SNJB's Late Sau. K. B. Jain College of Engineering, Chandwad
(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)
Curriculum and Evaluation Scheme
To be implemented for 2024-28 Batch
(With Effect from Academic Year 2026-27)

MDM Syllabus for SEM V and SEM VI Offered by AIDS & Computer Engineering for Other Branch Students

24-MDM-CS-3-01: Object Oriented Programming in Java

Teaching Scheme: **Theory:** 02 Hours/Week	**Credit:** 2	**Evaluation Scheme:** **CIE:** 20 Marks **SEE:** 30 Marks

Prerequisite Courses: 24-ESC-1-02: Programming and Problem Solving, 24-ESC-1-14: Programming and Problem Solving Lab

Companion Course: 24-MDM-CS-3-02: Java Programming Lab

Course Objectives:

- To understand the fundamentals of platform independent object oriented language Java.
- To demonstrate skills in writing programs using exception handling techniques.
- To understand efficient user interface design techniques.

Course Outcomes:

After completion of the course, learners should be able to

CONo	CO	BL
CO1	**Use** syntax and semantics of Java programming language and basic concepts of OOP.	3
CO2	**Develop** reusable and modular programs	3
CO3	**Integrate** exception handling and error management techniques for efficient program execution.	3
CO4	**Develop** practical solutions by implementing concurrency and multithreading techniques	3

Course Contents

Unit I	Basics of Java Programming Language	6 Hours

Introduction to Java, Features and Java Programming Environment, Java Virtual Machine, Program structure, Naming conventions, Classes and Objects in Java, Reading and displaying input/output, Type Casting, Garbage Collection, Command line Arguments, finalize() method, Access Specifiers: public, private, protected, default, Strings: String class and its functions, Wrapper classes.

Exemplar/Case Studies: Demonstrate Online Bookstore Management System for a local bookstore using basics concepts of Java.

*Mapping of Course Outcomes	CO1

Unit II	Inheritance, Interface and Package	6 Hours

Inheritance: Types of inheritance, multiple inheritance using interface, **Interfaces:** Define interface, Implementing interface, Accessing interface variables and methods, extending interfaces, **Package:** Define Package, naming and **creating** package, accessing package, import statement.

Example/Case Studies: Demonstrate interfaces and packages for online payment systems.

*Mapping of Course Outcomes	CO2

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Unit III	**Exception Handling**	**6 Hours**
Error and Exception: Types of errors, exceptions, try and catch statement, nested try statement, throws and finally statement, built in exceptions, chained exceptions, creating own exception(throw clause) and subclasses.		
Exemplar/Case Studies: Demonstrate exception handling in the banking application that has to deal with scenarios such as insufficient funds, invalid account numbers.		
***Mapping of Course Outcomes**		**CO3**
Unit IV	**Multithreading**	**6 Hours**
Java Thread Model: Main Thread, Life Cycle of thread, Creating thread: Implementing Thread using thread class and Runnable interface. isAlive() and join(), Thread priorities, Synchronization.		
Exemplar/Case Studies: Multithreading in Online food ordering system: Managing concurrent orders safely.		
***Mapping of Course Outcomes**		**CO4**
Learning Resources		
Text Books		
T1. Herbert Schildt, "The Complete Reference Java", McGraw Hill Education, 9th Edition, ISBN: 978-0071808552. **T2.** Balagurusamy E., "Programming with JAVA", McGraw Hill Education, 5th Edition, ISBN: 978-9351343219.		
Reference Books		
R1. Dr. R. Nageshwar Rao, "Core Java: An Integrated Approach", Dreamtech Press, ISBN: 978-9351199250		
Additional Resources: (Books, e-Resources) https://docs.oracle.com/Javase/8/docs/		
MOOC Courses links : 1. Programming in Java: https://nptel.ac.in/courses/106105191		

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24-MDM-CS-3-02: Java Programming Lab

Teaching Scheme:	**Credit:** 1	**Evaluation Scheme:**
Practical: 02 Hours/Week		**Termwork (TW):** 25 Marks **Practical (PR):** 25 Marks

Prerequisite Courses: 24-ESC-1-07: Programming & Problem Solving Lab

Companion Course: 24-MDM-CS-3-01: Object Oriented Programming using Java

Course Objectives:

- To introduce Java compiler and Eclipse platform.
- To write programs for solving real world problems using the Java collection framework.
- To write GUI programs using applet controls in Java.
- To impart hands-on experience with Java programming.

Course Outcomes:

After completion of the course, learners should be able to

CONo	COs	BL
CO1	**Use** the Integrated Development Environment to develop and execute Java Programs	3
CO2	**Develop Java** programs for solving real world problems using its Collection Framework.	3
CO3	**Develop** error free codes using exception handling.	3
CO4	**Apply** Java multithreading techniques to develop simple concurrent programs	3

Guidelines for Instructor's Manual

The instructor‘s manual is to be developed as a reference and hands-on resource. It should include prologue (about University/program/ institute/ department/foreword/ preface), curriculum of the course, conduction and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by students in the form of a journal. Journal consists of Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, onclusion/analysis. Program codes with sample output of all performed assignments are to be submitted as softcopy. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journals must be avoided. Use of the LMS platform for uploading and maintaining student programs is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.

Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work should be based on overall performance of Laboratory assignments by a student. Each Laboratory assignment assessment will assign grade/marks based on parameters, such as timely completion, performance, efficient codes, and punctuality etc.

Guidelines for Practical Examination

Problem statements must be decided jointly by the internal examiner and external examiner. During practical assessment,

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maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals, effective and efficient implementation. This will encourage, transparent evaluation and fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy needs to address the average students and inclusive of an element to attract and promote the intelligent students. Use of open source software is encouraged. Based on the concepts learned. Instructors may also set one assignment or mini-project that is suitable to each branch beyond the scope of the syllabus.

Operating System recommended:- 64-bit Open source Linux or its derivative.

Programming tools recommended: Open Source Eclipse IDE.

Suggested List of Laboratory Experiments/Assignments

Sr. No.	Assignment Title	*Mapping of Course Outcomes
1.	Study of Installation of Java software, Eclipse IDE, compile, debug and execute Java program.	CO1
2.	Write a Java program to develop a Student Grading System that calculates the total marks, percentage, and final grade of a student. **Percentage Range** / **Grade** 65 & Above / First Class with Distinction 60 - 64 / First Class 55 - 59 / Higher Second Class 40 - 55 / Second Class 0 – 39 / Fail	CO1
3.	Write a Java program that takes input as a person name in the format of First, middle and last name and print it in the form Last, first and middle name where in the middle name, first character is capital letter.	CO1, CO2
4.	Write a package for string operation which has two classes Con and Comp, Con has to concat two strings and comp class compares two strings, also display proper message on execution.	CO1, CO2
5.	Create an interface Device with methods turnOn(), turnOff(), and getStatus(). Implement the interface in classes Light, Thermostat, and SecurityCamera. Create a SmartHome class that stores an array of Device objects and controls all devices by calling their methods.	CO1, CO2
6.	Write a Java program to manage employee information with attributes such as name, date of birth (DOB), and mobile number. Implement exception handling to validate input data, ensuring that day values range from 1 to 31 and month values range from 1 to 12 for DOB.	CO3
7.	Write a Java program where two threads print even and odd numbers separately up to 20.	CO4

Learning Resources

Virtual Lab: Core Java Programming

- https://Java-iitd.vlabs.ac.in/

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24-MDM-CS-3-03: Cloud Computing

Teaching Scheme: Theory: 2 Hours/Week	**Credit:** 2	**Examination Scheme:** **CIE** : 20 Marks **SEE** : 30 Marks

Prerequisites courses:24-MDM-CS-2-01: Data Structures, 24-MDM-CS-2-03: Database Management System.

Companion Course: -NA

Course Objectives:

- To study fundamental concepts of cloud computing.
- To Implement cloud based services using cloud platforms.
- To apply cloud computing techniques to solve real-world problems.
- To understand risk management and advanced technologies in cloud computing.

