boundary analysis. Given a reference architecture (VM or container workload, API, database,	CO1	1



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	storage, CI/CD, admin access), mark trust boundaries and entry points. List at least 10 threats grouped by boundary, then rate them using likelihood and impact. Propose 5 baseline mitigations mapped to the highest risks. Submit an annotated diagram and a risk table.		
3	Objective: Data classification and protection decision matrix. Given a mixed dataset pack (PII, credentials, telemetry logs, business documents, backups), classify data using a 3 to 4 level classification scheme. For each class, decide protection requirements for encryption scope, key ownership approach, retention, access constraints, and audit needs. Include one exception case and justify it. Submit a decision matrix and rationale.	CO1	1, 2
4	Objective: IAM access review using policy evidence. Review a provided IAM dump consisting of users, roles, groups, and 8 to 10 sample policies. Identify excessive permissions, wildcard actions, risky trust relationships, and missing MFA requirements. Propose a least-privilege redesign using roles, scoped policies, and separation of duties. Submit findings (issues list) and a corrected policy outline.	CO2	1, 2
5	Objective: Cloud network security control assessment. Analyze a set of security group rules and network ACLs for a workload with web tier, app tier, and database tier. Identify overexposed ports, overly broad CIDR ranges, missing egress control, and lack of tier isolation. Recommend corrected rules and explain how each change reduces risk. Submit before and after rule tables and short justification.	CO2	1, 3
6	Objective: Logging and monitoring evaluation using sample logs. Given sample audit logs, authentication events, and network flow logs, identify visibility gaps and propose a minimum logging baseline. Write 5 detection use-cases in the format “signal, condition, context, response.” Include at least one detection each for IAM abuse, data access anomaly, network exposure, and configuration change. Submit baseline list and detection write-ups.	CO2	1, 2
7	Objective: Cloud incident response tabletop exercise. Run a tabletop on credential compromise leading to suspicious data access. Define triage questions, evidence to collect, containment steps, eradication actions, and recovery verification. Add a communications plan and a post-incident improvement list tied back to controls. Submit a short IR playbook and a timeline of actions.	CO2	1, 3
8	Objective: MQTT security demonstration with and without TLS. Set up an MQTT broker and two clients, then document message flow and exposure under two conditions: plaintext and TLS. Compare what an observer could learn in each case, then add authentication and topic-level authorization and note the change in risk. Submit a short comparison report and a security checklist for MQTT deployments.	CO3	4, 5
9	Objective: IoT protocol behavior and security property analysis. Study IoT-style communication using HTTP, HTTPS, and WebSockets for device-to-cloud telemetry and command messages. For each protocol, identify security properties, typical weaknesses, and misconfiguration risks. Provide recommended secure defaults for headers, session handling, and message integrity assumptions. Submit a protocol comparison table and recommendations.	CO3	4, 5
10	Objective: Non-IP IoT communication security case analysis. Use a non-IP IoT communication case (sensor networks, constrained environments, proprietary radio). Identify trust assumptions, authentication	CO3	4



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	approach, replay risks, integrity requirements, and key management challenges. Recommend a security control set at device, gateway, and backend layers. Submit a layered threat and mitigation summary.		
11	Objective: Smart home security case study evaluation. Given a smart home setup (router, cameras, smart lock, voice assistant, mobile app, cloud service), identify vulnerabilities in home network configuration and device onboarding. Describe realistic impacts (privacy breach, unauthorized access, service disruption). Evaluate mitigations and rank them by effectiveness and feasibility. Submit a risk register and mitigation ranking.	CO4	4
12	Objective: Industrial IoT ecosystem mitigation evaluation. Given an IIoT architecture (sensors, PLC gateway, edge compute, cloud analytics, remote operations), evaluate mitigations for device identity, secure onboarding, firmware update integrity, segmentation, monitoring, and incident handling. Include safety and availability constraints while choosing mitigations. Submit an evaluated control plan with tradeoffs.	CO4	4, 5
13	Objective: Public cloud baseline security review. Using AWS or Azure or Google Cloud free tier, create a minimal workload (one compute instance, one storage bucket, one simple network). Review default exposure, identity permissions, and data access paths. Produce a baseline security checklist and highlight at least 8 improvement actions with justification. Submit screenshots or evidence and a checklist report.	CO1	1, 2
14	Objective: Public cloud IAM and audit logging assessment. Using AWS or Azure or Google Cloud free tier, review IAM structure (users, roles, groups) and enable core audit logging. Identify top misconfiguration risks such as overly permissive roles, missing MFA enforcement, unused credentials, and insufficient logging retention. Recommend a prioritized remediation plan. Submit an assessment report with findings and recommendations.	CO2	1, 2, 3