Course Outcomes:
After completion of the course, learners should be able to

CO No.	CO	BL
CO1	**Understand** the different cloud computing environment.	2
CO2	**Apply** knowledge of cloud services to design and deploy cloud based solutions.	3
CO3	**Explore** cloud computing techniques to real-world applications.	3
CO4	**Understand** the risks, security issues, and advanced technologies associated with cloud computing.	2

Course Contents

Unit I	**Basic of Cloud Computing**	**8 Hours**

Definition and Evolution of Cloud Computing, Key Characteristics and Benefits of Cloud Computing, **Cloud Deployment Models**: Public, Private, Hybrid, Community Clouds; **Cloud Service Models:** IaaS, PaaS, SaaS, Benefits & challenges for engineering domains. **Virtualization Fundamentals:** Virtual Machines, Hypervisors, Containers, Resource Pooling and Elasticity. **Types of Virtualization:** Full Virtualization, Para Virtualization. Introduction to Kubernetes, Docker and Containerization.

#Exemplar/Case Studies : To explore an enterprise application from an on-premise environment to the cloud.

***Mapping of Course Outcomes**	**CO1**

Unit II	**Cloud Platforms & Core Services**	**7 Hours**

Overview of major cloud platforms: AWS, Azure, Google Cloud, **Amazon Web Services (AWS):** Introduction to AWS and its global infrastructure, **AWS Core Services:** Elastic Compute Cloud (EC2), Amazon Storage Services–S3 (object storage), EBS (block storage),

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Amazon Database Services: RDS (Relational Database Service), DynamoDB. **Additional AWS Services:** Lambda,Aurora,Redshift.		
#Exemplar/Case Studies: 1. Comparison of Services for Various Cloud Platforms based on security,availability,billing etc. 2. Comparison between open-source cloud platforms (such as OpenStack and CloudStack).		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Cloud Applications**	**8 Hours**
Need for cloud-based applications, Traditional vs. cloud-enabled applications, CAD/CAM on cloud, simulation (CAE/CFD), Digital twin concepts, Building Information Modelling (BIM), GIS mapping, collaborative construction projects, remote sensing, signal processing on the cloud, IoT data processing and storage on cloud, Cloud-based telecommunication services (VoIP, 5G, NFV), Smart healthcare systems using cloud & IoT.		
#Exemplar/Case Studies: Cloud Applications for Smart City Development.		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Security and Future Trends in Cloud**	**7 Hours**
Security challenges in cloud (data security, identity management, encryption), Compliance standards (ISO, GDPR, HIPAA), Reliability, availability and disaster recovery, Risk management for engineering projects. Multi cloud, Hybrid cloud, Serverless computing, edge computing, Fog computing, Sustainable cloud computing (Green IT, carbon-aware computing), Generative AI with cloud.		
#Exemplar/Case Studies: 1. Exploring various cloud security tools, such as AWS Identity and Access Management (IAM). 2.Explore different cloud simulators, such as CloudSim.		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1. Cloud Computing -Concepts Technology And Architecture,Thomas Erl Mahmood Zaigham,Pearson Education India; 2018. **T2.** Cloud Computing: A Practical Approach for Learning and Implementation, A. Srinivasan & J. Suresh,Pearson Education ,ISBN: 978-8131776513 (10-digit: 8131776514).		
Reference Books :		
R1. Architecting the Cloud: Design Decisions for Cloud Computing Service Models (IaaS, PaaS, SaaS),Michael J. Kavis, Wiley, ISBN 9781118826270**.** **R2.** Architecting the Cloud: Design Decisions for Cloud Computing Service Models (IaaS, PaaS, SaaS) by Michael J. Kavis, Wiley, ISBN 978-1-118-82627-0. **R3.** Amazon Web Services For Dummies by Bernard Golden, Wiley, ISBN 978-1-118-57183-5.		
Additional Resources: (Books, e-Resources) • AWS Documentation : https://docs.aws.amazon.com/ • Google Cloud Documentation : https://cloud.google.com/docs/ • Microsoft Azure Documentation : https://learn.microsoft.com/en-us/azure/?product=popular • Salesforce Developer Resources : https://developer.salesforce.com/docs		

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- OpenStack Documentation : https://docs.openstack.org/2024.2/

MOOC Courses links :

1. Cloud Computing by Prof. Soumya Kanti Ghosh IIT Kharagpur **:** https://onlinecourses.nptel.ac.in/noc25_cs11/preview
2. Cloud Computing Specialization by University of Illinois: https://www.coursera.org/specializations/cloud-computing
3. AWS Cloud Practitioner Essentials by Amazon Web Services: https://www.edx.org/learn/amazon-web-services-aws/amazon-web-services-aws-cloud-practitioner-essentials?index=undefined&position=2
4. Google Cloud Training**:** https://cloud.google.com/learn/training?hl=en
5. Microsoft Azure Fundamentals**:** https://learn.microsoft.com/en-us/training/azure/

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24-MDM-CE-3-01: Water and Land Management

Teaching Scheme: Theory: 2 Hours/Week	**Credit:** 2	**Examination Scheme:** **CIE** : 20 Marks **SEE** : 30 Marks

Prerequisites Courses: -

Companion Course: 24-MDM- CE- 3–02: Water and Land Management Lab

Course Objectives:

- Enable students to analyze and design efficient irrigation and groundwater systems.
- Develop students' understanding of soil–water–plant interactions and water management strategies to enhance crop productivity under diverse conditions.
- Equip students with practical expertise in watershed evaluation, irrigation system planning, and sustainable water management in agriculture.
- Prepare students to address challenges in water management, drainage, and salinity mitigation in problematic soils and waterlogged environments.

Course Outcomes:

After completion of the course, learners should be able to

CO No	CO	BL
CO1	**Interpret** India's water resources and summarize irrigation and groundwater development scope.	2
CO2	**Implement** irrigation and crop management practices to optimize productivity.	3
CO3	**Plan** watershed and irrigation systems for efficient water use.	3
CO4	**Apply** methods to interpret causes and characteristics of problematic soils and waterlogging.	3

Course Contents

Unit I	**Groundwater Development, Wells and Pumps**	**8 Hours**

Water resources of India, irrigation potential, role of groundwater and scope of development, aquifers, types, parameters and principles of groundwater flow. Surface–groundwater interaction and recharge (natural & artificial), Irrigation wells, **Pumps –** selection, performance evaluation, and energy requirements, groundwater issues.

#Exemplar/Case Studies: Ground water recharge - Haripura Percolation tank in the Jalgaon district.

***Mapping of Course Outcomes**	**CO1**

Unit II	**Soil- Plant- Water Relationship**	**7 Hours**

Soil and water in agriculture: Soil moisture characteristics, soil erodibility and factors affecting water storage, field water budget, evapotranspiration, crop stages, plant water relations, water movement in the soil–plant system, crop water deficit,

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strategies for productivity under limited water, cropping patterns.		
#Exemplar/Case Studies: Improving crop productivity through soil and water management in rainfed agriculture – A case of the Hiware bazar watershed management, Maharashtra.		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Watershed and Irrigation management**	**7 Hours**
Watershed concept, characterization, land capability and soil maps. principles and planning of watershed management, Land levelling and equipment, History and management of irrigation in India, major projects, Irrigation methods and hydraulics, Irrigation efficiency, economics and agronomic considerations, irrigation strategies under varying water availability.		
#Exemplar/Case Studies: Jal Yukta Shivar Abhiyan - Construction of farm ponds to increase water storage capacity and combat drought in Maharashtra.		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Integrated soil and water resource management**	**8 Hours**
Concept and importance of land–water management, Soils distribution and water quality management, salt-affected soils and reclamation, crop production and alternate uses of problematic soils, field drainage, reclamation of waterlogged areas, water user associations and legal aspects.		
#Exemplar/Case Studies: Case study on Participatory watershed management at Ralegan Siddhi village in district Ahilyanagar, Maharashtra.		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1. Majumdar Dilip Kumar, Irrigation Water Management: Principles and Practice, PHI learning India, Vol. 1, Second Edition. **T2.** Garg S. K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 38th Revised Edition.		
Reference Books		
R1. Michael A.M, Irrigation: Theory and Practice, Vikas publishing house New Delhi, Vol 1, Second Edition. **R2.** Jain S.K. and Singh V. P., Water Resource Systems Planning and Management, Elsevier Science, Vol.1 Second Edition.		

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24-MDM-CE-3-02: Water and Land Management Lab

Teaching Scheme: **Practical:** 2 Hours/Week	**Credit:** 1	**Examination Scheme:** **Termwork (TW)**: 25 Marks **Oral (OR)** : 25Marks

Prerequisites Courses: -

Companion Course: 24-MDM-CE-3-01: Water and Land Management

Course Objectives:

- To impart practical skills in the measurement and management of water resources.
- To familiarize students with irrigation methods, water conveyance, and water application efficiencies.
- To study the soil-water-plant relationship and land management techniques.
- To provide information regarding field visit, field measurement, data collection and performance evaluation of the irrigation system.

Course Outcomes:

After completion of the course, learners should be able to

CO No	CO	BL
CO1	**Compare** different discharge measurement techniques and evaluate their suitability for irrigation projects.	3
CO2	**Apply** irrigation methods (surface, sprinkler, drip) to assess their efficiency, cost, and water-saving potential.	3
CO3	**Apply** soil moisture characteristics for efficient crop water management.	3
CO4	**Apply** field investigation skills to evaluate irrigation systems and prepare reports.	3

Guidelines for Instructor's Manual

The instructor‘s manual is to be developed as a reference and hands-on resource. It should include a prologue (about University/program/ institute/ department/foreword/ preface), curriculum of the course, conduction and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

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The laboratory assignments are to be submitted by students as a journal. The journal consists of a Certificate, table of contents, and handwritten write-up of each assignment Title, Date of Completion, Objectives, Problem Statement, Assessment grade/marks and assessor's sign. As a conscious effort and little contribution towards environmental awareness, attaching printed papers for industrial visit and audits. maintained with program prints in the Laboratory.

Guidelines for Laboratory /Term Work Assessment

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innovation, efficient codes, and punctuality.

Guidelines for Practical Examination

Problem statements must be decided jointly by the internal examiner and external examiner. During the practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals and effective and efficient implementation. This will encourage transparent evaluation and a fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

Guidelines for Laboratory Conduction

1. Always wear appropriate footwear and safety gear during field experiments.
2. Handle instruments carefully.
3. Ensure proper water drainage after irrigation trials.
4. Follow environmental ethics – avoid wastage of water and soil disturbance.
5. Maintain cleanliness in the lab and field area.

Virtual Laboratory: (If Any):

Suggested List of Laboratory Experiments/Assignments

Group A: Assignments (Mandatory Assignments)

Sr No	Assignment Title	*Mapping of Course Outcomes
1.	Prepare a report on different discharge measurement techniques and their suitability in irrigation projects.	CO1
2.	Conduct a comparative study of surface, sprinkler, and drip irrigation systems with respect to efficiency, cost, and water saving.	CO2
3.	Prepare a report on the role of soil moisture characteristics in irrigation scheduling.	CO3
4.	Collect primary data from farmers regarding irrigation practices and prepare a performance evaluation of the system.	CO4

Group B: Assignments (Out of List perform any 2)

Sr No	Assignment Title	*Mapping of Course Outcomes
1.	Write a report on soil moisture content by the gravimetric method.	CO1
2.	Write a report on the Sprinkler or Drip irrigation system – measurement of water distribution pattern and uniformity coefficient.	CO2
3.	Write a report on the Canal water distribution system.	CO3
4.	Collect and compile field visit observations into a structured report on water management practices.	CO4

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Group C: Assignment on Field Visit (any one)		
Sr No	**Assignment Title**	***Mapping of Course Outcomes**
1.	Field Visit to an irrigation project (Dam or Canal system) and Preparation of Report.	CO4
2	Field Visit to Water and Land Management Institute, Kanchanwadi, Chhatrapati Sambhaji Nagar, and Preparation of Report.	CO4
3	Field Visit to the watershed/Groundwater recharge site and Preparation of the Report.	CO4

Learning Resources (If applicable)
Text Books
T1. Garg S. K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 38th Revised Edition. **T2.** R.K. Sharma & T. K. Sharma, Irrigation Engineering, S.Chand Publishing New Delhi, Vol. 1, Revised Edition.
Reference Books :
R1. Michael A.M, Irrigation: Theory and Practice, Vikas publishing house New Delhi, Vol 1, Second Edition. **R2.** V.E. Hansen, O.W. Israelsen, G. E. Stringham, Irrigation Principles and Practices, John Wiley and Sons, Vol.1, Fourth Edition.

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24-MDM-CE-3-03 Socio-Economic Management

Teaching Scheme: **Theory:** 2 Hours/Week	**Credit:** 2	**Examination Scheme:** **CIE** : 20 Marks **SEE** :- 30 Marks

Prerequisites Courses: - 24-AEC-3-01: Environmental Science

Companion Course:

Course Objectives:

- To understand the interaction between social structures and economic systems.
- To assess challenges and solutions in managing resources and human development.
- To promote ethical and socially responsible decision-making in management.
- To study principles of Good governance, transparency, accountability and Citizen participation.

Course Outcomes:

After completion of the course, learners should be able to

CO No.	CO	BL
CO1	**Discuss** the interrelationship between society, economy and management.	2
CO2	**Apply** the concepts of the economy in analyzing development practices.	3
CO3	**Demonstrate** the role of Non-Government Organisations in addressing issues of social development.	3
CO4	**Interpret** the principles of the circular economy and environmental management.	3

Course Contents

Unit I	**Introduction to Socio-Economic Management**	**8 Hours**

Definition and scope, Interrelationship between society, economy and management, Historical perspectives and contemporary relevance, Role of government, private sector and civil society, Social stratification, Urbanization and rural migration.

#Exemplar/Case Studies: Case study on Impact PM Kisan Urja Suraksha Evam Utthan Mahabhiyan (PM-KUSUM). Mukhyamantri Saur Krishi Pump Yojana, Maharashtra

***Mapping of Course Outcomes**	**CO1**

Unit II	**Resources and Environmental Management**	**7 Hours**

Sustainable use of natural resources, **Environmental challenges:** pollution, climate change, land degradation, Community-based resource management, Green economy and circular economy models.

#Exemplar/Case Studies: Case study on Waste-to-Energy Initiatives in Indore: From Trash to Green Economy.

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***Mapping of Course Outcomes**	**CO2**	
Unit III	**Governance, Ethics and Social Responsibility**	**7 Hours**
Principles of good governance, Transparency, accountability and citizen participation, Corporate Social Responsibility (CSR), Ethical decision-making in socio-economic management, Role of NGOs.		
#Exemplar/Case Studies: Case study on The Right To Information Act (RTI), India-Governance, Ethics and Citizen Empowerment Case study on Centralised Public Grievance Redress and Monitoring System (CPGRAMS).		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Global economic challenges and Emerging Trends**	**8 Hours**
Global economic challenges and their socio-economic impact, Digital economy and social transformation, Social equity, diversity, and inclusion in organizations, Future of socio-economic policy-making.		
#Exemplar/Case Studies: Case study on Covid-19 Pandemic- A catalyst for Global Socio-Economic Transformation.		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1. Laurent Cappelletti, Henri Savall, Veronique Zardet, Socio-Economic Approach to Management: Science-Based Consulting for Sustainability, Palgrave Macmillan, 1st Edition. **T2**.Adam Szirmai, Socio-Economic Development, Cambridge University Press, Second Edition.		
Reference Books :		
R1. Sengupta Sivani**,** Indian Economy, A.B.D. Publishers. **R2**. Datt & Sundaram, Indian Economy, S Chand Publication, 73rd Edition.		
MOOC Courses links : https://nptel.ac.in/courses/129106001		

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24-MDM-ET-3-01A: Drone Technology

Teaching Scheme: Theory: 2 Hours/Week	**Credit:** 2	**Examination Scheme:** **CIE :** 20 Marks **SEE** : 30 Marks

Prerequisites Courses: 24-MDM-ET-2-01A- Internet of Things

Companion Course: 24-MDM-ET-3-02A-Drone Technology Laboratory, 25-BSC1-01-Engineering Physics, 25-ESC1-01-Basic Electrical and Electronics Engineering.

Course Objectives:

- To Understand the fundamentals of drone technology.
- To Learn about drone components, sensors, control systems used in drones.
- To Understand and Apply drone controls, communication, and simulation tools for drone operations.
- Explore drones with evaluation techniques and advanced applications for innovation.

Course Outcomes:

After completion of the course, learners should be able to

CONo	CO	BL
CO1	**Understand** the concepts of Unmanned Aerial Vehicle categories, flight rules, aerodynamics, and regulations.	2
CO2	**Identify** drone components, sensors, and payloads.	2
CO3	**Apply** control, communication, and simulation tools for drone operations.	3
CO4	**Elaborate** UAV performance and explore advanced drone applications.	2

Course Contents

Unit I	**Fundamentals of Drone Technology**	**7 Hours**

Basics of Drone: Evolution of drones & Unmanned Aerial Vehicle(UAV) categories (fixed wing, rotary, hybrid), UAS Types as per Size.