Self-learning:

1. Self-learning hours include MOOCs, spoken tutorials, online resources, and extended study hours to enhance independent learning and better understanding of each module of the course content.
2. Evaluation of the self-learning components is carried out in all the evaluation components.

Course Assessment: -

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Tutorial:

- ISE:** a. will be conducted for 50% of tutorials. Continuous pre-defined rubrics-based evaluation for 20 marks.
 c. Will be conducted for remaining tutorials. Continuous pre-defined rubrics-based evaluation for 20 marks.
 d. Simulation using modern tools to solve the given problem statement for 10 marks OR Research papers analysis presentation.



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Recommended Books:

1. Chris Dotson, *Practical Cloud Security*, O'Reilly Media, 2019.
2. Jamuna S. Murthy, Siddesh G. M., Srinivasa K. G., *Cloud Security: Concepts, Applications and Practices*, Chapman and Hall/CRC, 2024.
3. Mark Buckwell, Stefaan Van Daele, Carsten Horst, *Security Architecture for Hybrid Cloud: A Practical Method for Designing Security Using Zero Trust Principles*, O'Reilly Media, 2024.
4. Ajay Prasad, Thipendra P. Singh, Samidha Dwivedi Sharma, *Communication Technologies and Security Challenges in IoT: Present and Future*, Springer, 2024.
5. Vidushi Sharma, Gamini Joshi, Gamini Joshi, *Enhancing IoT Security: A holistic approach to security for connected platforms*, BPB Publications.

Remember	Understand	Apply	Analyze	Evaluate	Create
	✓	✓	✓		



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HONORS and MINOR Courses

Offered to all branches in SEM VII/SEM VIII



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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM061	Environmental Management	2	--	--	2	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Lab			--		--				

Pre-requisite Course Codes	--	
After the successful completion students should be able to:		
Course Outcomes	CO1	Explain major global environmental issues, ecological concepts, biodiversity loss, and Sustainable Development Goals (SDGs).
	CO2	Interpret environmental laws, regulatory frameworks, and governance mechanisms in India and globally.
	CO3	Analyse environmental impact assessment procedures and corporate environmental responsibilities.
	CO4	Apply Environmental Management Systems (EMS), ISO 14001 standards, and environmental auditing principles.
	CO5	Evaluate the role of digital tools (AI, GIS, IoT, blockchain, carbon credits) in modern environmental management.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Environmental Management		7
	1.1	Global Environmental concerns: - Global Warming, Acid Rain, Ozone Depletion, Chemical smog, Hazardous Wastes.	1,2	
	1.2	Endangered life-species, Loss of Biodiversity, Ecology and Ecological successions and its types, Population as a global problem.	3,4,5	
	1.3	Significance of UN 17 Sustainable Development Goals (SDGs), Natural Circular economy frameworks	2	
2		Environmental Laws and Governing Policies		6
	2.1	Environmental policy frameworks, Major environmental laws in India (Salient Features of: - Air Act, Water Act, EPA, Forest & Wildlife Acts), Regulatory agencies and enforcement,	1,2	
	2.2	Central and State Pollution control boards—Powers and Functions. International conventions and protocols	1,2	
3		Environmental Impact Analysis		5
	3.1	Role and functions of Government as a planning and regulating	4,5	



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		agency, Environment Quality Management and Corporate Environmental Responsibility		
	3.2	Objectives of environmental impact Analysis, Impact prediction, evaluation and mitigation measures, Environmental clearance	4,5	
4		Environmental Management		4
	4.1	Environmental Management Systems (EMS) and ISO 14001, Implementation steps and certification processes	6,7	
	4.2	Environmental auditing: purpose & process, Waste audits and pollution prevention assessment, Role of EMS in corporate sustainability	6,7	
5		Digital Tools & Emerging Technologies in Environmental Management		4
	5.1	AI and machine learning in pollution prediction, GIS & Remote sensing applications,	1,3,7	
	5.2	IoT-based environmental monitoring, Smart cities and environmental dashboards, Blockchain in carbon trading, Role of Carbon credits in solving environmental problem.	1,3,7	
			Total	26