Rules and Regulations: Drone flight Rules, Drone Zone-Permission Protocol, Limitation of Drone (Environmental, Technical, Operator level), Penalty Rule, Use of DGCA Form 1 to Form 5.

Basic flight principles and aerodynamics- Four forces of Flight ,Bernoulli's Principle, Aerodynamics of flight**,** Three axes of Flight.

#Exemplar/Case Studies: Namo Didi, Drone Shakti, SVAMITVA government scheme supports UAV Technology.

***Mapping of Course Outcomes**	**CO1**

Unit II	**Drone components and Designs**	**7 Hours**

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Drone Components: Main Components and secondary components of Drone and its working ,Selection of components as per sizes. Frame Types with propeller. **Drone Designs:** Pixhauk Flight Controller design with all ports & firmware, Thrust to Weight ratio, KV ratings of motors. **Drone Sensors:** Gyroscope, Accelerometer, Magnetometer, Barometer. **Pay Loads of UAV:** Types, Considerations, Impact		
#Exemplar/Case Studies- Lidar and Thermal Sensors		
***Mapping of Course Outcomes**	**CO2**	
Unit-III	**Drone Controls, Communications and Simulation**	**7 Hours**
Drone Controls and Communications: Radio Frequency Transmission, Wi-Fi, Global Position System (GPS) Navigation, Inertial Measurement Units (IMUs), Flight Controller Software, Satellite Link, Internet of Drones. **Simulation:** Overview of Ground Control Stations(Desktop, Tablet and other), Waypoint navigation: uses and Process, Auto-grid, Pre-flight checks, Calibration process of drones in Mission Planner.		
#Exemplar/Case Studies: Gazebo, AirSim, DroneKit		
***Mapping of Course Outcomes**	**CO3**	
Unit-IV	**UAV Performance Analysis and Advanced Applications**	**7 Hours**
Basics of estimation and Kalman filtering, Proportional-Integral-Derivative(PID) tuning of Drone, obstacle avoidance, Concept of kinematics and dynamics. Simultaneous Localization and Mapping (SLAM) with its application, SLAM Drone. **Applications of Drone**, **Future directions:** Swarm drones, 5G-enabled drones, underwater and space drones, Agriculture drones		
#Exemplar/Case Studies: SWARM of UAVs for 3D Mapping using Stereo vision system.		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1. M.LaFay, Building Drones for Dummies, John Wiley & Sons, Inc., n.d. **T2.** K.S.Fu, R.C.Gonzalez, C.G.Lee, Robotics control, sensing, vision and intelligencell MGH, 1st Edition, 1987		
Reference Books :		
R1. Creating Autonomous Vehicle Systems by Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, Morgan & Claypool Publishers, 2018 **R2**. Vasilis Tzivaras, "Building a Quadcopter with Arduino", Packt Publishing, 2016.		

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Additional Resources: (Books, e-Resources)

1. https://www.wevolver.com/article/artificial-intelligence-in-drone-technology
2. https://www.analyticsinsight.net/what-is-the-role-of-artificial-intelligence-in-drone-technology/
3. Essential Drone Sensors and Why Every Flight Needs Them
4. Drone Payloads Explained | Types, Considerations, Impact - Drone Surveys World
5. Drone Control: How to Control a Drone - The Ultimate Guide for New Pilots
6. How Drone Controllers Work (Explained for Beginners) - Droneblog
7. Choosing a Ground Station — Copter documentation
8. Understanding SLAM in Robotics and Autonomous Vehicles

MOOC Courses links :

https://nptel.ac.in/courses/101108661
UAV in Engineering Applications - Course
Drone Systems and Control - Course

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24-MDM-ET-3-02A : Drone Technology Laboratory

Teaching Scheme:	**Credit:** 1	**Examination Scheme:**
Practical: 2 Hours/Week		Termwork **(TW)** : 25 Marks Practical **(PR)** : 25 Marks

Prerequisites Courses: 24-MDM-ET-2-02A: Internet of Things Laboratory

Companion Course: 24-MDM-ET-3-01A : Drone Technology

Course Objectives:

- To provide basic understanding of drone components, structure, and functionality.
- To develop skills in remote controller calibration and basic drone operation using simulators.
- To train students in drone assembly, configuration, and calibration using software tools.
- To enable students to program autonomous drone missions using Python and simulation platforms.
- To introduce AI/ML-based image processing for analyzing drone-captured data.
- To prepare students for planning and documenting real-world drone operations..

Course Outcomes:

After completion of the course, learners should be able to

CONo	Course Outcome	BL
CO1	**Identify and describe** drone components.	2
CO2	**Calibrate** remote controllers and perform basic flight maneuvers using simulators.	3
CO3	**Assemble**, configure, and calibrate drones through manual and software-based methods.	3
CO4	**Program** autonomous missions, apply AI/ML on drone imagery, plan operations.	4

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a reference and hands-on resource. It should include a prologue (about University/program/ institute/ department/foreword/ preface), curriculum of the course, conduction and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by students as a journal. The journal consists of a Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, designs, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments will be submitted as softcopy. As a conscious effort and little contribution towards Green IT and environmental awareness, attaching printed papers as part of write-ups and program listing to journals must be avoided.

Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work should be based on the overall performance of Laboratory assignments by a student.

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Each Laboratory assignment assessment will assign grades/marks based on parameters, such as timely completion, performance, innovation, efficient codes, and punctuality.

Guidelines for Practical Examination

Problem statements must be decided jointly by the internal examiner and external examiner. During the practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals and effective and efficient implementation. This will encourage transparent evaluation and a fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

Guidelines for Laboratory Conduction

Virtual Laboratory: (If Any):

- https://drone-iitd.vlabs.ac.in/

Suggested List of Laboratory Experiments/Assignments

Group A: Assignments (Mandatory Assignment)

Sr No	Assignment Title	*Mapping of Course Outcomes
1.	Identification of basic drone components and its uses.	CO1
2.	Calibration of Remote Control using **Phoenix RC Simulator.**	CO2
3.	Operate Aircraft/Copter using a Remote Control through the **Picasim flight Simulator.**	CO2
2.	Drone Assembly: Step-by-step assembly of a drone kit, through **iitd.vlab portal** and then manually by using components.	CO3
3.	Drone calibration with the use of **Mission Planner**.	CO3
4.	Prepare a Flight plan using GCS software **(Mission Planner/Aerogcs Green/QGroundControl).**	CO2,CO3
5.	Demonstration of Hands-on conduct of Real time Flight of drones.	CO3
6.	Programming Drone With Python 1. Set up ArduPilot firmware 2. Install DroneKit Python 3. Run your first autonomous flight script	CO3
7.	Python based Drone control (e.g., takeoff, move, hover, land) using Airsim API	CO4
8.	Processing and analyzing image data collected by drones using AI/ML technique. (e.g. Crack and Damage Detection on Roads and Bridges from Drone Photos)	CO4
	Group B: Assignment	
1.	Prepare a short report and calculations on planning a pesticide spraying operation	CO4

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	on a 10-acre grape vineyard using an agricultural drone that answer: 1. How much spray mixture (litres) is required in total? 2. How many full tank loads (refills) will the drone need? 3. Total flight time to cover the field (hours & minutes). 4. Total operation time including setup, refills, transit, and pack-down (hours & minutes). 5. Recommended manpower (roles and counts) and a simple schedule for the operation. (Students will consider other crops also like Onions, Sugarcane,Maize, cotton etc. for preparation of report)	

Learning Resources

Text Books :

T1. M.LaFay, Building Drones for Dummies, John Wiley & Sons, Inc., n.d.
T2. K.S.Fu, R.C.Gonzalez, C.G.Lee, Robotics control, sensing, vision and intelligenceII MGH, 1st Edition, 1987

Additional Resources: (Books, e-Resources)

- https://www.wevolver.com/article/artificial-intelligence-in-drone-technology
- https://www.analyticsinsight.net/what-is-the-role-of-artificial-intelligence-in-drone-technology/
- https://www.dronezon.com/learn-about-drones-quadcopters/
- https://ardupilot.org/copter/docs/advanced-multicopter-design.html
- Mission Planner Simulation — Mission Planner documentation
- How to program a drone using Python: A beginner's guide - The Drone Girl
- Drone Programming | How to Control a Drone with Python - Drone Dojo

MOOC Courses links :

- https://nptel.ac.in/courses/101108661

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24-MDM-ET-3-03A: Robotics

Teaching Scheme: Theory: 2 Hours/Week	**Credits:** 2	**Examination Scheme:** **CIE** : 20 Marks **SEE** : 30 Marks

Prerequisite Courses: 24-MDM-ET-2-01A- Internet of Things.

Companion Course: -

Course Objectives:

- To provide an overview of the fundamental concepts, history, and structure of robots.
- To Develop understanding of sensing technologies, vision systems, and electrical actuation systems and their role in robotic applications.
- To use the Robot Operating System to develop Simulation.
- To Familiarize with robot programming and emerging trends in Robotics.

Course Outcomes:

After completion of the course, learners should be able to

CONo	CO	BL
CO1	**Understand** the fundamental architecture, anatomy, and classification of robots	2
CO2	**Use** different types of sensors, vision systems and actuators in robotics.	3
CO3	**Apply** Robot Operating System (ROS) tools to model and simulate robotic systems.	3
CO4	**Implement** fundamental robot programming and simulation techniques to build simple autonomous robotic functions.	3

Course Contents

Unit I	Introduction to robotics	7 Hours

Evolution of Rots and Robotics, Laws of Robotics, Meaning of Robot, Progressive advancement in robots, Robot anatomy, Human arm characteristics, Design and Control Issues. Introduction of Cobots, Difference between cobots and industrial robots

#Exemplar/Case Studies: Human Arm vs. Robotic Arm – Comparing Anatomy & Motion

*Mapping of Course Outcomes	CO1

Unit II	Robotics Sensors and Actuators	7 Hours

The meaning of sensing, Sensors in Robotics, Kinds of sensors used in robotics, Robotic Vision, Industrial applications of vision controlled robotic systems, Process of Imaging, Architecture of Robotic Vision Systems, Image Acquisition, Actuators used in Robotics

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#Exemplar/Case Studies: Colour-Sorting Robot with Camera or Sensor		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Robot Operating System**	**7 Hours**
Introduction to ROS, Need for middleware. ROS architecture. ROS Master & Nodes, **ROS Communication:** Topics, Messages, Services, Actions, Parameter Server, **ROS File System & Tools:** Packages, Launch files, Catkin workspace, URDF basics, **Simulation Tools:** Gazebo & RViz introduction, Robot model visualization, environment setup		
#Exemplar/Case Studies: Visualize a robot model and simulate basic movement or sensor reading.		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Robot Programming and Emerging Trends In Robotics**	**7 Hours**
Basics of Robot Programming: Flow, Logic, and Structure, Simulation Tools: Tinkercad, Webots, RoboDK, Simple Path-Following Logic using Python, Introduction to Computer Vision and AI in Robotics, Future Trends: IoT-enabled Robots, Drones, and Autonomous Systems		
#Exemplar/Case Studies: Simulation in Tinkercad / Webots / RoboDK – Simulate motion of a robotic arm or mobile robot using code.		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1: R. K. Mittal and I J Nagrath, "Robotics and Control", Tata McGraw-Hill, 2007 **T2**: Ramchandran, Vijayraghavan and Balsundaram, "Mechatronics", Wiley India Pvt. Ltd., 2008 **T3**: Fu, Gonzalez and Lee, "Robotics Control, Sensing, Vision, and Intelligence", McGraw-Hill International Edition		
Reference Books :		
R1: John J Craig, "Introduction to Robotics", Prentice Hall International, 2005 **R2**: Robert J. Schilling, "Fundamentals of Robotics", Pearson Education, 2013 **R3**: Ashitva Ghosal, "Robotics Fundamental Concepts and Analysis", Oxford University Press, 2010 **R4**: S K Saha, "Introduction to Robotics", Tata McGraw-Hill		
Mooc Courses		
https://nptel.ac.in/courses/107106090		

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SNJB's Late Sau. K. B. Jain College of Engineering, Chandwad
(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)
Curriculum and Evaluation Scheme
To be implemented for 2024-28 Batch
(With Effect from Academic Year 2026-27)

MDM (B) Syllabus for SEM V and SEM VI Offered by E&TC Engineering for Other Branch Students

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24-MDM-ET-3-01B: Advanced Lean Practices

Teaching Scheme: Theory: 02 Hours/Week	**Credit:** 02	**Examination Scheme:** **CIE**: 20 Marks **SEE**: 30 Marks

Prerequisites Courses: 24-MDM-ET-2-01B: Lean Systems Fundamentals

Companion Course: 24-MDM-ET-3-02B: Lean Simulation and Automation Lab

Course Objectives:

- To develop an understanding of **advanced Lean tools and practices** for improving operational efficiency
- To integrate **Lean and Six Sigma methodologies** for systematic process and quality improvement.
- To apply Lean principles to **supply chain, logistics, and performance management systems** using digital enablers.
- To introduce **sensors and actuators** as enabling technologies for automation and Lean implementation.

Course Outcomes:
After completion of the course, learners should be able to

CO No	CO	BL
CO1	**Apply** Total Productive Maintenance (TPM) and OEE concepts to evaluate equipment and process performance	3
CO2	**Classify and apply** Lean Six Sigma tools for process improvement and defect reduction	3
CO3	**Apply** Lean principles to supply chain, logistics, and organizational performance management using the PQCDSME framework	3
CO4	**Explain** the role of sensors and actuators in automation-enabled Lean systems across multidisciplinary applications	2

Course Contents

Unit I	**Total Productive Maintenance (TPM)**	**07 Hours**

TPM fundamentals, Autonomous maintenance, Planned maintenance, Quality maintenance, Kobetsu Kaizen (focused improvement), Early equipment management, Training and education, Safety–Health–Environment (SHE), Administrative & Office TPM, Overall Equipment Effectiveness (OEE), Sixteen losses in manufacturing,

#Exemplar/Case Studies: TPM using predictive sensor-based monitoring in the automotive industry.

***Mapping of Course Outcomes**	**CO1**

Unit II	**Lean Six Sigma Integration**	**07 Hours**

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Overview of Lean and Six Sigma synergy, DMAIC methodology, DFSS (Design for Six Sigma) – overview, PDCA cycle, Value Stream Mapping (VSM), Takt Time, SMED, Defect reduction and cycle time optimization		
#Exemplar/Case Studies: Lean Six Sigma for defect reduction in electronics assembly.		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Lean Supply Chain and Performance Management**	**07 Hours**
Part A: Lean Supply Chain & Logistics : Lean supply chain principles, Supplier integration, Lean logistics and warehousing, Just-In-Time (JIT) and Kanban, Bullwhip effect and its mitigation **Part B: Lean Performance Management (PQCDSME Framework):** PQCDSME metrics and significance, Visual management systems Key Performance Indicators (KPIs), Daily Work Management (DWM) Kaizen culture and continuous improvement.		
#Exemplar/Case Studies: PQCDSME-based performance review in an electronics manufacturing organization.		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Sensors and Actuators for Lean and Automation Systems**	**07 Hours**
Introduction to sensors and actuators in engineering systems, **Classification of sensors:** Mechanical, thermal, electrical, optical, proximity sensors, Working principles of commonly used sensors **Actuators:** Electrical, pneumatic, hydraulic actuators, **Role of sensors and actuators in:** Automation systems, Manufacturing and process industries, Mechatronics and smart systems		
#Exemplar/Case Studies: Use of sensors and actuators in an automated assembly line to support Lean manufacturing principles.		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1. Carreira, Bill. Lean Manufacturing That Works: Powerful Tools for Dramatically Reducing Waste and Maximizing Profits. 1st ed., Prentice-Hall of India Private Limited, 2007. **T2.** Askin, Ronald G. Design and Analysis of Lean Production Systems. 1st ed., John Wiley and Sons, 2007. **T3.** Michael L. George, Lean Six Sigma: Combining Six Sigma Quality with Lean Speed, McGraw-Hill, 2002.		
Reference Books :		
R1. Suzaki, Kiyoshi. The New Manufacturing Challenge: Techniques for Continuous Improvement. Reprint ed., Free Press, 2012. **R2.** Shingo, Shigeo. A Study of the Toyota Production System from an Industrial Engineering Viewpoint. Reprint ed., Routledge, 2019.		