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha - Oxford University Press
2. Environmental Studies: From Crisis to Cure by R. Rajagopalan - Oxford University Press
3. A Textbook of Environmental Studies by D.K. Asthana - S. Chand Publishing
4. A Text Book of Environmental Studies by Dr. G.R. Chatwal & Dr. Harish Sharma - Himalaya Publishing House
5. Perspectives in Environmental Studies –Anubha Kaushik, C P Kaushik Third Edition, New age International Publishers
6. Environmental Studies- Benny Joseph, Second Edition the McGraw Hill Publishers
7. A Textbook of Environmental Studies, Deeksha Dave, S S Katewa, Second Edition Cengage Publishers,

SUGGESTED CO - PO articulation Matrix



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Course Outcomes	Program Outcomes (POs)												(PSOs)	
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2
CO1	3	2					3							
CO2	3	2					3							
CO3	3	2					3							
CO4	3	2					3							
CO5	3	2					3							

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM 062	Management Information Systems	2	--	--	--	2	--	--	2
		Examination Scheme							
				ISE	MSE	ESE		Total	
						Min	Max		
		Theory		20	30	20	50	100	
Lab		--	--	--	--	--			

Pre-requisite Course Codes --

After the successful completion students should be able to:

Course Outcomes	CO1	Examine the impact of information systems in transforming Businesses.
	CO2	Analyse the ethical, social, and security considerations in the management and governance of information systems.
	CO3	Evaluate the major tools, technologies, and data management approaches used to support business intelligence and managerial decision-making.
	CO4	Assess the influence of social media platforms on business strategy, marketing practices, and customer engagement.
	CO5	Compare and critique the methodologies involved in the development and implementation of information systems within business organizations.

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	Foundations of Information Systems (IS): Computer Based Information Systems, Components of IS: People, Process, Technology, Data, Role of IS in organizational efficiency. Organizational Strategy and Competitive Advantages using IS	[1],[2]	4
	1.2	Digital Transformation and Platform Economy: Digital transformation strategy, Platform-based business models and digital ecosystems, Case discussions: Platform enterprises		
2	2.1	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management	[1]	7
	2.2	Business Intelligence (BI): Managers and Decision Making, Descriptive, predictive and prescriptive analytics, Data visualization and data storytelling BI for Data analysis and Presenting Results.		
	2.3	Artificial Intelligence in Business: AI-powered Decision Support Systems, Generative AI in enterprises, Intelligent automation and robotic process automation (RPA), AI-driven personalization and forecasting		
3	3.1	Information Security and Risk Management: Threats to Information Systems, Security controls and cyber resilience, Zero-trust security model.	[1],[3]	6
	3.2	Ethical and Social Implications: Ethical issues in information systems, Algorithmic bias and explainable AI, Responsible AI principles, Societal impacts of automation and digital platforms		
	3.3	Social Computing (SC): Web 2.0 and 3.0, SC in business, shopping, Marketing, Operational and Analytic CRM, E-		



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		business, E-commerce & M-commerce		
4	4.1	Enterprise Systems: Transaction Processing Systems (TPS), Functional Area Information Systems, Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and Analytics	[1]	3
	4.2	Cloud Computing and Emerging Technologies: Cloud computing models: IaaS, PaaS, SaaS, Blockchain applications in business, Digital twins and automation.	[1],[3]	3
5	5.1	System Development, Agile Methods and Organizational Implementation: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models	[1],[3]	3
Total				26

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

- [1] Kelly Rainer, Brad Prince, Management Information Systems, Wiley
- [2] K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
- [3] Tom Taulli, Artificial Intelligence Basics: A Non-Technical Introduction.
- [4] Lindsay Herbert: Digital Transformation: Build Your Organization's Future for the Innovation Age
- [5] Thomas Erl, Ricardo Puttini & Zaigham Mahmood: Cloud Computing: Concepts, Technology & Architecture