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MOOC Courses links :

- Foundations of Lean Manufacturing, https://onlinecourses.swayam2.ac.in/imb24_mg119/preview
- Six Sigma, https://onlinecourses.nptel.ac.in/noc25_mg83/preview
- Lean Thinking Case Studies, https://www.coursera.org/learn/lean-management

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24-MDM-ET-3-02B: Lean Simulation and Automation Lab		
Teaching Scheme: Practical: 02 Hours/Week	**Credit:** 01	**Examination Scheme:** **Term work (TW)**: 25 Marks **Oral (OR)**: 25 Marks

Prerequisites Courses: 24-MDM-ET-2-01B: Lean Systems Fundamentals

Companion Course: 24-MDM-ET-3-01B: Advanced Lean Practices

Course Objectives:

- To provide hands-on exposure to Lean tools and techniques through simulations and structured assignments.
- To enable students to apply TPM, OEE, and Lean Six Sigma concepts for analyzing and improving system performance.
- To develop practical understanding of Lean supply chain and performance management frameworks such as PQCDSME.
- To familiarize students with sensors and actuators and their role in automation-enabled Lean systems.

Course Outcomes:

After completion of the course, learners should be able to

CO No	**CO**	**BL**
CO1	**Apply** TPM and OEE concepts to evaluate equipment and process performance using simulation and case-based data	3
CO2	**Apply** Lean Six Sigma tools such as VSM and DMAIC for process analysis and improvement	3
CO3	**Apply** Lean principles to supply chain and organizational performance evaluation using PQCDSME and related metrics	3
CO4	**Identify** and explain the application of sensors and actuators in Lean and automation systems	2

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a reference and hands-on resource. It should include a prologue (about University/program/ institute/ department/foreword/ preface), curriculum of the course, conduction and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by students as a journal. The journal consists of a Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments will be submitted as softcopy. As a conscious effort and little contribution towards Green IT and environmental awareness, attaching printed papers as part of write-ups and program listing to journals must be avoided. DVD containing student programs maintained by the Laboratory in charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory.

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Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work should be based on the overall performance of Laboratory assignments by a student. Each Laboratory assignment assessment will assign grades/marks based on parameters, such as timely completion, performance, innovation, efficient codes, and punctuality.

Guidelines for Oral/ Practical Examination

Problem statements must be decided jointly by the internal examiner and external examiner. During the practical assessment, maximum weightage should be given to satisfactory implementation of the problem statement. Relevant questions may be asked at the time of evaluation to test the student's understanding of the fundamentals and effective and efficient implementation. This will encourage transparent evaluation and a fair approach, and hence will not create any uncertainty or doubt in the minds of the students. So, adhering to these principles will consummate our team efforts to the promising start of student's academics.

Guidelines for Laboratory Conduction

Guidelines for Laboratory Conduction

These guidelines ensure the safe, efficient, and productive execution of laboratory experiments and activities:

1. Preparation Before the Experiment

- Understand the Objective: Students must review the theory, principles, and expected outcomes of the experiment beforehand.
- Read the Procedure: Familiarize yourself with the steps and equipment involved in the experiment by referring to the lab manual or handouts.
- Check the Apparatus: Inspect the instruments and apparatus for proper functioning. Report any issues to the lab in-charge.
- Safety Measures:
- Ensure knowledge of safety protocols for handling equipment, chemicals, and power supplies.
- Be aware of emergency procedures, such as using fire extinguishers or first aid kits.

2. Conduct During the Experiment

- Follow the Procedure: Perform the experiment strictly according to the prescribed steps to ensure accuracy and safety.
- Handle Equipment with Care: Avoid rough handling of lab equipment or devices. Use tools as intended.
- Collaborate Effectively: Work in assigned groups, ensuring that tasks are divided equally among team members.
- Record Observations Systematically: Note down all readings and observations in a neat, organized, and systematic manner in a lab notebook.
- Ask for Guidance: Seek help from the instructor or lab technician in case of doubt or if facing operational difficulties.

3. Post-Experiment Practices

- Analyze and Interpret Results:
- Perform calculations and analyses based on observations.
- Compare results with theoretical expectations and discuss any deviations.
- Document the Experiment:
- Prepare a detailed lab report that includes the objective, procedure, observations, calculations, and conclusions.
- Feedback: Provide constructive feedback to the lab in-charge if equipment or procedures can be improved.

4. Safety and Discipline

- No Unauthorized Access: Do not operate equipment or begin experiments without instructor approval.
- Avoid Distractions: Maintain focus; avoid the use of mobile phones or engaging in unrelated activities.
- Report Accidents Immediately: Notify the instructor of any accidents, spills, or equipment failures to ensure prompt resolution.
- Maintain Lab Decorum: Work quietly and respectfully without disturbing others.

5. Attendance and Punctuality

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- Attend all scheduled lab sessions promptly and sign the attendance sheet as instructed.
- Students arriving late or without prior preparation may not be allowed to perform the experiment.

Suggested List of Laboratory Experiments/Assignments

Group A: Assignments (Mandatory Assignment)

Sr No	Assignment Title	*Mapping of Course Outcomes
1.	To calculate Overall Equipment Effectiveness (OEE)	CO1
2.	To simulate implementation of TPM pillars in a manufacturing system.	CO1
3.	To develop Current State and Future State VSM for a given process.	CO2
4.	Development of a PQCDSME Performance Dashboard and Review of Key Performance Indicators (KPIs)	CO3
5.	Study of Sensors Used in Lean and Automation Systems	CO4
6	Study of Actuators and Their Role in Lean Automation	CO4

Group B: Assignments (Out of List perform any 2)

Sr No	Assignment Title	*Mapping of Course Outcomes
6	To apply DMAIC methodology to a quality or productivity problem.	CO2
7	Lean Layout Improvement and SMED Analysis	CO2
8	Automation Support for Lean Systems: Sensors and Actuators Mapping	CO4

Group C: Industrial Visit

Sr No	Industrial Visit	*Mapping of Course Outcomes
9	**Industrial Visit to Study Lean Practices and Automation Systems** *(TPM, OEE, Lean Supply Chain, Visual Management, Sensors & Actuators)*	CO1, CO3, CO4

Learning Resources

Text Books

T1. Carreira, Bill. Lean Manufacturing That Works: Powerful Tools for Dramatically Reducing Waste and Maximizing Profits. 1st ed., Prentice-Hall of India Private Limited, 2007.

T2. Askin, Ronald G. Design and Analysis of Lean Production Systems. 1st ed., John Wiley and Sons, 2007.

T3. Michael L. George, Lean Six Sigma: Combining Six Sigma Quality with Lean Speed, McGraw-Hill, 2002.

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Reference Books :

R1. Suzaki, Kiyoshi. The New Manufacturing Challenge: Techniques for Continuous Improvement. Reprint ed., Free Press, 2012.

R2. Shingo, Shigeo. A Study of the Toyota Production System from an Industrial Engineering Viewpoint. Reprint ed., Routledge, 2019.

Additional Resources:

- Arena Simulation / FlexSim / Plant Simulation
- Minitab (for Lean Six Sigma analysis)
- Spreadsheet (for PQCDSME dashboards)

MOOC Courses links :

- Foundations of Lean Manufacturing, https://onlinecourses.swayam2.ac.in/imb24_mg119/preview
- Six Sigma, https://onlinecourses.nptel.ac.in/noc25_mg83/preview
- Lean Thinking Case Studies, https://www.coursera.org/learn/lean-management

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24-MDM-ET-3-03B: Smart Manufacturing Systems and Digital Transformation

Teaching Scheme: Theory: 02 Hours/Week	**Credit:** 02	**Examination Scheme:** **CIE** : 20 Marks **SEE** : 30 Marks

Prerequisites Courses: Industry 4.0 Concepts and Technologies (24-MDM-ET-2-02B)

Companion Course: -

Course Objectives:

- To understand Smart Systems concepts and Digital Transformation frameworks.
- To study enabling technologies such as IIoT, CPS, Cloud, and Digital Twins.
- To analyze data-driven decision-making and integration strategies.
- To explore sustainability practices and circular economy principles in digital infrastructures.