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3			2								2		
CO2	3			2		2		2				2		3
CO3	3				1							2	2	
CO4	3			2		2		2				2	2	
CO5	3			2							1	2		

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -
 Blooms level

Remember	Understand	Apply ✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM071	Disaster Management	2	--	--	2	2	--	--	2
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
		Theory	20	30	20	50	100		
Tutorial 1		--		--					

Pre-requisite Course Codes	--	
After the successful completion students should be able to:		
Course Outcomes	CO1	Analyze disaster risk, vulnerability, and hazard assessment frameworks
	CO2	Explain types, causes, and impacts of natural and anthropogenic disasters
	CO3	Apply national and international disaster management policies and institutional mechanisms.
	CO4	Evaluate institutional frameworks in disaster management
	CO5	Measure the importance of Financing Relief and Risk mapping

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Disaster Management	1,2	5
	1.1	Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters		
	1.2	Climate change and disaster linkages, global warming, Sea level rise and Ozone layer depletion		
2		Natural and Manmade disasters	2,3,4	6
	2.1	Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge		
	2.2	Manmade disaster: Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization		
3		Disaster Management, Policy and Administration	3,4	4
	3.1	Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.		
	3.2	Policy and administration: Importance and principles of disaster management policies, command and co- ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the process.		



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4		Institutional Framework for Disaster Management in India	5,6	7
	4.1	Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.		
	4.2	Methods and measures to avoid disasters, Management of casualties. set up of emergency facilities, importance of effective Communication amongst different agencies in such situations		
	4.3	Use of Internet and software for effective disaster Management. Applications of GIS, Remote sensing and GPS in this regard		
5		Financing Relief Measures and Risk mapping	5,6,7	4
	5.1	Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters International relief aid agencies and their role in extreme events.		
	5.2	Pre-disaster, during disaster and post-disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis	1,3,7	
			Total	26

Course Assessment:

Theory:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

The written summative examination of 30 marks based on 50% syllabus for 90 minutes.

ESE:

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. 'Disaster Management' by Harsh K. Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann, Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat



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Publications

7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yongng – Prentice Hall (India) Publications.

SUGGESTED CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)												(PSOs)	
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO2
CO1	3	2			3									
CO2	3	2			3									
CO3	3	2			3									
CO4	3	2			3									
CO5	3	2			3									

Legends :- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember	Understand	Apply✓	Analyze	Evaluate	Create
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P	SL	L	T	P	Total
25MDM072	Finance Management	2	--	--	--	2	--	--	2
		Examination Scheme							
			ISE	MSE	ESE		Total		
					Min	Max			
	Theory	20	30	20	50	100			

Pre-requisite Course Codes	--
Course Outcomes	At the End of the course students will be able to :
	CO1 Understand Indian finance system and corporate finance
	CO2 Take investment, finance as well as dividend decisions

Module No.	Unit No.	Topics	CO	Ref.	Hrs
1.	1.1	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.	1	1, 2, 4, 5	4
	1.2	Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills Financial Markets: Meaning, Characteristics and Classification of Financial Markets Capital Market, Money Market and Foreign Currency Market. Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions, Commercial Banks, Investment-Merchant Banks and Stock Exchanges	1	1	
2.	2.1	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two- security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.	2	1	4
	2.2	Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting	2	1	
3.	3.1	Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance Investment Decision, Financing Decision, and Dividend Decision.	2	1	6



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	3.2	Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis	2	1	
4.	4.1	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion - Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value (NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)	2	1	6
	4.2	Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities	1	1	
5.	5.1	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short-Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	1	1	4
		Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure.	1		
6.	6.1	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches - Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	2	1	2
Total					26

Course Assessment:

ISE:

ISE activities carry 20 marks. These activities will be conducted throughout the semester.

MSE:

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ESE :

The written summative examination will be conducted for 50 marks based on the complete syllabus (20% questions on syllabus covered before MSE and 80% questions on the remaining syllabus) for 120 minutes.

Recommended Books:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.



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2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

CO - PO articulation Matrix

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes* (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	-	-	-	-	02	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	02	-	-	-

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -

Blooms level

Remember✓	Understand✓	Apply✓	Analyze	Evaluate	Create
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