Course Outcomes:

After completion of the course, learners should be able to

CO No	CO	BL
CO1	**Recognize** the core concepts and frameworks related to smart systems and their application in modern industry.	2
CO2	**Recognize** enabling technologies such as IIoT, CPS, Cloud, and Digital Twins in smart manufacturing scenarios.	2
CO3	**Apply** smart technologies such as Big Data, IIoT, and predictive systems to improve efficiency and performance in smart networks.	3
CO4	**Integrate** sustainability practices and digital transformation strategies in system optimization for smart systems.	3

Course Contents

Unit I	**Fundamentals of Smart Manufacturing**	**07 Hours**

Definition, scope and evolution of Smart Manufacturing, Smart Factory vs. Conventional Factory, Digital Transformation roadmap and maturity models, **Drivers of Smart Manufacturing** – Connectivity, Automation, Data-driven Decisions, **Benefits** – Flexibility, Mass Customization, Reduced Downtime, Energy Efficiency, **Challenges** – Investment cost, Workforce skills gap, Standardization issues

#Exemplar/Case Studies: Adoption of smart systems in modern digital infrastructure.

***Mapping of Course Outcomes**	**CO1**

Unit II	**Enabling Technologies for Smart Manufacturing**	**07 Hours**

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Industrial Internet of Things (IIoT), Cyber-Physical Systems (CPS), Cloud and Edge Computing, Digital Twins, Artificial Intelligence and Machine Learning, Human–Machine Collaboration (Overview/concept only)		
#Exemplar/Case Studies: Adoption of IIoT and CPS in optimizing smart infrastructure.		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Data-Driven System Optimization**	**07 Hours**
Computerized Maintenance Management System (CMMS), Big Data Analytics, Real-time monitoring, Predictive Maintenance, Prescriptive Maintenance, Smart Quality Control, Digital Supply Chains (Overview/concept only)		
#Exemplar/Case Studies: Real-time monitoring and predictive maintenance in systems.		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Sustainability and Future Trends**	**07 Hours**
Sustainable Smart Systems– energy efficiency, waste reduction, closed-loop systems, **Circular Economy principles** – product life cycle, remanufacturing, recycling, **Blockchain for supply chain transparency and trust, Industry 5.0** – human-centric, resilient, sustainable production systems, **Smart Workforce** – skill development, human–robot collaboration, digital workplace, **Adoption challenges in Indian context** – infrastructure, SMEs, government policy support		
#Exemplar/Case Studies: Sustainability and energy efficiency in digital systems.		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1. Gilchrist, A. *Industry 4.0: The industrial internet of things*. Apress, 2016. **T2.** Ajay, & Singh, H., et al. *Handbook of smart manufacturing: Forecasting the future of Industry 4.0*. CRC, Press, 2024.		
Reference Books :		
R1. Schwab, K. *The fourth industrial revolution*. World Economic Forum, 2017 **R2.** Dhanaraj, R. K., Bashir, A. K., et al. *Digital twin for smart manufacturing: Emerging approaches and applications*. Elsevier, 2023.		
MOOC Courses links : ● NPTEL: *Introduction to Industry 4.0 and Industrial Internet of Things:* https://onlinecourses.nptel.ac.in/noc25_cs146/preview ● Coursera: *Digital Technology in Manufacturing Specialization:* https://www.coursera.org/specializations/digital-technology-in-manufacturing		

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SNJB's Late Sau. K. B. Jain College of Engineering, Chandwad

(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

Curriculum and Evaluation Scheme

To be implemented for 2024-28 Batch

(With Effect from Academic Year 2026-27)

MDM Syllabus for SEM V and SEM VI Offered by Mechanical Engineering for Other Branch Students

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24-MDM-ME-3-01: HVAC and Green Building

Teaching Scheme: Theory: 2 Hours/Week	**Credit:** 2	**Examination Scheme:** **CIE** : 20 Marks **SEE** : 30 Marks

Prerequisites Courses:

Companion Course: HVAC and Building Energy Systems Lab:(24-MDM-ME-3-02)

Course Objectives:

- To understand the basics of psychrometry, thermal comfort, and heat-load estimation.
- To understand the concepts of ventilation, infiltration, and simple duct design.
- To know different types of air-conditioning systems used in buildings.
- To understand energy audits, and simple energy-saving methods.

Course Outcomes:

After completion of the course, learners should be able

CO No	CO	BL
CO1	**Apply** psychrometric properties, comfort conditions and the basics of load estimation.	3
CO2	**Apply** ventilation & infiltration Principles to design simple duct and air-distribution layouts..	3
CO3	**Identify** different air-conditioning systems used in buildings.	2
CO4	**Apply** basic energy audit tools and energy-saving opportunities.	3

Course Contents

Unit I	Psychrometry	8 Hours

Introduction to Heating, Ventilation & Air conditioning (HVAC) : Introduction to Air Conditioners & its components, Refrigerant.
Psychrometry: Psychrometry and Psychrometric Properties, Basic Terminologies, Psychrometric Chart, Psychrometric Processes, and adiabatic mixing of two air streams.
Heat load estimation: heating & cooling load calculations.
Thermal Comfort: Thermal comfort and Comfort charts, Factors affecting thermal comfort. Indoor air quality requirements.

#Exemplar/Case Studies: Evaluate thermal comfort and indoor air quality of a room.

*Mapping of Course Outcomes	CO1

Unit II	Ventilation, Infiltration & Air Distribution systems (Ducts)	8 Hours

Ventilation and infiltration: Concept of Ventilation and infiltration,Natural ventilation, Mechanical ventilation.
Duct Design: Definition of duct and types of ducts, Economic factors influencing duct layout, Materials for ducts, Flow through duct,

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Pressure in ducts, Friction loss in ducts, Friction chart for circular ducts, Equivalent diameter of a circular duct for rectangular sections. (Numerical treatment on duct design). **Air Distribution System:** Factors considered in the air distribution system, Types of air distribution devices, Fan laws, Types of fans used in air conditioning applications, Types of supply air outlets.		
#Exemplar/Case Studies: Duct Design & Air Distribution for the room.		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Air Conditioning Systems**	**6 Hours**
Air Conditioning Systems: Introduction to Air Conditioning in Buildings, Types of Air Conditioning Systems, Working of summer, winter, and all-year-round AC systems and central air conditioning. Heat Load & Building Design Factors, Energy Efficiency in Air Conditioning.		
#Exemplar/Case Studies: Heat load calculations for seminar/conference halls.		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Green Building**	**8 Hours**
Concept of Green Energy, Components of Green Buildings, Energy-Efficient Materials & Construction, Green Building Rating Systems, Concept of Building Energy Audits & Performance Assessment: Types of audits (Walk-through, detailed audit).		
#Exemplar/Case Studies: Energy-efficient building		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill **T2**. Manohar Prasad, Refrigeration and Air Conditioning, Willey Eastern Ltd, 1983		
Reference Books :		
R1. Dossat Ray J, Principles of refrigeration, S.I. version, Willey Eastern Ltd, 2000 **R2.** Stockers W.F and Jones J.W., Refrigeration and Air conditioning, McGraw Hill International editions 1982 **R3.** Energy Conservation and Sustainable Building Code 2024.		

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24-MDM-ME-3-02: HVAC and Green Building Lab

Teaching Scheme: **Practical:** 2Hours/Week	**Credit:** 1	**Examination Scheme:** **Termwork (TW)**: 25Marks **Oral (OR)**: 25Marks

Prerequisites Courses:

Companion Course:24-MDM-ME-3-01: HVAC and Building Energy Systems

Course Objectives:

- To gain practical insight into the operation of vapour compression, heat pump, and air-conditioning systems.
- To explore the construction and purpose of essential HVAC elements used in cooling applications
- To develop skills to calculate cooling and heat loads for basic indoor spaces.
- To expose students to real-world HVAC facilities and simple energy performance assessment techniques.

Course Outcomes:

After completion of the course, learners should be able to

CO No	CO	BL
CO1	**Apply** AQI monitoring techniques and psychrometric analysis to evaluate indoor air quality and thermal comfort in a classroom as per ASHRAE standards.	3
CO2	**Understand** the concept of BEE star rating and its importance in split air conditioners.	2
CO3	**Compute** the cooling and heat load of a room or classroom using basic engineering methods.	3
CO4	**Perform** calculations of cooling capacity and COP using the observed trial data on air conditioning setup.	3
CO5	**Prepare** a report on a visit to an Air Conditioning Plant / Cold Storage and explaining its major operational features.	3

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a reference and hands-on resource. It should include a prologue (about University/program/ institute/ department/foreword/ preface), curriculum of the course, conduction and Assessment guidelines, topics under consideration, concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.

Guidelines for Student's Laboratory Journal

The laboratory assignments are to be submitted by students as a journal. The journal consists of a Certificate, table of contents, and handwritten write-up of each assignment (Title, Date of Completion, Objectives, Problem Statement, Software and Hardware requirements, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, test cases, Test Data Set(if applicable), mathematical model (if applicable), conclusion/analysis. Program codes with sample output of all performed assignments will be submitted as Hard copy.

Guidelines for Laboratory /Term Work Assessment

Continuous assessment of laboratory work should be based on the overall performance of Laboratory assignments by a student. Each Laboratory assignment assessment will assign grades/marks based on parameters, such as timely completion, performance,

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innovation, efficient codes, and punctuality.

Guidelines for Laboratory Conduction

These guidelines ensure the safe, efficient, and productive execution of laboratory experiments and activities:

1. Preparation before the Experiment

- **Understand the Objective:** Students must review the theory, principles, and expected outcomes of the experiment beforehand.
- **Read the Procedure:** Familiarise yourself with the steps and equipment involved in the experiment by referring to the lab manual or handouts.
- **Check the Apparatus:** Inspect the instruments and apparatus for proper functioning. Report any issues to the lab in-charge.
- **Safety Measures:**
  - Ensure knowledge of safety protocols for handling equipment, chemicals, and power supplies.
  - Be aware of emergency procedures, such as using fire extinguishers or first aid kits.

2. Conduct during the Experiment

- **Follow the Procedure:** Perform the experiment strictly according to the prescribed steps to ensure accuracy and safety.
- **Handle Equipment with Care:** Avoid rough handling of lab equipment or devices. Use tools as intended.
- **Collaborate Effectively:** Work in assigned groups, ensuring that tasks are divided equally among team members.
- **Record Observations Systematically:** Note down all readings and observations in a neat, organized, and systematic manner in a lab notebook.
- **Ask for Guidance:** Seek help from the instructor or lab technician in case of doubt or if facing operational difficulties.

3. Post-Experiment Practices

- **Analyze and Interpret Results:**
  - Perform calculations and analyses based on observations.
  - Compare results with theoretical expectations and discuss any deviations.
- **Document the Experiment:**
  - Prepare a detailed lab report that includes the objective, procedure, observations, calculations, and conclusions.
- **Feedback:** Provide constructive feedback to the lab in-charge if equipment or procedures can be improved.

4. Safety and Discipline

- **No Unauthorized Access:** Do not operate equipment or begin experiments without instructor approval.
- **Avoid Distractions:** Maintain focus; avoid the use of mobile phones or engaging in unrelated activities.
- **Report Accidents Immediately:** Notify the instructor of any accidents, spills, or equipment failures to ensure prompt resolution.
- **Maintain Lab Decorum:** Work quietly and respectfully without disturbing others.

5. Attendance and Punctuality

- Attend all scheduled lab sessions promptly and sign the attendance sheet as instructed.
- Students arriving late or without prior preparation may not be allowed to perform the experiment.

Suggested List of Laboratory Experiments/Assignments

Group A: Mandatory Assignments

Sr. No.	Assignment Title	*Mapping of Course Outcomes
1.	Measurement and Evaluation of Indoor Air Quality (IAQ) in a room Using an AQI Monitor.	**CO1**

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2.	Measurement of Thermal Comfort in a room by using Use psychrometric chart & comparing with ASHRAE comfort standards	**CO1**
3	Study of BEE star rating of split air conditioner system	**CO2**
4	Heat Load Estimation of a room	**CO3**
5	Trial on Air Conditioning test rig.	**CO4**
Group B: Mandatory Assignments		
Sr. No.	**Assignment Title**	***Mapping of Course Outcomes**
1	Mini Energy Audit of a Room (Use lux meter, IR thermometer) to check lighting, temperature, and appliances.	**CO5**
2	Write a report with your suggestions to lower the temperature of a room.	**CO3**
Group C: Visit		
Sr No	**Assignment Title**	***Mapping of Course Outcomes**
1.	Visit to the Air Conditioning Plant / Cold Storage.	**CO5**

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24-MDM-ME-3-03: Project Planning & Management

Teaching Scheme: **Theory:** 2 Hours/Week	**Credit :** 2	**Examination Scheme:** **CIE** : 20 Marks **SEE** : 30 Marks

Prerequisites Courses: -

Companion Course: -

Course Objectives:

- To understand project management principles, life cycle approaches, and portfolio governance for aligning projects.
- To develop the ability to plan, construct, and analyze project networks for effective scheduling and time management under uncertainty.
- To develop the knowledge and skills to manage project risks and optimize resource scheduling for successful project delivery.
- To develop the ability to monitor and control project performance using earned value management and forecasting techniques.

Course Outcomes:

After completion of the course, learners should be able to

CO No	CO	BL
CO1	**Understand** the project management concepts, life cycle models, and portfolio selection techniques.	2
CO2	**Compute** project networks using Activity–on–Node (AON), Activity–on–Arrow (AOA) methods.	3
CO3	**Demonstrate** project risks and apply resource scheduling techniques including time-phased budgeting and critical chain project management.	3
CO4	**Apply** earned value analysis, performance indexes, and forecasting methods to monitor and control project cost and schedule effectively.	3

Course Contents

Unit I	**Project management and strategy**	**7 Hours**

Importance to project management, Characteristics of project, Project life cycle, Classification of projects, Traditional and agile project management, Current drivers of project management, Linkages between strategy and projects, Project portfolio management system, Project governance, Design of project portfolio system – financial criteria of project selection, Creating the Work Breakdown Structure(WBS), Integrating the WBS with the organization, Coding the WBS for the information System.

#Exemplar/Case Studies - Development of solar power plant project in an industrial estate.

***Mapping of Course Outcomes**	**CO1**

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Unit II	**Estimating project time and cost**	**7 Hours**
Developing project network, Constructing a project network, Activity–on–Node (AON), Activity–on–Arrow (AOA), Network computation process by CPM (Critical path method) and PERT (Project evaluation and review technique) method, Forward pass and Backward pass computation, Level of details for activities, Extended network techniques, Concepts of lags, Laddering, Hammock activities, Uncertainty in activities- three time estimates, Probability of completion of Project on time.		
#Exemplar/Case Studies - Installation & commissioning of CNC machining industry in an automotive component manufacturer.		
***Mapping of Course Outcomes**	**CO2**	
Unit III	**Project risk management**	**7 Hours**
Risk management process, Risk identification, Risk assessment, Risk response development, Contingency planning, Contingency funding and time buffers, Risk response control, Change control management, Risk assessment of capital projects, Overview of resource scheduling, Types of resource constraints, Classification of scheduling problem, Resource allocation method – Time constraint project, Resource constraints project, Splitting activities, Creating a time phased budget, Critical-chain project management.		
#Exemplar/Case Studies -Development and deployment of automated material handling system (Robotic conveyor system) in a warehouse.		
***Mapping of Course Outcomes**	**CO3**	
Unit IV	**Project performance measurement**	**7 Hours**
Project monitoring information system, Project control process, Development of an earned value cost/schedule system, Index to monitor project process–performance indexes, Project percent complete indexes, Technical performance measurement, Additional earned value rules, Forecasting final project time and cost, Resource updation, Introduction to project management software.		
#Exemplar/Case Studies - Construction and commissioning of a new academic building block in a campus.		
***Mapping of Course Outcomes**	**CO4**	
Learning Resources		
Text Books		
T1. K. K. Chitkara, Project management- Planning, Scheduling and control, Tata Mcgraw Hill, Edition -1. **T2.** B. C. Punmia and K. K. Khandelwal, Project Planning and Control with PERT and CPM, Laxmi Publications, Edition 4.		
Reference Books :		
R1. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling, and Controlling, New Delhi CBS publishers & distributors, Edition -1. **R2.** Jack R. Meredith, Project Management: A Managerial Approach, Scham's outline series, Edition 5.		
Additional Resources: (Books, e-Resources) ● https://www.google.co.in/books/edition/Project_Management/B1u9e0Dgx80C?hl=en&gbpv=1&dq=E+book+on+Project++management+-+A+system+approach+to+planning,+scheduling+and+control&printsec=frontcover		

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MOOC Courses links :

- https://www.nptelprep.in/courses/110105167/materials

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